UNITED STATES DEPARTMENT OF AGRICULTURE

Complementary Feeding and Growth, Body Composition, and Risk of Obesity: A Systematic Review

Jennifer Orlet Fisher, PhD,[a, b] Steven A. Abrams, MD,[a, c] Aline Andres, PhD, RD,[a, d] Carol Byrd-Bredbenner, PhD, RD, FAND,[a, e] Andrea L. Deierlein, PhD, MPH, MS,[a, f] Heather A. Eicher-Miller, PhD,[a, g] Angela Odoms-Young, PhD, MS,[a, h] Cristina Palacios, PhD, MSc,[a, i] Charlotte Bahnfleth, PhD,[j] Julia H. Kim, PhD, MPH, RD,[j] Molly Higgins, MLIS,[k] Julie Nevins, PhD,[j] Gisela Butera, MEd, MLIS,[l] Nancy Terry, MS, MLIS,[l] Julie Obbagy, PhD[m]

[a] Diet in Pregnancy and Birth through Adolescence Subcommittee, 2025 Dietary Guidelines Advisory Committee

[b] Temple University, Subcommittee Chair

[c] University of Texas at Austin

[d] University of Arkansas for Medical Sciences

[e] Rutgers, The State University of New Jersey

[f] New York University

[g] Purdue University

[h] Cornell University, Committee Vice Chair

[i] Florida International University

[j] Systematic Review Analyst, Nutrition Evidence Systematic Review (NESR) Branch; Nutrition Guidance and Analysis Division (NGAD), Center for Nutrition Policy and Promotion (CNPP), Food and Nutrition Service (FNS), U.S. Department of Agriculture (USDA)

[k] Systematic Review Librarian, NESR Branch; NGAD, CNPP, FNS, USDA

[l] Biomedical Librarian/Informationist, National Institutes of Health Library

[m] Branch Chief, NESR Branch; NGAD, CNPP, FNS, USDA

Suggested citation: Fisher JO, Abrams SA, Andres A, Byrd-Bredbenner C, Deierlein AL, Eicher-Miller HA, Odoms-Young A, Palacios C, Bahnfleth C, Kim JH, Higgins M, Nevins J, Butera G, Terry N, Obbagy J. Complementary Feeding and Growth, Body Composition, and Risk of Obesity: A Systematic Review. November 2024. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://doi.org/10.52570/NESR.DGAC2025.SR18

Related citations:

2025 Dietary Guidelines Advisory Committee. 2024. Scientific Report of the 2025 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Health and Human Services and Secretary of Agriculture. U.S. Department of Health and Human Services. https://doi.org/10.52570/DGAC2025.

English LK, Obbagy JE, Wong YP, Psota TL, Nadaud P, Johns K, Terry N, Butte NF, Dewey KG, Fleischer DM, Fox MK, Greer FR, Krebs NF, Scanlon KS, Casavale KO, Spahn JM, Stoody E. Timing of Introduction of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. April 2019. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://doi.org/10.52570/NESR.PB242018.SR0305.

English LK, Obbagy JE, Wong YP, Psota TL, Nadaud P, Johns K, Terry N, Butte NF, Dewey KG, Fleischer DM, Fox MK, Greer FR, Krebs NF, Scanlon KS, Casavale KO, Spahn JM, Stoody E. Types and Amounts of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. April 2019. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://doi.org/10.52570/NESR.PB242018.SR0306.

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Plain language summary

What is the question?
The question is: What is the relationship between complementary feeding and growth, body composition, and risk of obesity? The populations of interest for this question include infants and young children at intervention or exposure and infants, young children, children, adolescents, adults, and older adults at outcome.

Why was this question asked?
This systematic review was conducted by the 2025 Dietary Guidelines Advisory Committee as part of the process to develop the *Dietary Guidelines for Americans, 2025-2030*.

How was this question answered?
The Committee conducted a systematic review to answer this question with support from the USDA Nutrition Evidence Systematic Review team. This review updated existing reviews that were conducted as part of the Pregnancy and Birth to 24 Months Project.

What is the answer to the question?

<u>Timing of introduction of specific types of complementary foods and beverages</u>

- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to 100% juice and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available.
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to fruit and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available.
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to vegetables and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available.
- Introducing grains at or before age 4 months is associated with higher BMI z-score during childhood. This conclusion statement is based on evidence graded as limited.
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to grains and body composition and risk of obesity during childhood because there is not enough evidence available.
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to foods from the protein foods group and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency in the body of evidence.
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to the dairy food group and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available, and the evidence that is available has substantial concerns with consistency.
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to sugar-sweetened beverages and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency in the body of evidence.
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to food sources of added sugars and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available.

<u>Types and amounts of complementary foods and beverages</u>

- A conclusion statement cannot be drawn about the relationship between 100% juice consumption by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency and precision in the body of evidence.
- Fruit consumption by infants and young children, up to age 24 months, is not associated with unfavorable outcomes related to growth patterns during childhood. This conclusion statement is based on evidence graded as limited.

- A conclusion statement cannot be drawn about the relationship between fruit consumption by infants and young children, up to age 24 months, and body composition and risk of obesity during childhood because there is not enough evidence available.
- Vegetable consumption by infants and young children, up to age 24 months, is not associated with unfavorable outcomes related to growth patterns during childhood. This conclusion statement is based on evidence graded as limited.
- A conclusion statement cannot be drawn about the relationship between vegetable consumption by infants and young children, up to age 24 months, and body composition and risk of obesity during childhood because there is not enough evidence available.
- Grains consumption by infants and young children, from age 6 months up to age 24 months, is not associated with unfavorable outcomes related to growth patterns and risk of obesity during childhood. This conclusion statement is based on evidence graded as limited.
- A conclusion statement cannot be drawn about the relationship between grains consumption by infants and young children, from age 6 months up to age 24 months, and outcomes related to body composition during childhood because there is not enough evidence available.
- A conclusion statement cannot be drawn about the relationship between consumption of protein foods as a food group by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency and directness in the body of evidence.
- A conclusion statement cannot be drawn about the relationship between dairy consumption by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency in the body of evidence.
- Sugar-sweetened beverage consumption by infants, children, and adolescents is associated with unfavorable growth patterns and body composition, and higher risk of obesity in childhood up to early adulthood. This conclusion statement is based on evidence graded as moderate.
- A conclusion statement cannot be drawn about the relationship between consumption of food sources of added sugars by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available.

How up-to-date is this systematic review?
Conclusion statements from this review are based on articles published between January 1980 and May 2023.

Abstract

Background

This systematic review was conducted by the 2025 Dietary Guidelines Advisory Committee as part of the process to develop the *Dietary Guidelines for Americans, 2025-2030*. The U.S. Departments of Health and Human Services (HHS) and Agriculture (USDA) appointed the 2025 Dietary Guidelines Advisory Committee (Committee) in January 2023 to review evidence on high priority scientific questions related to diet and health. Their review forms the basis of their independent, science-based advice and recommendations to HHS and USDA, which is considered as the Departments develop the next edition of the *Dietary Guidelines*. As part of that process, the Committee conducted a systematic review with support from the USDA Nutrition Evidence Systematic Review (NESR) team to answer the following question: What is the relationship between complementary feeding and growth, body composition, and risk of obesity? This review is an update to existing reviews that were conducted by the Complementary Feeding Technical Expert Collaborative of the Pregnancy and Birth to 24 Months Project.

Methods

The Committee conducted a systematic review using the methodology of the USDA NESR team. The Committee first developed a protocol. The interventions/exposures were first introduction of a specific type of complementary food or beverage (fruit, including 100% fruit juice, vegetables, grains, protein foods, dairy and fortified soy alternatives, and food/beverage sources of added sugars) and types and amounts of complementary foods and beverages (fruit, including 100% fruit juice, vegetables, grains, protein foods, dairy and fortified soy alternatives, and food/beverage sources of added sugars) in infants and young children (birth up to 24 months); the comparators were different timing of the first introduction of a specific type of complementary food or beverage and different amount of the same complementary food or beverage or different type of complementary food or beverage; and the outcomes were measures of growth in infants, young children, children, adolescents, body composition in infants, young children, children, adolescents, adults, older adults, and risk of obesity in children, adolescents, adults, older adults. Additional inclusion criteria were established for the following study characteristics: a) use randomized or non-randomized controlled trial, prospective or retrospective cohort, or nested case-control study designs, b) be published in English in peer-reviewed journals, c) be from countries classified as high or very high on the Human Development Index, and d) enroll participants with a range of health statuses. The review excluded randomized or non-randomized controlled trials that were not designed to examine growth, body composition, and/or risk of obesity as a primary outcome.

NESR librarians conducted a literature search in PubMed, Embase, CINAHL, and Cochrane to identify articles published between July 2016 and May 2023. Two NESR analysts independently screened all electronic results and the reference lists of included articles based on the pre-determined criteria. The results of this search were combined with included articles from the existing review.

NESR analysts extracted data, from each included article, with a second analyst verifying accuracy of the extraction. Two NESR analysts independently conducted a formal risk of bias assessment, by study design, for each included article, then reconciled any differences in the assessment. The Committee qualitatively synthesized the evidence, from all included articles identified in the updated literature search and from the existing review, according to the synthesis plan, with attention given to the overarching themes or key concepts from the findings, similarities and differences between studies, and factors that may have affected the results. The Committee developed conclusion statements and graded the strength of evidence based on its consistency, precision, risk of bias, directness and generalizability.

Results

Timing of the first introduction: 100% juice

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to 100% juice and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)

Summary of the evidence:
- One article examined timing of the first introduction of 100% juice and growth, body composition, and risk of obesity. This study was a prospective cohort study.
- There was not enough evidence available to draw a conclusion statement.

Timing of the first introduction: fruit

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to fruit and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)

Summary of the evidence:

- Three articles examined timing of the first introduction of fruit and growth, body composition, and risk of obesity. All 3 were prospective cohort studies.
- There was not enough evidence available to draw a conclusion statement.

Timing of the first introduction: vegetables

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to vegetables and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)

Summary of the evidence:

- Three articles examined timing of the first introduction of vegetables and growth, body composition, and risk of obesity. All 3 were prospective cohort studies.
- There was not enough evidence available to draw a conclusion statement.

Timing of the first introduction: grains

Conclusion statement and grade: Introducing grains at or before age 4 months is associated with higher BMI z-score during childhood. This conclusion statement is based on evidence graded as limited. (Grade: Limited)

Summary of the evidence:

- Six articles examined timing of the first introduction of grains and growth. All 6 were prospective cohort studies.
- There was some inconsistency in the statistical significance of results, however, the direction of the associations were primarily consistent.
- Effect estimates were small. Few studies met inclusion criteria.
- Few studies were designed and conducted well.
- The populations, exposures, comparators, and outcomes that were examined directly represented those of interest in this review.
- The evidence may not apply to the U.S. population.

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to grains and body composition and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)

Summary of the evidence:

- Three articles examined timing of the first introduction of grains and body composition and risk of obesity. All 3 were prospective cohort studies.
- There was not enough evidence available to draw a conclusion statement.

Timing of the first introduction: protein foods

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to foods from the protein foods group and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency in the body of evidence. (Grade: Grade Not Assignable)

Summary of the evidence:

- Four articles examined timing of the first introduction of foods from the protein foods group and growth, body composition, and risk of obesity. All 4 were prospective cohort studies.
- A conclusion statement was not drawn because the exposures were too different across studies.

Timing of the first introduction: dairy and fortified soy alternatives

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to the dairy food group and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available, and the evidence that is available has substantial concerns with consistency. (Grade: Grade Not Assignable)

Summary of the evidence:

- Thirteen articles examined timing of the first introduction of dairy and growth, body composition, and risk of obesity. All 13 were prospective cohort studies.
- A conclusion statement was not drawn because the exposures and comparators were too different across studies.

Timing of the first introduction: sugar-sweetened beverages

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to sugar-sweetened beverages and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency in the body of evidence. (Grade: Grade Not Assignable)

Summary of the evidence:
- Nine articles examined timing of the first introduction of sugar-sweetened beverages and growth, body composition, and risk of obesity. All 9 were prospective cohort studies.
- A conclusion statement was not drawn because the exposures, comparators, and age at outcome assessment were too different across studies.

Timing of the first introduction: food sources of added sugars

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to food sources of added sugars and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)

Summary of the evidence:
- One article examined timing of the first introduction of food sources of added sugars and growth, body composition, and risk of obesity. This study was a prospective cohort study.
- There was not enough evidence available to draw a conclusion statement.

Types and amounts: 100% juice

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between 100% juice consumption by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency and precision in the body of evidence. (Grade: Grade Not Assignable)

Summary of the evidence:
- Four articles examined 100% juice consumption and growth, body composition, and risk of obesity. All 4 were prospective cohort studies.
- A conclusion statement was not drawn because few studies met inclusion criteria and the results and outcomes were too different across studies.

Types and amounts: fruit

Conclusion statement and grade: Fruit consumption by infants and young children, up to age 24 months, is not associated with unfavorable outcomes related to growth patterns during childhood. This conclusion statement is based on evidence graded as limited. (Grade: Limited)

Summary of the evidence:
- Five articles examined fruit consumption and growth. All 5 were prospective cohort studies.
- Results were similar across studies, reporting primarily null associations.
- Variation around the effect estimates were wide across studies. Few studies met inclusion criteria.
- Few studies were designed and conducted well.
- The populations, exposures, comparators, and outcomes that were examined directly represented those of interest in this review.
- The evidence may not apply to the U.S. population.

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between fruit consumption by infants and young children, up to age 24 months, and body composition and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)

Summary of the evidence:
- Three articles examined fruit consumption and body composition and risk of obesity. All 3 were prospective cohort studies.

- There was not enough evidence available to draw a conclusion statement.

Types and amounts: vegetables

Conclusion statement and grade: Vegetable consumption by infants and young children, up to age 24 months, is not associated with unfavorable outcomes related to growth patterns during childhood. This conclusion statement is based on evidence graded as limited. (Grade: Limited)

Summary of the evidence:
- Five articles examined vegetable consumption and growth. All 5 were prospective cohort studies.
- Results were similar across studies, reporting primarily null associations.
- Few studies met inclusion criteria.
- Many studies had a risk of bias due to confounding, missing data, and selection of the reported result.
- The populations, exposures, comparators, and outcomes that were examined directly represented those of interest in this review.
- The evidence may not apply to the U.S. population.

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between vegetable consumption by infants and young children, up to age 24 months, and body composition and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)

Summary of the evidence:
- Three articles examined vegetable consumption and body composition and risk of obesity. All 3 were prospective cohort studies.
- There was not enough evidence available to draw a conclusion statement.

Types and amounts: grains

Conclusion statement and grade: Grains consumption by infants and young children, from age 6 months up to age 24 months, is not associated with unfavorable outcomes related to growth patterns and risk of obesity during childhood. This conclusion statement is based on evidence graded as limited. (Grade: Limited)

Summary of the evidence:
- Fourteen articles examined grains consumption and growth and risk of obesity. Three were randomized controlled trials and 11 were prospective cohort studies.
- Studies were somewhat inconsistent in the significance and direction of findings, with several studies reporting null findings.
- The size of study groups was too small in some studies. Few studies reported power.
- Few studies were designed and conducted well.
- The populations, interventions/exposures, comparators and outcomes that were examined primarily directly represented those of interest in this review, but a few of the interventions/exposures and comparators did not.
- The evidence may not apply to the U.S. population.

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between grains consumption by infants and young children, from age 6 months up to age 24 months, and outcomes related to body composition during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)

Summary of the evidence:
- One article examined grains consumption and body composition. This study was a prospective cohort study.
- There was not enough evidence available to draw a conclusion statement.

Types and amounts: protein foods

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between consumption of protein foods as a food group by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency and directness in the body of evidence. (Grade: Grade Not Assignable)

Summary of the evidence:
- Thirteen articles examined consumption of protein foods and growth, body composition, and risk of obesity. Three were randomized controlled trials, 2 were cluster-randomized controlled trials, and 8 were prospective cohort studies.
- A conclusion statement was not drawn because the interventions/exposures and comparators were too different across studies and the interventions/exposures that were examined did not directly represent those of interest in this review.

Types and amounts: dairy and fortified soy alternatives

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between dairy consumption by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency in the body of evidence. (Grade: Grade Not Assignable)

Summary of the evidence:
- Fourteen articles examined dairy consumption and growth, body composition, and risk of obesity. Four were randomized controlled trials, 2 were non-randomized controlled trials, and 8 were prospective cohort studies.
- A conclusion statement was not drawn because the ages at intervention/exposure, comparators, and outcomes were too different across studies.

Types and amounts: sugar-sweetened beverages

Conclusion statement and grade: Sugar-sweetened beverage consumption by infants, children, and adolescents is associated with unfavorable growth patterns and body composition, and higher risk of obesity in childhood up to early adulthood. This conclusion statement is based on evidence graded as moderate. (Grade: Moderate)

Summary of the evidence:
- Seventeen articles examined sugar-sweetened beverage consumption and growth, body composition, and risk of obesity. All 17 were prospective cohort studies.
- The articles were synthesized as part of the systematic review with meta-analysis on sugar-sweetened beverages and growth, body composition, and risk of obesity across the lifespan to avoid duplication of effort.[*]

Types and amounts: food sources of added sugars

Conclusion statement and grade: A conclusion statement cannot be drawn about the relationship between consumption of food sources of added sugars by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)

Summary of the evidence:
- Five articles examined consumption of food sources of added sugars and growth, body composition, and risk of obesity. All 5 were prospective cohort studies.
- There was not enough evidence available to draw a conclusion statement.

[*] Raynor HA, Deierlein AL, Byrd-Bredbenner C, et al. Sugar-Sweetened Beverages and Growth, Body Composition, and Risk of Obesity: A Systematic Review with Meta-Analysis. November 2024. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://doi.org/10.52570/NESR.DGAC2025.SR23

Introduction

To prepare for the development of the *Dietary Guidelines for Americans, 2025-2030*, the U.S. Departments of Health and Human Services (HHS) (**Appendix 1**) and Agriculture (USDA) identified a proposed list of scientific questions based on relevance, importance, potential federal impact, and avoiding duplication, which were posted for public comment.* The Departments appointed the 2025 Dietary Guidelines Advisory Committee (Committee) in January 2023 to review evidence on the scientific questions. The Committee's review of the evidence forms the basis of the Scientific Report of the 2025 Dietary Guidelines Advisory Committee,† which includes independent, science-based advice and recommendations to HHS and USDA and is considered during the development of the next edition of the *Dietary Guidelines*.

The proposed scientific questions were refined and prioritized by the Committee for consideration in their review of the evidence. As part of that process, the following systematic review question was prioritized: What is the relationship between complementary feeding and growth, body composition, and risk of obesity? The Committee conducted a systematic review to address this question, with support from USDA's Nutrition Evidence Systematic Review (NESR) team. This review is an update to the systematic reviews conducted by the Pregnancy and Birth to 24 Months Project's Complementary Feeding Technical Expert Collaborative (**Table 1**), and the conclusion statements developed as part of that existing work can be found in **Appendix 2**.

Table 1. Review history

Date	Description	Citation
April 2019	Original systematic reviews conducted by the Pregnancy and Birth to 24 Months Project, Complementary Feeding Technical Expert Collaborative published	English LK, Obbagy JE, Wong YP, Psota TL, Nadaud P, Johns K, Terry N, Butte NF, Dewey KG, Fleischer DM, Fox MK, Greer FR, Krebs NF, Scanlon KS, Casavale KO, Spahn JM, Stoody E. Timing of Introduction of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. April 2019. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://doi.org/10.52570/NESR.PB242018.SR0305.
		English LK, Obbagy JE, Wong YP, Psota TL, Nadaud P, Johns K, Terry N, Butte NF, Dewey KG, Fleischer DM, Fox MK, Greer FR, Krebs NF, Scanlon KS, Casavale KO, Spahn JM, Stoody E. Types and Amounts of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. April 2019. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://doi.org/10.52570/NESR.PB242018.SR0306.
May 2023	Systematic review protocol for the 2025 Dietary Guidelines Advisory Committee published online	Fisher JO, Abrams SA, Andres A, Byrd-Bredbenner C, Deierlein AL, Eicher-Miller HA, Odoms-Young A, Palacios C, Obbagy J, Bahnfleth C, Kim JH, Nevins J, Higgins M, Butera G, Terry N. Complementary Feeding and Growth, Body Composition, and Risk of Obesity: A Systematic Review Protocol. May 2023. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://nesr.usda.gov/protocols

* Dietary Guidelines for Americans: Learn About the Process. 2022. Available at: https://www.dietaryguidelines.gov/work-under-way/learn-about-process

† 2025 Dietary Guidelines Advisory Committee. 2024. Scientific Report of the 2025 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Health and Human Services and Secretary of Agriculture. U.S. Department of Health and Human Services. https://doi.org/10.52570/DGAC2025

Date	Description	Citation
June 2024	Revisions to the systematic review protocol for the 2025 Dietary Guidelines Advisory Committee published online	Fisher JO, Abrams SA, Andres A, Byrd-Bredbenner C, Deierlein AL, Eicher-Miller HA, Odoms-Young A, Palacios C, Obbagy J, Bahnfleth C, Kim JH, Nevins J, Higgins M, Butera G, Terry N. Complementary Feeding and Growth, Body Composition, and Risk of Obesity: A Systematic Review Protocol. May 2023. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://nesr.usda.gov/protocols

Methods

The Committee used NESR's methodology to conduct this systematic review. NESR's methodology is described in detail in its methodology manual,[*] as well as in the Committee's Scientific Report.[†] This section presents an overview of the specific methods used to answer the systematic review question: What is the relationship between complementary feeding and growth, body composition, and risk of obesity?

This systematic review is an update to existing NESR systematic reviews completed as part of the Pregnancy and Birth to 24 Months Project by the Complementary Feeding Technical Expert Collaborative,[‡§] which included evidence published from January 1980 to July 2016. This update synthesized all of the eligible studies from January 1980 to May 2023 to develop and grade conclusion statements, according to the methods described below. This means that all of the eligible articles from the existing reviews and the newly published articles were resynthesized as one body of evidence.

In addition, this review is related to 2 systematic reviews with meta-analysis conducted by the Committee to answer the systematic review questions: "What is the relationship between 100% juice consumption and growth, body composition, and risk of obesity?"[**] and "What is the relationship between sugar-sweetened beverages consumption and growth, body composition, and risk of obesity?"[††] These systematic reviews with meta-analysis examined 100% juice and sugar-sweetened beverage (SSB) consumption, respectively, across the lifespan from infancy through adulthood. Relevant articles from the present systematic review on complementary feeding were included and synthesized in these 2 systematic reviews with meta-analysis and contributed to the review of evidence from infancy through adolescence.

[*] USDA Nutrition Evidence Systematic Review Branch. USDA Nutrition Evidence Systematic Review: Methodology Manual. February 2023. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://nesr.usda.gov/methodology-overview

[†] 2025 Dietary Guidelines Advisory Committee. 2024. Scientific Report of the 2025 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Health and Human Services and Secretary of Agriculture. U.S. Department of Health and Human Services. https://doi.org/10.52570/DGAC2025

[‡] English LK, Obbagy JE, Wong YP, et al. Timing of Introduction of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2019. https://doi.org/10.52570/NESR.PB242018.SR0305.

[§] English LK, Obbagy JE, Wong YP, et al. Types and Amounts of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2019. https://doi.org/10.52570/NESR.PB242018.SR0306.

[**] Deierlein AL, Raynor HA, Andres A, et al. 100% Juice and Growth, Body Composition, and Risk of Obesity: A Systematic Review with Meta-Analysis U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2024. https://doi.org/10.52570/NESR.DGAC2025.SR05

[††] Deierlein AL, Raynor HA, Byrd-Bredbenner C, et al. Sugar-Sweetened Beverages and Growth, Body Composition, and Risk of Obesity: A Systematic Review with Meta-Analysis. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2024. https://doi.org/10.52570/NESR.DGAC2025.SR23.

Develop a protocol

A systematic review protocol is the plan for how NESR's methodology will be used to conduct a specific systematic review and is established by the Committee, *a priori*, before any evidence is reviewed. The protocol is designed to capture the most appropriate and relevant body of evidence to answer the systematic review question. Development of the protocol involves discussion of the strengths and limitations of various methodological approaches relevant to the question, which then inform subsequent steps of the systematic review process. The protocol describes all of the methods that will be used throughout the systematic review process. Additionally, the protocol includes the following components, which are tailored to each systematic review question: the analytic framework, the inclusion and exclusion criteria, and the synthesis plan. The Committee used the analytic framework and the inclusion and exclusion criteria from the existing review and made adjustments to the protocol, as needed. Differences in the inclusion and exclusion criteria between existing and updated reviews are documented in **Appendix 3**.

The protocol was posted online (https://nesr.usda.gov/protocols) for the public to view and comment on. Revisions to the systematic review protocol were made during the review process. These amendments are documented in **Table 2**.

Table 2. Protocol revisions

Date	Protocol revision	Description
March 2024	Inclusion and exclusion criteria were added for study directness, specifying that randomized and non-randomized controlled trials not directly designed to measure the effects of complementary feeding on growth, body composition, and risk of obesity would be excluded.	This revision was made to enable focus on a stronger body of evidence that was more directly designed to answer the research question. This revision was made at the beginning of evidence synthesis.
April 2024	Exclusion criteria were added for interventions and exposures, specifying that studies that did not address 100% juice, fruit, vegetables, grains, protein foods, dairy and fortified soy alternatives, or food/beverage sources of added sugars would be excluded	This revision was made to enable focus on evidence more directly designed to answer the research question and in consideration of project workload and timelines. This revision was made at the beginning of evidence synthesis.
April 2024	The timing of the first introduction of any complementary food or beverage was removed as an intervention or exposure in this systematic review	This revision was made in consideration of project workload and timelines. This intervention/exposure has an existing conclusion statement that was graded as moderate, based on studies published from 1980 to 2016. Therefore, it was determined to be lower priority to update. This revision was made before evidence synthesis.

Develop an analytic framework

An analytic framework visually represents the overall scope of the systematic review question and depicts the contributing elements that were examined and evaluated. It presents the core elements of each systematic review question, including the **P**opulation (i.e., those who experience the intervention/exposure and/or outcome), **I**ntervention and/or exposure (i.e., the independent variable of interest), **C**omparator (i.e., the alternative being compared to the intervention or exposure), and **O**utcome(s). Definitions for key terms are also included because they provide the basis for how concepts are operationalized throughout the review. The Committee identified key confounders based on their knowledge of nutrition and health research and experience as subject matter experts. Key confounders are participant characteristics, such as demographics, health status, and diet and lifestyle behaviors, and/or other factors related to both the intervention/exposure and the outcome of interest that may impact the relationships of interest. Key confounders were considered during review and evaluation of the evidence, particularly during the risk of bias assessment of non-randomized and observational studies.

Figure 1 is the analytic framework for the systematic review. The interventions or exposures of interest are the timing of the first introduction of a specific type of complementary food or beverage (further subdivided by the following food and beverage groups: fruit, including 100% fruit juice, vegetables, grains, protein foods, dairy and fortified soy alternatives, and food/beverage sources of added sugars) and types and amounts of complementary foods and beverages (further subdivided by the following food and beverage groups: fruit, including 100% fruit juice, vegetables, grains, protein foods, dairy and fortified soy alternatives, and food/beverage sources of added sugars) in infants and young children (birth up to 24 months). The comparators are different timing of the first introduction of a specific type of complementary food or beverage and different amount of the same complementary food or beverage or different type of complementary food or beverage. The outcomes are: Growth (in infants, young children, children, adolescents) including: height, length/stature-for-age, weight, weight-for-age, stunting, failure to thrive, wasting, BMI-for-age, weight-for-length/stature, body circumferences (arm, neck, thigh), head circumference; Body composition (in infants, young children, children, adolescents, adults, older adults) including: skinfold thickness, fat mass, ectopic fat, fat-free mass or lean mass, waist circumference, waist-to-hip-ratio; Risk of obesity (in children, adolescents, adults, older adults) including: BMI, overweight and obesity, underweight, normal/healthy weight. The key confounders are socioeconomic position, sex, race and/or ethnicity, milk feeding practices (human milk, infant formula, or both), gestational age, and baseline anthropometry.

Figure 1. Analytic framework for the systematic review question: What is the relationship between complementary feeding and growth, body composition, and risk of obesity?

Population	*Intervention/exposure*	*Comparator*	*Outcomes*	*Key confounders*
Infants and young children (birth up to 24 months)	Timing of the first introduction of a *specific type* of complementary food or beverage (CFB): 1) Fruit, including 100% fruit juice 2) Vegetables 3) Grains 4) Protein foods 5) Dairy and fortified soy alternatives 6) Food/beverage sources of added sugars	Different timing of the first introduction of a *specific type* of CFB	Growth (in infants, young children, children, adolescents) • Height, length/stature-for-age • Weight, weight-for-age • Stunting, failure to thrive, wasting • BMI-for-age, weight-for-length/stature • Body circumferences (arm, neck, thigh) • Head circumference Body composition (in infants, young children, children, adolescents, adults, older adults) • Skinfold thickness • Fat mass, ectopic fat • Fat-free, lean mass • Waist circumference, waist-to-hip ratio Risk of obesity (in children, adolescents, adults, older adults) • BMI • Overweight and obesity • Underweight • Normal/healthy weight	• Socioeconomic position • Sex • Race and/or ethnicity • Milk feeding practices (human milk, infant formula, or both) • Gestational age • Baseline anthropometry
	Types and amounts of CFB: 1) Fruit, including 100% fruit juice 2) Vegetables 3) Grains 4) Protein foods 5) Dairy and fortified soy alternatives 6) Food/beverage sources of added sugars	Different amount of the same CFB Different type of CFB		

Synthesis organization:

I. ***Intervention/exposure:*** Timing of the first introduction of a specific type of complementary food or beverage: 1) Fruit, including 100% fruit juice; 2) Vegetables; 3) Grains; 4) Protein foods; 5) Dairy and fortified soy alternatives; 6) Food/beverage sources of added sugars

   a. ***Outcome:*** Growth; Body composition; Risk of obesity

II. ***Intervention/exposure:*** Types and amounts of complementary food or beverage: 1) Fruit, including 100% fruit juice; 2) Vegetables; 3) Grains; 4) Protein foods; 5) Dairy and fortified soy alternatives; 6) Food/beverage sources of added sugars

   a. ***Outcome:*** Growth; Body composition; Risk of obesity

Key definitions:

Complementary feeding: The process that starts when human milk or infant formula is complemented by other foods and beverages. The complementary feeding period typically continues to 24 months as the young child transitions to family foods.

Complementary foods and beverages (CFB): Foods and beverages (liquids, semisolids, and solids) other than human milk or infant formula provided to an infant or young child to provide nutrients and energy.

Develop inclusion and exclusion criteria

The inclusion and exclusion criteria provide an objective, consistent, and transparent framework for determining which articles to include in the systematic review (**Table 3**). These criteria ensure that the most relevant and appropriate body of evidence is identified for the systematic review question, and that the evidence reviewed is[*]:

- Applicable to the U.S. population of interest
- Relevant to Federal public health nutrition policies and programs
- Rigorous from a scientific perspective

Table 3. Inclusion and exclusion criteria

Category	Inclusion Criteria	Exclusion Criteria
Study design	• Randomized controlled trials • Non-randomized controlled trials[†] • Prospective cohort studies • Retrospective cohort studies • Nested case-control studies	• Uncontrolled trials[‡] • Case-control studies • Cross-sectional studies • Ecological studies • Narrative reviews • Systematic reviews • Meta-analyses • Modeling and simulation studies
Publication date	• January 1980 – May 2023[§]	• Before January 1980, after May 2023
Population: Study participants	• Human	• Non-human
Population: Life stage	• At intervention or exposure: ○ Infants and young children (birth up to 24 months) • At outcome: ○ Infants and young children (birth up to 24 months) ○ Children and adolescents (2 up to 19 years) ○ Adults and older adults (19 years and older)	• At intervention or exposure: ○ Children and adolescents (2 up to 19 years) ○ Adults and older adults (19 years and older)

[*] USDA Nutrition Evidence Systematic Review Branch. USDA Nutrition Evidence Systematic Review: Methodology Manual. February 2023. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://nesr.usda.gov/methodology-overview

[†] Including quasi-experimental and controlled before-and-after studies

[‡] Including uncontrolled before-and-after studies

[§] This review update date range encompasses the original systematic review date range, which included articles published from January 1980 to July 2016

Category	Inclusion Criteria	Exclusion Criteria
Population: Health status	• Studies that exclusively enroll participants not diagnosed with a disease[*] • Studies that enroll some participants: o diagnosed with a disease; o with severe undernutrition, failure to thrive/underweight, stunting, or wasting; o born preterm,[†] with low birth weight,[‡] and/or small for gestational age o and/or hospitalized for an illness, injury, or surgery	• Studies that exclusively enroll participants: o diagnosed with a disease;[§] o with severe undernutrition, failure to thrive/underweight, stunting, or wasting; o born preterm,[**] with low birth weight,[††] and/or small for gestational age; o and/or hospitalized for an illness, injury, or surgery
Intervention/ exposure	• Timing of the first introduction of a *specific type* of complementary food or beverage (CFB)[**] o Fruit, including 100% fruit juice o Vegetables o Grains o Protein foods o Dairy and fortified soy alternatives o Food/beverage sources of added sugars • Types and amounts of CFB o Fruit, including 100% fruit juice o Vegetables o Grains o Protein foods o Dairy and fortified soy alternatives o Food/beverage sources of added sugars	• Isolated consumption of human milk, infant formulas (e.g., milk-based, soy, partially hydrolyzed, extensive-hydrolyzed, amino acid based), or vitamin and mineral supplements (e.g., iron drops) • Dietary patterns • Interventions/exposures that do not address any of the following (including interventions/exposures of multiple food groups examined jointly): fruit, including 100% fruit juice, vegetables, grains, protein foods, dairy and fortified soy alternatives, and food/beverage sources of added sugars • Type and/or amount of food or beverage not described • Timing of the first introduction of *any* CFB
Comparator	• Different timing of the first introduction of a *specific type* of CFB • Different types and amounts of CFB o Consumption of a different amount of the same CFB o Consumption of a different type of CFB	• No comparator

[*] Studies that enroll participants who are at risk for chronic disease were included

[†] Gestational age <37 weeks and 0/7 days

[‡] Birth weight <2500g

[§] Studies that exclusively enroll participants with obesity were included

[**] Complementary foods and beverages (CFB) are defined as foods and beverages (liquids, semisolids, and solids) other than human milk or infant formula provided to an infant or young child to provide nutrients and energy

Category	Inclusion Criteria	Exclusion Criteria
Outcomes	Growth (in infants, young children, children, adolescents) • Height, length/stature-for-age • Weight, weight-for-age • Stunting, failure to thrive, wasting • BMI-for-age, weight-for-length/stature • Body circumferences (arm, neck, thigh) • Head circumference Body composition (in infants, young children, children, adolescents, adults, older adults) • Skinfold thickness • Fat mass, ectopic fat • Fat-free mass, lean mass • Waist circumference, waist-to-hip ratio Risk of obesity (in children, adolescents, adults, older adults) • BMI • Overweight and obesity • Underweight • Healthy/normal weight	• Not applicable
Directness of experimental studies	• Randomized or non-randomized controlled trials designed to examine growth, body composition and/or risk of obesity as a primary outcome	• Randomized or non-randomized controlled trials that were not designed to examine growth, body composition, and/or risk of obesity as a primary outcome (i.e., designed to examine another primary outcome).
Publication status	• Peer-reviewed articles published in research journals	• Non-peer-reviewed articles, unpublished data or manuscripts, pre-prints, reports, editorials, retracted articles, and conference abstracts or proceedings
Language	• Published in English	• Not published in English
Country*	• Studies conducted in countries classified as high or very high on the Human Development Index the year(s) the intervention/exposure data were collected	• Studies conducted in countries classified as medium or low on the Human Development Index the year(s) the intervention/exposure data were collected

* The classification of countries on the Human Development Index (HDI) is based on the UN Development Program Human Development Report Office (http://hdr.undp.org/en/data) for the year the study intervention occurred or data were collected. If the study does not report the year(s) in which the intervention/exposure data were collected, the HDI classification for the year of publication is applied. Studies conducted prior to 1990 are classified based on 1990 HDI classifications. If the year is more recent than the available HDI values, then the most recent HDI classifications are used. If a country is not listed in the HDI, then the current country classification from the World Bank is used (The World Bank Country and Lending Groups, available from: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-country-and-lending-groups)

Search for and screen studies

NESR librarians, in collaboration with NESR analysts and the Committee, used the analytic framework and inclusion and exclusion criteria to develop a comprehensive literature search strategy. The literature search strategy included selecting and searching the appropriate bibliographic databases, translating search using syntax appropriate for the databases being searched, and employing search refinements, such as search filters. For existing reviews, search strategies were updated, as appropriate, for each database. The full literature search is documented in **Appendix 4.**

The results of all electronic database searches, after removal of duplicates, were screened independently by 2 NESR analysts using a step-wise process by reviewing titles, abstracts, and full-texts to determine which articles meet the inclusion criteria. Manual searching was conducted to find peer-reviewed published articles not identified through the electronic database search. These articles were also screened independently by 2 NESR analysts at the abstract and full-text levels.

Extract data and assess the risk of bias

NESR analysts extracted all essential data from each included article to describe key characteristics of the available evidence, such as the author, publication year, cohort/trial name, study design, population life stage at intervention/exposure and outcome, intervention/exposure and outcome assessment methods, and outcomes. One NESR analyst extracted the data and a second NESR analyst reviewed the extracted data for accuracy. Each article included in the systematic review underwent a formal risk of bias assessment, with 2 NESR analysts independently completing the risk of bias assessment using the tool that is appropriate for the study design.[*†‡]

Synthesize the evidence

The Committee described, compared, and combined the evidence from all included studies to answer the systematic review question.[§] Synthesis of the body of evidence involved identifying overarching themes or key concepts from the findings, identifying and explaining similarities and differences between studies, and determining whether certain factors impact the relationships being examined, which includes potential causes of heterogeneity across all included evidence.

Extracted data and risk of bias assessments for all included studies were tabulated to visually display results and facilitate synthesis. During synthesis, the Committee considered the effect direction, magnitude, and statistical significance of the results reported across the articles included in the body of evidence. The evidence was synthesized qualitatively without meta-analysis of effect estimates, statistical pooling or conversion of data, or quantitative tests of heterogeneity.

The synthesis plan for this review was designed with the end-use in mind, to inform the Committee's advice to HHS and USDA regarding dietary guidance across life stages. The first level of synthesis organization was by intervention/exposure (timing of the first introduction of a specific type of complementary food and beverage; types and amounts of complementary foods and beverages). The evidence was further organized by food

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[*] Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019; 366: l4898.doi:10.1136/bmj.l4898

[†] Sterne JAC, Hernán MA, Reeves BC, et al. ROBINS-I: a tool for assessing risk of bias in non-randomized studies of interventions. BMJ 2016; 355; i4919; doi: 10.1136/bmj.i4919

[‡] Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). Environment International 2024 (published online Mar 24); doi:10.1016/j.envint.2024.108602

[§] USDA Nutrition Evidence Systematic Review Branch. USDA Nutrition Evidence Systematic Review: Methodology Manual. February 2023. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://nesr.usda.gov/methodology-overview and/or beverage groups (fruit, including 100% fruit juice; vegetables; grains; protein foods; dairy and fortified soy alternatives; food/beverage sources of added sugars). Then, within each of the intervention/exposure groups, the evidence was organized by similar outcomes (growth; body composition; risk of obesity) based on the available evidence. Depending on the available evidence for types and amounts of complementary foods and beverages, a final level of synthesis organization was going to be according to age at intervention/exposure.

In addition to the present systematic review on complementary feeding, 2 systematic reviews with meta-analysis were conducted on the related topics of SSB intake and growth, body composition, and risk of obesity[*] and 100% juice intake and growth, body composition, and risk of obesity[†] across the lifespan, including infants and young children. Results of the meta-analyses that were relevant to complementary feeding in infants and young children (up to 24 months) were considered during the synthesis of the evidence and documented in the complementary feeding and growth, body composition, and risk of obesity systematic review.

Develop conclusion statements and grade the evidence

After the Committee synthesized the body of evidence, they drafted conclusion statements. A conclusion statement is one or more summary statements carefully constructed to answer the systematic review question. Each conclusion statement reflects the evidence reviewed, as outlined in the analytic framework (e.g., PICO elements) and synthesis plan, and does not take evidence from other sources into consideration. Conclusion statements do not draw implications and should not be interpreted as dietary guidance. The Committee reviewed, discussed, and revised the conclusion statements until they reached agreement on wording that accurately reflected the body of evidence.

The Committee then graded the strength of the evidence underlying each conclusion statement. They did this using NESR's predefined criteria, based on 5 grading elements: consistency, precision, risk of bias, directness and generalizability of the evidence. Study design and publication bias were also considered.[‡]

- Consistency: Consistency considers the degree of similarity in the direction and magnitude of effect across the body of evidence. This element also considers whether differences across the results can be explained by variations in study designs and methods.
- Precision: Precision considers the degree of certainty around an effect estimate for a given outcome. This element considers measures of variability, such as the width and range of confidence intervals, the number of studies, and sample sizes, within and across studies.
- Risk of bias: Risk of bias considers the likelihood that systematic errors resulting from the design and conduct of the studies could have impacted the accuracy of the reported results across the body of evidence.
- Directness: Directness considers the extent to which studies are designed to directly examine the relationship among the interventions/exposures, comparators, and outcome(s) of primary interest in the systematic review question.
- Generalizability: Generalizability considers whether the study participants, interventions and/or exposures, comparators, and outcomes examined in the body of evidence are applicable to the U.S. population of interest for the review.

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[*] Deierlein AL, Raynor HA, Byrd-Bredbenner C, et al. Sugar-Sweetened Beverages and Growth, Body Composition, and Risk of Obesity: A Systematic Review with Meta-Analysis. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2024. https://doi.org/10.52570/NESR.DGAC2025.SR05

[†] Deierlein AL, Raynor HA, Andres A, et al. 100% Juice and Growth, Body Composition, and Risk of Obesity: A Systematic Review with Meta-Analysis U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2024. https://doi.org/10.52570/NESR.DGAC2025.SR05

[‡] Spill MK, English LK, Raghavan R, et al. Perspective: USDA Nutrition Evidence Systematic Review Methodology: Grading the Strength of Evidence in Nutrition- and Public Health-Related Systematic Reviews. Adv Nutr. 2022 Aug 1;13(4):982-991. doi: 10.1093/advances/nmab147

The Committee assigned a grade to each conclusion statement (i.e., strong, moderate, limited, or grade not assignable). The grade communicates the strength of the evidence supporting a specific conclusion statement to decision makers and stakeholders. A conclusion statement can receive a grade of Strong, Moderate, or Limited, and if insufficient or no evidence is available to answer a systematic review question, then no grade is assigned (i.e., Grade Not Assignable) (**Table 4**). The overall grade is not based on a predefined formula for scoring or tallying ratings of each element. Rather, each overall grade reflects the expert group's thorough consideration of all of the grading elements, as they each relate to the specific nuances of the body of evidence under review.

Table 4. Definitions of NESR grades

Grade	Definition
Strong	The conclusion statement is based on a strong body of evidence as assessed by consistency, precision, risk of bias, directness, and generalizability. The level of certainty in the conclusion is strong, such that if new evidence emerges, modifications to the conclusion are unlikely to be required.
Moderate	The conclusion statement is based on a moderate body of evidence as assessed by consistency, precision, risk of bias, directness, and generalizability. The level of certainty in the conclusion is moderate, such that if new evidence emerges, modifications to the conclusion may be required.
Limited	The conclusion statement is based on a limited body of evidence as assessed by consistency, precision, risk of bias, directness, and generalizability. The level of certainty in the conclusion is limited, such that if new evidence emerges, modifications to the conclusion are likely to be required.
Grade Not Assignable	A conclusion statement cannot be drawn due to either a lack of evidence, or evidence that has severe limitations related to consistency, precision, risk of bias, directness, and generalizability.

Recommend future research

The Committee identified and documented research gaps and methodological limitations throughout the systematic review process. These gaps and limitations are used to develop research recommendations that describe the research, data, and methodological advances that are needed to strengthen the body of evidence on a particular topic. Rationales for the necessity of additional or stronger research are also provided with the research recommendations.

Peer review

This systematic review underwent external peer review in a process coordinated by staff from the National Institutes of Health (NIH). NIH staff identified potential peer reviewers through outreach to a variety of professional organizations to select academic reviewers from U.S. colleges and universities across the country with a doctorate degree, including MDs, and expertise specific to the questions being reviewed. All peer reviewers were external to the *Dietary Guidelines* process, and therefore, current Committee members or Federal staff who supported the Committee or the development of the *Dietary Guidelines* were not eligible to serve as peer reviewers.

The peer review process was anonymous and confidential in that the peer reviewers were not identified to the Committee members or NESR staff, and in turn, the reviewers were asked not to share or discuss the review with anyone. Peer reviewers were made aware that per USDA, Food and Nutrition Service (FNS) agency policy, all peer reviewer comments would be summarized and made public, but comments would not be attributed to a specific reviewer.

Peer review occurred after draft conclusion statements were discussed by the full Committee at its third, fourth, fifth, and sixth public meetings. NIH staff assigned and distributed the reviews to at least 2 peer reviewers based on area of expertise. Following peer review, the Committee reviewed and discussed comments and made revisions to the systematic review, as needed, based on the discussion.

Health equity considerations

The Committee was charged by HHS and USDA to review all scientific questions with a health equity lens to ensure that the next edition of the *Dietary Guidelines* is relevant to people with diverse racial, ethnic, socioeconomic, and cultural backgrounds. The Committee made a number of health equity considerations throughout the NESR systematic review process. The Committee's Scientific Report[*] includes a more detailed discussion of their approach to applying a health equity lens to their review of evidence, but examples include consideration of key confounders relevant to health equity and assessment of generalizability of the evidence.

Results

Literature search and screening results

The literature search (**Appendix 4**) yielded 38,203 search results after the removal of duplicates (see **Figure 2**). Dual-screening resulted in the exclusion of 35,700 titles, 1,928 abstracts, and 540 full-texts articles. Reasons for full-text exclusion are in **Appendix 5**. Twenty-three additional articles were identified from the existing reviews[†‡] and 7 additional articles were identified from the manual search. The body of evidence included 65 articles:

- Timing of the first introduction of a specific type of complementary food or beverage:
    - 100% juice: 1 article[1]
    - Fruit: 3 articles[2-4]
    - Vegetables: 3 articles[3-5]
    - Grains: 6 articles[3-8]
    - Protein foods: 4 articles[5,8-10]
    - Dairy and fortified soy alternatives: 13 articles[1,6,8,11-20]
    - SSBs: 9 articles[3,4,6,8,21-25]
    - Food sources of added sugars: 1 article[25]

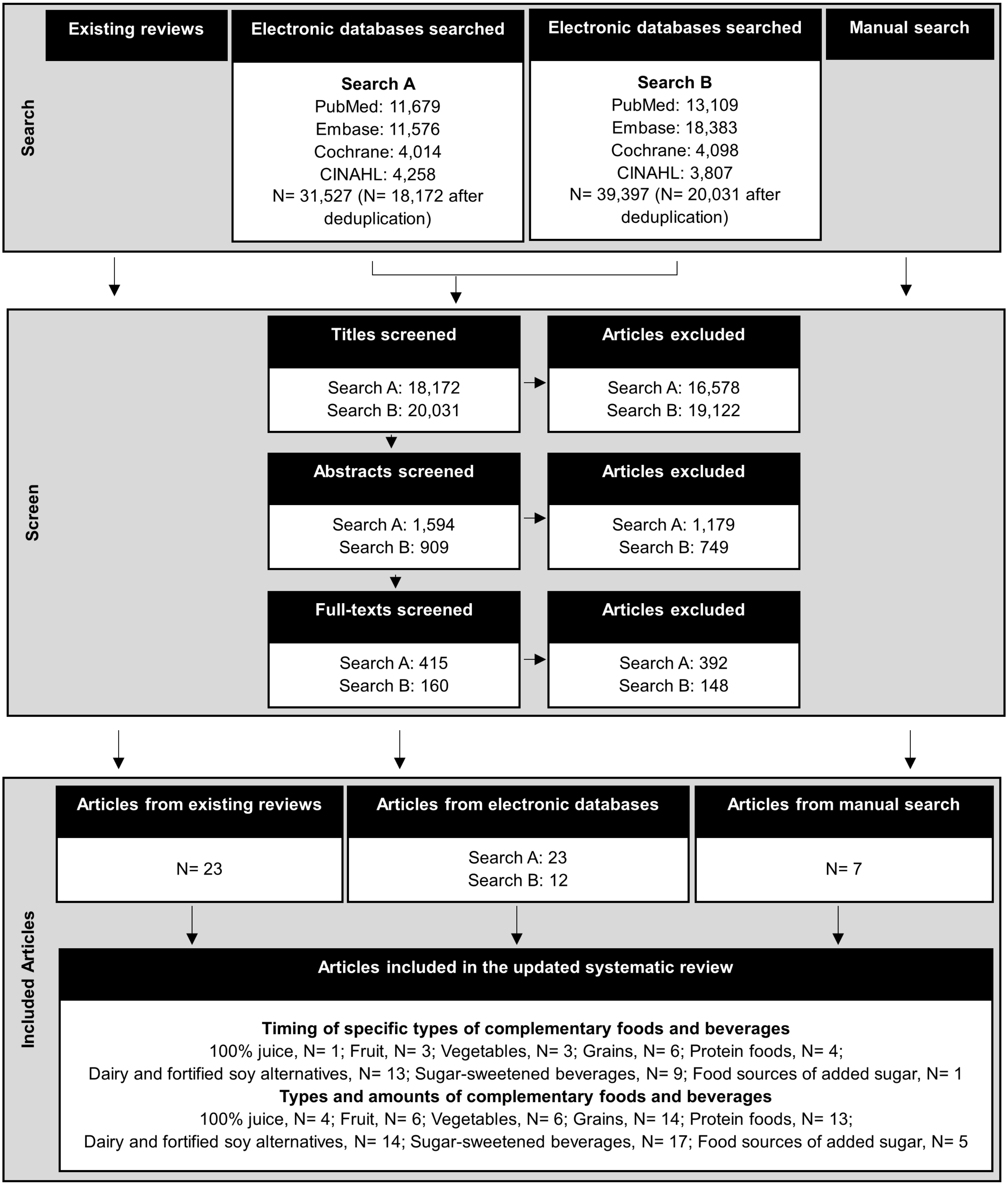
[*] 2025 Dietary Guidelines Advisory Committee. 2024. Scientific Report of the 2025 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Health and Human Services and Secretary of Agriculture. U.S. Department of Health and Human Services. https://doi.org/10.52570/DGAC2025

[†] English LK, Obbagy JE, Wong YP, et al. Timing of Introduction of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2019. https://doi.org/10.52570/NESR.PB242018.SR0305.

[‡] English LK, Obbagy JE, Wong YP, et al. Types and Amounts of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2019. https://doi.org/10.52570/NESR.PB242018.SR0306.

- Types and amounts of complementary foods and beverages:
  - 100% juice: 4 articles[1,26-28]
  - Fruit: 6 articles[1,6,27,29-31]
  - Vegetables: 6 articles[1,6,27,29-31]
  - Grains: 14 articles[1,29,30,32-42]
  - Protein foods: 13 articles[1,27,29-31,35,39,41,43-47]
  - Dairy and fortified soy alternatives: 14 articles[14,29,30,45-55]
  - SSBs: 17 articles[1,23,27-30,50,56-65]
  - Food sources of added sugars: 5 articles[1,27,29,30,40]

Figure 2. Literature search and screen flowchart



Timing of introduction of specific types of complementary foods and beverages

100% juice

Description of the evidence

One article from a prospective cohort study (PCS) met inclusion criteria and examined the relationship between the timing of introduction of 100% juice in infants and young children, up to age 24 months, and growth, body composition, and risk of obesity (**Table 6**).[1] Studies that examined measures of juice introduction that included sugar-sweetened juice or that did not define the juice as being 100% juice were synthesized with the evidence for SSBs.

Population

The study was conducted in the United States (specifically, Puerto Rico). The study analytic N was 68 and the article did not report a power calculation related to the timing of introduction to 100% juice and the relevant outcomes.

One hundred percent of the participants in this study were Hispanic. Approximately 68% of mothers had a high school education or higher, and 100% participated in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Approximately 56% of the parents were less than 30 years old. In regards to human milk and formula feeding practices, 51% exclusively breastfed for at least 1 month, approximately 70% were ever formula-fed, and approximately 21% were breastfeeding around 10 months. Forty-seven percent of the children were female. Information on birth size, gestational age, and anthropometry at baseline were not reported.

Exposure and comparator

Timing of introduction to 100% juice was assessed through an interviewer-administered questionnaire completed by caregivers when their infants or young children were age 0 to 24 months. Timing of introduction was examined categorically (<6 months versus ≥6 months).

Outcome

Trained research staff measured weight and length from age 11 to 36 months in this study. The outcome analyzed by the study was the odds of weight-for-length z-score (WLZ) ≥1, which was calculated based on World Health Organization (WHO) growth charts.

Synthesis of the evidence

The single study that met inclusion criteria and assessed timing of introduction to 100% juice reported that introduction before or after age 6 months was not associated with odds of WLZ ≥1 at age 11-36 months (**Table 6**).[1]

Conclusion statement and grade

The Committee did not draw a conclusion statement about the relationship between the timing of introduction of 100% juice in infants and young children, up to age 24 months, and growth, body composition, and risk of obesity because there is not enough evidence available (**Table 5**). The risk of bias assessments for this body of evidence are documented in **Table 7**. Publication bias may be a limitation, but the small body of evidence makes it difficult to assess. Additionally, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias.

Table 5. Conclusion statement, grade for timing of introduction of 100% juice and growth, body composition, and risk of obesity

Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to 100% juice and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available.**
Grade	Grade Not Assignable
Body of Evidence	1 article: 1 prospective cohort study
Rationale	There is not enough evidence available to draw a conclusion statement.

Table 6. Evidence examining the relationship between the timing of introduction to 100% juice and growth, body composition, and risk of obesity[a]

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, and Funding
Amaro-Rivera, 2019[1] PCS, U.S. (Puerto Rico) Analytic N = 68 (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Hispanic: 100% Maternal education: ≤HS: 32.5%, >HS: 67.5% Other SEP measure(s): WIC participation: 100% Maternal age: Parent's age: <30 y: 55.8%, ≥30 y: 44.2% Milk feeding practices: EBF for ≥1 mo: 51%, Ever FF: 70.1%, Any BF at ~10 mo: 20.8% Child sex (female): 47% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Juice (<6 mo vs ≥6 mo) **Dietary assessment methods:** Interviewer-administered questionnaire completed by caregivers **Age(s) at dietary assessment:** 0-24 mo **Age of introduction:** <6 mo: 32.5% **Outcome(s):** WLZ ≥1 **Outcome assessment methods:** Weight and length measured by trained research staff. Weight status assessed using WHO age- and sex-specific WLZ growth charts. Relative risk for WLZ (≥1 z-score vs <1 z-score), with underweight defined as WLZ ≤-2 SD, healthy weight status defined as WLZ >-2 and <1 SD, risk of overweight defined as WLZ between 1-<2, and overweight or obesity defined as WLZ ≥2 SD. **Age(s) at outcome assessment:** 11-36 mo (Median: 21 mo, 11-23 mo: 61.0%, 24-36 mo: 39.0%)	**WLZ (≥1 vs <1) @ 11-36 mo** <6 mo vs ≥6 mo: Data NR, NS	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry **Key confounders NOT accounted for:** gestational age **Model adjustments:** WLZ at baseline **Funding:** University of Puerto Rico Central Administration Grant; Capacity Advancement in Research Infrastructure; NIMHD

[a] Abbreviations: @: at; BF: breastfeeding; EBF: exclusive breastfeeding; FF: formula feeding; FFQ: food frequency questionnaire; HS: high school; mo: month; NR: not reported; PCS: prospective cohort study; ref: reference; SD: standard deviation; SEP: socioeconomic position; U.S.: United States; vs: versus; WIC: Special Supplemental Nutrition Program for Women, Infants, and Children; WHO: World Health Organization; WLZ: weight-for-length z-score; y: year

Table 7. Risk of bias for observational studies examining the timing of introduction to 100% juice and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Amaro-Rivera, 2019[1]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Fruit

Description of the evidence

Three studies met inclusion criteria and examined the relationship between timing of introduction of fruit in infants and young children, up to age 24 months, and growth, body composition, and risk of obesity (**Table 9**).[2-4] All studies were PCS, using data from the following cohorts: Generation R,[2] Project Viva,[4] and 1 unnamed cohort.[3]

Population

The studies were conducted in the United States[3,4] and the Netherlands.[2] The analytic sample sizes of the studies were 94, [3] 747[2] and 1,013.[4] None of the studies reported power calculations related to the timing of introduction of fruit.

Three studies provided information on the racial and/or ethnic background of participants: 100% of participants were White in 1 study,[3] 100% of participants were of Dutch ethnicity in the second study,[2] and 69% were White, 12% were Black or African American, 12% were other race and/or ethnicity, 4% were Hispanic and 3% were Asian in the last study.[4] Across all 3 studies that reported maternal age, the average age of the women was the early thirties.[2-4] Human milk and formula feeding practices were reported in all 3 studies and varied: 1 study reported that 83% ever breastfed, 33% exclusively breastfed at 4 months, and 12% exclusively breastfed at 6 months[3]; a second study reported that approximately 90% ever breastfed and the mean duration of breastfeeding was about 5 months[2]; the third reported that the rate of any breastfeeding at 4 months was 69%.[4] Socioeconomic position (SEP), particularly maternal education, was reported in all 3 studies.[2-4] Two studies reported that at least 50% of participants had a college degree[3,4] and that the sample in the remaining study had a "higher level of education than the general population".[2] Other SEP measures included 1 study reporting that 66% of participants had a household income greater than $70,000 per year,[4] while the other reported that all participants were from "middle or upper socioeconomic status families".[3]

Regarding the characteristics of the infants and young children, all 3 studies noted that approximately 50% of participants were female[2-4] and the mean birth weight was about 3.5 kilograms.[2-4] Mean gestational age was approximately 40 weeks in 2 studies,[2,4] and the third study reported that all participants were born full-term.[3] None of the studies compared baseline growth, body composition, or risk of obesity across exposures.

Exposures and comparators

All studies assessed timing of introduction of fruit broadly; none of the studies reported the specific fruits that were included in these measures.[2-4] The exposure variable was analyzed in various ways across studies. One study analyzed a continuous measure of age of introduction of fruit,[3] another study compared introduction at less than age 5 months to greater than or equal to age 5 months,[2] and the third study compared introduction at less than age 4 months or age 6 months or greater to between age 4 months up to age 6 months.[3] Two studies used a questionnaire to measure timing of introduction of fruit,[2,4] while the third study used a 24-hour recall.[3] All of the studies assessed timing of introduction to fruit multiple times between ages 2 and 24 months, all of which included assessments up to age 12 months and 1 that additionally included assessments beyond age 12 months.[3]

Outcomes

Each study assessed unique measures of growth and body composition. None of the studies assessed a measure of risk of overweight or obesity. Specifically, the 3 studies analyzed: change in weight, change in length, and change in weight slope relative to length slope from age 2 to 8 months and from age 12 to 24 months,[3] body mass index (BMI) z-scores (BMIZ) and waist circumference at age 8 and 13 years,[4] and total sum of skinfolds at age 24 months.[2] U.S. national reference data was used to BMIZ in the single study that utilized z-scores.[4] Research staff or nurses measured all outcomes. The age at which the outcome was measured varied from 2 months to 13 years.

Synthesis of the evidence

Among the 3 articles that met inclusion criteria, all studies reported null associations between timing of introduction of fruit and growth or body composition (**Table 9**).[2-4] The 1 study that reported the direction of the non-significant associations tended to report higher BMIZ and waist circumference with introduction to fruit from 4 to less than 6 months.

Conclusion statement and grade

The Committee did not draw a conclusion statement about the relationship between timing of introduction of fruit in infants and young children, up to age 24 months, and growth, body composition, and risk of obesity because there is not enough evidence available (**Table 8**). The risk of bias assessments for this body of evidence are documented in **Table 10**. Publication bias may be a limitation, but the small body of evidence makes it difficult to assess. Additionally, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias.

Table 8. Conclusion statement, grade for timing of introduction of fruit and growth, body composition, and risk of obesity

Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to fruit and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available.**
Grade	Grade Not Assignable
Body of Evidence	3 articles: 3 prospective cohort studies
Rationale	There is not enough evidence available to answer this question.

Table 9. Evidence examining the relationship between timing of introduction to fruit and growth, body composition, and risk of obesity[a]

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Ay, 2008[2] PCS, Generation R, Netherlands Analytic N = 747 (Excluded participants who did not complete skinfold measurements at 24 mo) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Dutch ethnicity (2 parents and 4 grandparents born in the Netherlands): 100% Maternal education: "higher level of education than the general population" Other SEP measure(s): NR Maternal age: ~32 y Milk feeding practices: Ever BF: ~90%; BF duration: ~5 mo Child sex (female): 48% Birth weight: ~3,485 g Gestational age: 39.8 wk	**Exposure(s) and comparator(s):** Fruit snack (<5 mo vs ≥5 mo (ref)) **Dietary assessment methods:** Caregiver questionnaire **Age(s) at dietary assessment:** 2, 6, 12 mo **Age of introduction:** <5 mo: ~62%, ≥5 mo:~38% **Outcome(s):** Sum of skinfold thickness (triceps, biceps, suprailiacal, subscapular) **Outcome assessment methods:** Skinfold thickness measured by trained medical assistants. **Age(s) at outcome assessment:** 24 mo	**Total sum of skinfolds @ 24 mo** Data NR, p=NS	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; gestational age **Key confounders NOT accounted for:** milk feeding practices; baseline anthropometry **Model adjustments:** Age, gender, gestational age, observer, socioeconomic status (maternal age and educational level), smoking during pregnancy **Funding:** Erasmus Medical Center; Erasmus University Rotterdam; Netherlands Organization for Health Research and Development; National Diabetic Fund

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Carruth, 2000[3] PCS, U.S. Analytic N = 94 (Reasons for exclusions NR) Adequately powered: Yes **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: White: 100% Maternal education: College degree: 50% Other SEP measure(s): Hollingshead Index: 54 (9) – all "middle or upper SES families" Maternal age: 31 y Milk feeding practices: Ever BF: 83%, EBF at 4 mo: 33%, Mixed feeding at 4 mo: 33%, EBF at 6 mo: 12% Child sex (female): 46% Birth weight: Males: 7.8 (1.2) lb, Females: 7.6 (1.1) lb Gestational age: 100% full-term	**Exposure(s) and comparator(s):** Fruit (Continuous) **Dietary assessment methods:** 24-h recall (maternal report) with dietitian **Age(s) at dietary assessment:** 2, 3, 4, 6, 8, 10, 12, 16, 20, 24 mo (interviewed 3-5x from 2-10 mo, 2-4x from 12-24 mo) **Age of introduction:** Median (range): 5.0 (0.5-8.2) mo **Outcome(s):** Weight, length, Change in weight slope relative to length slope **Outcome assessment methods:** Weight and length measured by research staff **Age(s) at outcome assessment:** 2, 3, 4, 6, 8, 10, 12, 16, 20, 24 mo (measured 3-5x from 2-10 mo, 2-4x from 12-24 mo)	**Change in weight @ 2-8 mo, 12-24 mo (β (SE))** Change from 2-8 mo: Data NR, p>0.05 Change from 12-24 mo: Data NR, p>0.05 **Change in length @ 2-8 mo, 12-24 mo (β (SE))** Change from 2-8 mo: Data NR, p>0.05 Change from 12-24 mo: Data NR, p>0.05 **Change in weight slope relative to length slope @ 2-8 mo, 12-24 mo (β (SE))** Change from 2-8 mo: Data NR, p>0.05 Change from 12-24 mo: Data NR, p>0.05	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** None **Model adjustments:** length slope, sex, illness score, breast feeding (duration in mo and ever BF), infant age at first addition of vegetables (for food cluster of meat, mixed, table food), food cluster (meat, mixed food, table food) in the infant's diet by 8 mo (for vegetables); NA for other analyses (variables not retained in model) **Funding:** NR

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Gingras, 2019[4] PCS, Project Viva, U.S. Analytic N = 1,013 (Excluded participants who did not have complete exposure data, did not have outcomes measured, and children born <34 wk gestation) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR (Child race and/or ethnicity: White: 69%, Black or African American: 12%, Other: 12%, Hispanic: 4%, Asian: 3%) Maternal education: College graduate: 74% Other SEP measure(s): Household income >$70,000/y: 66% Maternal age: 32.6 (4.8) y Milk feeding practices: Any BF at 4 mo: 69% Child sex (female): 51% Birth weight: 3.53 (0.52) kg Birth weight for gestational age z-score: 0.23 (0.97) Gestational age: 39.7 (1.4) wk	**Exposure(s) and comparator(s):** Fruit (<4 mo, 4-<6 mo (ref), ≥6 mo) **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 6, 12 mo **Age of introduction:** <4 mo: 5.7% 4-<6 mo: 60.5%, ≥6 mo: 33.9% **Outcome(s):** BMIZ, WC **Outcome assessment methods:** All outcomes measured by trained research staff. Age- and sex-specific BMIZ calculated using U.S. national reference data. **Age(s) at outcome assessment:** Mean (SD): 7.9 (0.8) y; 13.2 (0.9) y	**BMIZ @ ~8 y (β (95% CI))** Among infants BF ≥4 mo: <4 mo vs 4-<6 mo (ref): 0.22 (-0.17, 0.61) ≥6 mo vs 4-<6 mo (ref): -0.08 (-0.23, 0.06) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): 0.11 (-0.24, 0.47) ≥6 mo vs 4-<6 mo (ref): 0.24 (-0.03, 0.50) **BMIZ @ ~13 y (β (95% CI))** Among infants BF ≥4 mo: <4 mo vs 4-<6 mo (ref): 0.27 (-0.15, 0.69) ≥6 mo vs 4-<6 mo (ref): 0.06 (-0.10, 0.22) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): 0.11 (-0.30, 0.53) ≥6 mo vs 4-<6 mo (ref): 0.06 (-0.25, 0.36) **WC (cm) @ ~8 y (β (95% CI))** Among infants BF ≥4 mo: <4 mo vs 4-<6 mo (ref): 0.87 (-1.89, 3.64) ≥6 mo vs 4-<6 mo (ref): 0.24 (-0.78, 1.26) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): -0.58 (-3.59, 2.42) ≥6 mo vs 4-<6 mo (ref): 0.78 (-1.50, 3.06) **WC (cm) @ ~13 y (β (95% CI))** Among infants BF ≥4 mo: <4 mo vs 4-<6 mo (ref): 3.72 (-0.56, 8.00) ≥6 mo vs 4-<6 mo (ref): 1.03 (-0.57, 2.64) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): 0.88 (-4.14, 5.90) ≥6 mo vs 4-<6 mo (ref): -0.50 (-4.21, 3.20)	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** None **Model adjustments:** child sex, child age, maternal education level, marital status, household income, maternal prepregnancy BMI, paternal BMI, child's race and/or ethnicity, gestational age at delivery, change in WAZ from 0 to 4 mo. **Funding:** NIH, CIHR

[a] Abbreviations: @: at; β: beta; BF: breastfeeding; BMI: body mass index; BMIZ: BMI z-score; CI: confidence interval; EBF: exclusive breastfeeding; FF: formula feeding; h: hour; kg: kilogram; lb: pound; mo: month; NA: not applicable; NR: not reported; NS: non-significant; PCS: prospective cohort study; ref: reference; SD: standard deviation; SE: standard error; SEP: socioeconomic position; SES: socioeconomic status; U.S.: United States; WAZ: weight-for-age z-score; WC: waist circumference; wk: week; x: times; y: year

Table 10. Risk of bias for observational studies examining timing of introduction to fruit and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Ay, 2008[2]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	SOME CONCERNS	LOW	HIGH	HIGH
Carruth, 2000[3]	LOW	LOW	LOW	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Gingras, 2019[4]	LOW	SOME CONCERNS	LOW	LOW	SOME CONCERNS	LOW	SOME CONCERNS	SOME CONCERNS

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Vegetables

Description of the evidence

Three studies met inclusion criteria and examined the relationship between timing of introduction to vegetables in infants and young children, up to age 24 months and growth, body composition, and risk of obesity (**Table 12**).[3-5] All studies were PCS, using data from the following cohorts: the Copenhagen Perinatal Cohort,[5] Project Viva,[4] and 1 unnamed cohort.[3]

Population

The studies were conducted in the Denmark[5] and the United States.[3,4] The analytic sample sizes of the studies were 94,[3] 1,013[4] and 1,675.[5] None of the studies reported power calculations related to the timing of introduction of vegetable.

Two studies provided information on the racial and/or ethnic background of participants, reporting that all participants were White in 1 study,[3] and 69% were White, 12% were Black or African American, 12% were “other” race and/or ethnicity, 4% were Hispanic, and 3% were Asian in the second study.[4] The average maternal age across studies ranged from the mid-twenties[5] to early thirties.[3,4] Human milk and formula feeding practices were reported in all 3 studies and tended to vary: 1 study reported that 83% ever breastfed, 33% exclusively breastfed at 4 months, and 12% exclusively breastfed at 6 months,[3] a second reported that the median duration of any breastfeeding was 2.5 months,[5] and the third reported that the rate of any breastfeeding at 4 months was 69%.[4] SEP was reported in all 3 studies. Maternal education was reported across 2 studies, showing that at least 50% of participants tended to have a college degree.[3,4] Additionally, 1 study reported that 66% of participants had a household income greater than $70,000 per year,[4] another reported that all participants were from “middle or upper socioeconomic status families”,[3] and the third reported that participants had an average social class score of about 4 on an 8-point scale.[5] One study recruited participants from a hospital that preferentially admitted mothers with previous or expected pregnancy or delivery complications, or mothers where a home delivery was not advised.[5]

Regarding characteristics of the infants and young children, approximately 50% of participants were female[3,4] and mean birth weight ranged from approximately 3.2 to 3.5 kilograms.[3-5] Mean gestational age was approximately 40 weeks in 1 study,[4] while all participants were born full-term in a second study,[3] and approximately 18% of infants were born preterm in the third.[5] None of the studies compared baseline growth, body composition, and risk of obesity across levels of exposures.

Exposures and comparators

All studies assessed timing of introduction of vegetables broadly; none of the studies reported the specific vegetables that were included in these measures.[3-5] The exposure variable was analyzed in various ways across studies. Two studies analyzed age of introduction of vegetables continuously,[3,5] 1 study examined introduction at age 4 months or later,[5] and 1 study compared introduction at less than age 4 months or age 6 months or greater to between age 4 months up to age 6 months.[4,5] One study used a questionnaire to measure timing of introduction of vegetables,[4] a second conducted a maternal interview,[5] while the third study used a 24-hour recall.[3] Two studies assessed timing of introduction to vegetables multiple times[3,4] while 1 study relied on a single assessment.[5] The age at which the exposure was measured varied from 2 to 24 months, with all studies including 1 or more assessments through age 1 year and 1 additionally including assessments beyond age 12 months.[3]

Outcomes

A variety of growth, body composition, or risk of overweight and obesity measures were assessed across the 3 studies. Specifically, reported outcomes across the 3 studies included: change in weight, change in length, and change in weight slope relative to length slope from age 2-8 months and from age 12-24 months in 1 study;[3] BMIZ and waist circumference at ages 8 and 13 years in the second study;[4] and BMIZ reported across multiple time points from age 1 year through age 42 years, in addition to waist circumference, risk of overweight, and risk of obesity at age 42 years, in the third study.[5] Z-scores were calculated using U.S. national reference data for 1 study,[4] while a second study utilized growth reference data from Britain (1990) for outcomes measured through adolescence.[5] Research staff or nurses measured all outcomes, except for weight, height, and waist circumference at 42 years in 1 study.[5] The age at which the outcome was measured varied from 2 months[3] to 42 years.[5]

Synthesis of the evidence

Among the 3 studies that met inclusion criteria, findings were mixed with all studies reporting null associations, and 2 of these studies also reporting 1 or more significant associations between timing of introduction to vegetables and outcomes related to growth, body composition, or risk of obesity (**Table 12**).[4,5] Among the null associations, all 3 studies reported no significant associations between timing of introduction of vegetables and growth, including weight, BMIZ, waist circumference, and risk of obesity. The 1 study that reported the direction of the non-significant associations tended to report higher BMIZ and waist circumference with introduction of vegetables from 4 to less than 6 months.[4] Two of these studies also reported significant associations, both of which trended towards lower growth or odds of overweight with later introduction of vegetables.[3,5]

Conclusion statement and grade

The Committee did not draw a conclusion statement about the relationship between timing of introduction of vegetables in infants and young children, up to age 24 months, and growth, body composition, and risk of obesity because there is not enough evidence available (**Table 11**). Publication bias may be a limitation, but the small body of evidence makes it difficult to assess. Additionally, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias. The risk of bias assessments for this body of evidence are documented in **Table 13**.

Table 11. Conclusion statement, grade for timing of introduction of vegetables and growth, body composition, and risk of obesity

Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to vegetables and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available.**
Grade	Grade Not Assignable
Body of Evidence	3 articles: 3 prospective cohort studies
Rationale	There is not enough evidence available to answer this question.

Table 12. Evidence examining the relationship between timing of introduction to vegetables and growth and body composition[a]

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Outcome	Key Confounders, Model Adjustments, Funding
Carruth, 2000[3] PCS, U.S. Analytic N = 94 (Reasons for exclusions NR) Adequately powered: Yes **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: White: 100% Maternal education: College degree: 50% Other SEP measure(s): Hollingshead Index: 54 (9) – all "middle or upper SES families" Maternal age: 31 y Milk feeding practices: Ever BF: 83%, EBF at 4 mo: 33%, Mixed feeding at 4 mo: 33%, EBF at 6 mo: 12% Child sex (female): 46% Birth weight: Males: 7.8 (1.2) lb, Females: 7.6 (1.1) lb Gestational age: 100% full-term	**Exposure(s) and comparator(s):** Vegetables (Continuous) **Dietary assessment methods:** 24-h recall (maternal report) with dietitian **Age(s) at dietary assessment:** 2, 3, 4, 6, 8, 10, 12, 16, 20, 24 mo (interviewed 3-5x from 2-10 mo, 2-4x from 12-24 mo) **Age of introduction:** Median (range): 5.5 (1-7.7) mo **Outcome(s):** Weight, length, change in weight slope relative to length slope **Outcome assessment methods:** Weight and length measured by research staff **Age(s) at outcome assessment:** 2, 3, 4, 6, 8, 10, 12, 16, 20, 24 mo (measured 3-5x from 2-10 mo, 2-4x from 12-24 mo)	**Change in weight @ 2-8 mo, 12-24 mo (β (SE))** Change from 2-8 mo: Data NR, p>0.05 Change from 12-24 mo: Data NR, p>0.05 **Change in length @ 2-8 mo, 12-24 mo (β (SE))** Change from 2-8 mo: Data NR, p>0.05 Change from 12-24 mo: Data NR, p>0.05 **Change in weight slope relative to length slope @ 2-8 mo, 12-24 mo (β (SE))** **Change from 2-8 mo: -0.0567 (0.0238), p=0.0457** Change from 12-24 mo: Data NR, p>0.05	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** None **Model adjustments:** length slope, sex, illness score, breast feeding (duration in mo and ever BF), infant age at first addition of vegetables (for food cluster of meat, mixed, table food), food cluster (meat, mixed food, table food) in the infant's diet by 8 mo (for vegetables); NA for other analyses (variables not retained in model) **Funding:** NR

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Outcome	Key Confounders, Model Adjustments, Funding
Gingras, 2019[4] PCS, Project Viva, U.S. Analytic N = 1,013 (Excluded participants who did not have complete exposure data, did not have outcomes measured, and children born <34 wk gestation) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR (Child race and/or ethnicity: White: 69%, Black or African American: 12%, Other: 12%, Hispanic: 4%, Asian: 3%) Maternal education: College graduate: 74% Other SEP measure(s): Household income >$70,000/y: 66% Maternal age: 32.6 (4.8) y Milk feeding practices: Any BF at 4 mo: 69% Child sex (female): 51% Birth weight: 3.53 (0.52) kg Birth weight for gestational age z-score: 0.23 (0.97) Gestational age: 39.7 (1.4) wk	**Exposure(s) and comparator(s):** Vegetables (<4 mo, 4-<6 mo (ref), ≥6 mo) **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 6, 12 mo **Age of introduction:** <4 mo: 4.1%, 4-<6 mo: 58.7%, ≥6 mo: 37.2% **Outcome(s):** BMIZ, WC **Outcome assessment methods:** All outcomes measured by trained research staff. Age- and sex-specific BMIZ calculated using U.S. national reference data. **Age(s) at outcome assessment:** Mean (SD): 7.9 (0.8) y; 13.2 (0.9) y	**BMIZ@ ~8 y (β (95% CI))** Among infants BF ≥4 mo: <4 mo vs 4-<6 mo (ref): 0.30 (-0.15, 0.75) ≥6 mo vs 4-<6 mo (ref): -0.08 (-0.22, 0.06) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): 0.16 (-0.24, 0.55) ≥6 mo vs 4-<6 mo (ref): 0.18 (-0.07, 0.42) **BMIZ @ ~13 y (β (95% CI))** Among infants BF ≥4 mo: <4 mo vs 4-<6 mo (ref): 0.34 (-0.16, 0.84) ≥6 mo vs 4-<6 mo (ref): 0.08 (-0.08, 0.23) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): 0.15 (-0.30, 0.61) ≥6 mo vs 4-<6 mo (ref): 0.01 (-0.26, 0.29) **WC (cm) @ ~8 y (β (95% CI))** Among infants BF ≥4 mo: <4 mo vs 4-<6 mo (ref): 0.75 (-2.45, 3.96) ≥6 mo vs 4-<6 mo (ref): 0.06 (-0.94, 1.06) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): -0.20 (-3.53, 3.14) ≥6 mo vs 4-<6 mo (ref): 0.67 (-1.40, 2.74) **WC (cm) @ ~13 y (β (95% CI))** Among infants BF ≥4 mo: <4 mo vs 4-<6 mo (ref): 4.17 (-0.96, 9.30) ≥6 mo vs 4-<6 mo (ref): 0.84 (-0.75, 2.42) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): 0.62 (-4.83, 6.07) ≥6 mo vs 4-<6 mo (ref): -0.93 (-4.27, 2.41)	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** None **Model adjustments:** child sex, child age, maternal education level, marital status, household income, maternal prepregnancy BMI, paternal BMI, child's race and/or ethnicity, gestational age at delivery, change in WAZ from 0 to 4 mo. **Funding:** NIH, CIHR

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Outcome	Key Confounders, Model Adjustments, Funding
Schack-Nielsen, 2010[5] PCS, Copenhagen Perinatal Cohort, Denmark Analytic N = 5,068 (N for individual analyses ranged from 367-1,675) (Excluded participants without information on BF, introduction of spoon feeding, birth weight, and/or at least 1 BMI measurement from 1-42 y.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): Social class: ~4.0 (1-8 point scale; 8=highest); Breadwinner's education: ~2.4 (1-4 point scale; 4=highest) Maternal age: ~26 y Milk feeding practices: Duration of any BF (median (10th, 90th percentile)): 2.50 (0.23, 6.50) mo Child sex (female): NR Birth weight: 3,232 (588) g Gestational age: ~18% preterm (≤37 wk) Other relevant characteristics: Participants were recruited from a hospital that preferentially admitted mothers with previous or expected pregnancy/delivery complications and mothers where a home delivery was not advised (primarily single mothers).	**Exposure(s) and comparator(s):** Vegetables (Continuous (mo); ≥4 mo vs <4 mo (ref)) **Dietary assessment methods:** Maternal interview **Age(s) at dietary assessment:** 1 y **Age of introduction:** 4.05 (1.34) mo **Outcome(s):** BMIZ, overweight, obesity, WC **Outcome assessment methods:** Weight and height at 1, 3, and 6 y measured by study personnel. Weight and height from 7-14 y measured at school health examinations. Weight and height for men from 16-23 y measured at draft board examinations. Weight and height at 20-34 y measured by study personnel. Weight, height, and WC at 42 y was self-reported. Childhood BMIZ calculated using British 1990 growth references adjusted for sex and age. Internal, sex-specific BMIZ were created for adults (20-34 y and 42 y). **Age(s) at outcome assessment:** 1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16-23 (draft board; men), 20-34, 42 y	**BMIZ @ 1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16-23 (draft board; men only), 20-34, 42 y (β (95% CI))** Continuous 1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16-23 y (draft board; men only): All data NR, p=NS **20-34 y: -0.072 (-0.133, -0.010)** **42 y: -0.064 (-0.101, -0.027)** **WC (cm) @ 42 y (β (95% CI))** Continuous Data NR, p=NS **Overweight @ 42 y (OR (95% CI)** **Continuous: 0.90 (0.81, 0.98)** **Categorical: Lower risk with later introduction (data NR), p=0.046** **Obesity @ 42 y (OR (95% CI)** Continuous: 0.89 (0.76, 1.03) Categorical: Data NR	**Key confounders accounted for:** SEP; sex; milk feeding practices; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; baseline anthropometry **Model adjustments:** Duration of BF, sex, maternal age at birth, prepregnancy BMI, gestational weight gain, smoking during pregnancy, social class, breadwinner's education, single mother status, prematurity, BMI (analysis of waist circumference only) **Funding:** NICHD; NIDA; The Danish Research Council; Danish National Board of Health; The National Danish Science Foundation; The National Danish Agricultural and Veterinary Research Council

[a] Abbreviations: @: at; β: beta; BF: breastfeeding; BMI: body mass index; BMIZ: BMI z-score; CI: confidence interval; EBF: exclusive breastfeeding; FF: formula feeding; h: hour; kg: kilogram;; lb: pound; mo: month; NA: not applicable; NR: not reported; NS: non-significant; OR: odds ratio; PCS: prospective cohort study; ref: reference; SD: standard deviation; SDS: standard deviation score; SE: standard error; SEP: socioeconomic position; SES: socioeconomic status; U.S.: United States; WAZ: weight-for-age z-score; WC: waist circumference; wk: week; x: times; y: year

Table 13. Risk of bias for observational studies examining timing of introduction to vegetables and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Carruth, 2000[3]	LOW	LOW	LOW	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Gingras, 2019[4]	LOW	SOME CONCERNS	LOW	LOW	SOME CONCERNS	LOW	SOME CONCERNS	SOME CONCERNS
Schack-Nielsen, 2010[5] (Outcome at 1-34 y)	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Schack-Nielsen, 2010[5] (Outcome at 42 y)	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	SOME CONCERNS	SOME CONCERNS	HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Grains

Description of the evidence

Six studies met inclusion criteria and examined the relationship between the timing of introduction of grains in infants and young children, up to age 24 months, and growth, body composition, and risk of obesity (**Table 15**).[3-8] All 6 studies were PCS, using data from the following cohorts: the Copenhagen Perinatal Cohort,[5] Global Exploration of Human Milk (GEHM),[8] Project Viva,[4] TARget Kids!,[7] the WIC Infant and Toddler Feeding Practices Study-2 (ITFPS-2),[6] and 1 unnamed study.[3]

Population

The studies were conducted in the United States,[3,4,6,8] Canada,[7] China,[8] Denmark,[5] and Mexico.[8] The analytic sample sizes of the studies ranged from 94[3] to 8,943,[7] although the sample sizes for most analyses were less than 2,000.[3-6,8] None of the studies reported power calculations related to the timing of introduction to grains and the relevant outcomes.

Four studies provided information on the racial and/or ethnic background of participants. Three studies predominantly or exclusively included participants who were White or European,[3,4,7] but in 2 of these studies individuals of other races and/or ethnicities were represented including individuals who identified as African, African American or Black, Asian, Hispanic, and Latin American.[4,7] The fourth study had a more racially and ethnically diverse group of participants, with ~41% of participants being Hispanic and ~25% of participants being non-Hispanic Black.[6] Maternal age, reported in 5 studies, typically ranged, on average, from the mid-twenties to the early thirties.[3-6,8] Human milk and formula feeding practices were reported in all studies, showing that breastfeeding was initiated in a large proportion of the participants, while duration and exclusivity of breastfeeding varied.[3-8] SEP was reported in all 6 studies using a variety of metrics. Maternal education was reported in 4 studies: a large proportion of participants attended or graduated from college in 3 studies,[3,4,8] while 1 study included a larger proportion of participants who had a high school level of education or less.[6] Household income was reported in 3 studies: 1 which reported that 66% participants had a household income >$70,000 per year,[4] 1 which reported that 64% of participants were at or below 75% of the U.S. poverty guideline,[6] and 1 which reported that 32% and 42% of participants had a family income of 80,000-149,999 CAD and ≥150,000 CAD, respectively.[7] WIC participation was reported in 2 studies: in 1 study all individuals were participating in WIC[6] and in the other, among participants from the United States, approximately 34% participated in WIC.[8]

The children enrolled in these studies were approximately 50% female. The mean birth weight ranged from approximately 3.2 kilograms[5] to 3.5 kilograms.[3,4] Regarding gestational age, 5 studies reported that most or all participants were born term,[5-8] while the sixth study reported that the mean gestational age at birth was 39.7 weeks.[4] Baseline anthropometry was not reported in most studies.[3-6,8]

Exposures and comparators

The studies examined the timing of introduction to a small number of grains products including cereal or infant cereal,[3,4,6,7] “firm food” (i.e., “soaked bread and biscuits),[5] and cereals more broadly (e.g., bread, tortillas, rice, cereal, pasta).[8] Timing of introduction to these products was examined continuously in 4 studies[3,5,6,8] and categorically in 3 studies.[4,5,7] However, 1 study that modeled timing of introduction continuously did so on the basis of adherence to guidelines, such that introduction both before and after age 6 to 7 months (age of maximum score) received lower scores.[6] Among the studies that examined timing of introduction categorically, 1 compared ≥4 months to <4 months,[5] 1 compared 4 months, 5 months, and 6 months,[7] and 1 compared 4 to <6 months to <4 months and ≥6 months.[4] The dietary assessment methods included 24-hour recall,[3,6] 24-hour food frequency recall,[8] and questionnaires or interviews, [4,5,7] completed by a mother or caregiver. For 3 studies, frequent assessments throughout infancy were conducted.[3,6,8]

Outcomes

Growth, body composition, and risk of obesity were assessed using a variety of measures. Outcomes related to growth were reported in all 6 studies,[3-8] with the most common outcome being BMIZ. One study examined measures of body composition[4] and 2 studies examined odds of overweight and obesity.[5,7] These outcomes were almost all measured by study personnel, with the exception of a single assessment in 1 study.[5] Z-scores were calculated using growth standards from the WHO,[7,8] the Centers for Disease Control and Prevention (CDC),[4,6] and Britain (1990).[5] The outcomes were assessed at a wide range of ages: 4 studies assessed outcomes among infants and young children up to age 24 months,[3,5,7,8] 4 studies assessed outcomes among children,[4-7] and 1 study assessed outcomes among adolescents and adults.[5]

Synthesis of the evidence

Among the 6 articles that met inclusion criteria and analyzed outcomes related to growth, 3 studies reported a mix of statistically significant and nonsignificant findings,[4,5,7] while 3 studies reported exclusively null findings[3,6,8] (**Table 15**) The 3 studies that reported statistically significant findings all examined BMIZ, and the direction and magnitude of these results were consistent. The first study found that introduction to infant cereal at age 4 months compared to age 6 months was associated with slightly higher BMIZ at age 1 and 10 years, while associations with BMIZ at age 5 and comparisons with introduction at age 5 months were statistically nonsignificant, but trended in the same direction.[7] Height-for-age z-score (HAZ) was also examined in this study, and while introduction to infant cereals at age 4 or 5 months was associated with higher HAZ at age 1 year compared to introduction at age 6 months, statistically significant differences in HAZ were no longer present at either age 5 or 10 years.[7] A second study reported that introduction to infant cereal <4 months, compared to introduction at 4 to <6 months, was associated with slightly higher BMIZ at age 8 years, as well as at age 13 years (but only among individuals who breastfed for less than 4 months; the association among individuals who were breastfed for at least 4 months was statistically non-significant but trended in the same direction).[4] Finally, the third study examined timing of introduction to “firm food” (i.e., soaked bread and biscuits) continuously and found that later introduction was associated with slightly lower BMIZ at ages 1, 10, and 11 years, but reported no significant association with BMIZ at any other age at assessment from childhood through adulthood.[5] All 3 of these studies analyzed several hundreds or thousands of participants,[4,5,7] including 1 study which analyzed approximately 8,900 participants.[7] The remaining 3 studies did not detect any statistically significant associations between timing of introduction to grains and outcomes related to growth, including BMIZ, weight-for-age z-score (WAZ), weight, length-for-age z-score (LAZ), and length; none of the studies reported the directionality of any non-significant trends.[3,6,8] While all 3 studies examined timing of introduction to grains, 1 study modeled age of introduction based on degree of adherence to guidelines (i.e., lower scores for introduction to iron-rich cereal both before and after age 6-7 months) versus directly by increasing age, limiting the comparability of these results to those of the other studies.[6] In sum, among studies that examined BMIZ, there was consistency of results such that the direction of both statistically significant and non-significant associations tended to be similar (among the 3 studies that reported this information). Further, among those studies that detected associations between timing of introduction of grains and BMIZ, 2 examined a similar cut-point (approximately age 4 months) and the sample sizes were relatively large ranging from approximately 350 participants to 8,900 participants. Other growth outcomes were less frequently reported across studies.

Few studies examined body composition or the odds of overweight and/or obesity as an outcome (**Table 15**).[4,5,7] Although a similar pattern of results was observed, with all reporting a mix of null associations and statistically significant associations between earlier introduction and greater waist circumference or odds of overweight and/or obesity, the small number of studies on these topics limit the ability to draw conclusions.

Conclusion statements and grades

The Committee developed a conclusion statement about the relationship between the timing of introduction of grains and growth, specifically BMIZ, based on their review of the body of evidence (**Table 14**). The grade reflects the strength of the evidence underlying the conclusion statement. However, the Committee did not draw a conclusion statement about the relationship between the timing of introduction of grains and body composition and risk of obesity because there is not enough available evidence (**Table 14**). The risk of bias assessments for this body of evidence are documented in **Table 16**.

Table 14. Conclusion statements, grades for timing of introduction to grains and growth and timing of introduction to grains and body composition and risk of obesity

Conclusion Statement	**Introducing grains at or before age 4 months is associated with higher BMI z-score during childhood. This conclusion is based on evidence graded as limited.**
Grade	Limited
Body of Evidence	6 articles (6 studies): 6 prospective cohort studies
Consistency	Some concerns with consistency due to some inconsistency in the significance of findings.
Precision	Some concerns with precision due to few studies and small effect sizes.
Risk of bias	Some concerns with risk of bias, particularly due to confounding and exposure measurement.
Directness	Minimal concerns with directness
Generalizability	Some concerns with generalizability due to more limited applicability to the U.S. population.
Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to grains and body composition and risk of obesity during childhood because there is not enough evidence available.**
Grade	Grade Not Assignable
Body of Evidence	3 articles: 3 prospective cohort studies
Rationale	There is not enough evidence available to draw a conclusion statement.

Assessment of the evidence

The body of evidence underlying the graded conclusion statement above includes 6 articles from 6 PCS. The evidence was graded based on an assessment of 5 grading elements, as described below. Publication bias was also a consideration; however, this was not assessed as a serious concern because the body of evidence included studies that reported only nonsignificant findings as well as studies that reported a mix of both significant and nonsignificant results, across a range of analytic sample sizes. However, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias.

Consistency

There was some inconsistency in the results; specifically, half of the studies reported a mix of statistically significant and non-significant results while half reported exclusively null results. However, the direction of the statistically significant results were consistent, with earlier introduction to grains, particularly before 4 months of age, associated with greater BMIZ, including both studies that assessed age of introduction to grains categorically. Further, the non-significant associations reported in these studies predominantly trended in the same direction. There was some inconsistency among the studies regarding the type of grains product under study, with 4 studies examining cereal or infant cereal, 1 study examining “firm food” (i.e., soaked bread and biscuits), and 1 study examining cereal products more broadly.

Precision

Only 6 studies examined the relationship between timing of introduction to grains and outcomes related to growth, 5 of which examined BMIZ. The analytic sample sizes ranged from 94 to 8,943, although most studies had an analytic sample size between 350 and 2,000 participants. The effect sizes, when reported, were generally small. None of the studies provided information regarding statistical power.

Risk of bias

There were several risk of bias concerns across the body of evidence (**Table 16**). Four studies did not account for all key confounders, 4 studies had some concerns regarding the methods of exposure measurement, and a pre-registered analysis plan was not available for any of the studies. Additionally, risk of bias due to missing data was of concern for half of the studies. Risk of bias due to selection of participants, post-exposure interventions, and outcome measurement were assessed as low for most or all studies.

Directness

The populations, exposures, comparators, and outcomes examined in the studies are directly related to the systematic review question. Specifically, all 6 studies examined timing of introduction to grains and outcomes related to growth. However, most studies examined timing of introduction to a single grain product (e.g., infant cereal) rather than assessing introduction to grains more broadly as a food group.

Generalizability

Four studies were conducted in the United States, either in part or in full, while the remaining studies were conducted in Canada, Denmark, China, and Mexico. Most of the studies tended to include participants with higher average levels of education and income, and who were predominantly White or European, with more limited representation of individuals from other racial and/or ethnic groups. However, some studies did include or focus on individuals with relatively lower SEP or were more racially and/or ethnically diverse.

Table 15. Evidence examining the relationship between timing of introduction to grains and growth, body composition, and risk of obesity[a]

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, and Funding
Au, 2023[6] PCS, WIC ITFPS-2, U.S. Analytic N = 1,523 (24 mo), 1,680 (36 mo), 1,872 (48 mo) (Excluded participants with missing data on HEI-2015 or BMI at 2, 3, or 4 y, born prematurely, had very low birth weight, or had long-term medical problems that could affect eating.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Hispanic: 40.6%, Non-Hispanic White: 29.1%, Non-Hispanic African American: 24.8%, Non-Hispanic Other: 5.5% Maternal education: <HS: 24.4%, HS: 37.7%, >HS: 37.5% Other SEP measure(s): Participating in WIC: 100%; Maternal employment at 6 mo: Full-time: 21.5%, Part-time: 20.2%, Not working for pay: 58.2%; Poverty level at enrollment: ≤75% of poverty guideline: 64.0%, >75-<130%: 26.3%, >130% poverty: 9.7% Maternal age: 16-19 y: 11.7%, 20-25 y: 41.1%, ≥26 y: 47.3% Milk feeding practices: Any BF: 81.9%; Any formula use: 95.5% Child sex (female): 49% Birth weight: Low (<2.5 kg): 5.3%, Normal (2.5-≤4.5 kg): 93.4%, High (>4.5 kg): 1.3% Gestational age: Excluded infants born prematurely	**Exposure(s) and comparator(s):** Iron-rich cereals (Continuous; Infant Diet Quality Index component score from 0-1 based on degree of adherence to guidelines; max score: introduced at 6-7 mo) **Dietary assessment methods:** 24-h dietary recall via telephone interview with caregiver **Age(s) at dietary assessment:** 1, 3, 5, 7, 9 11, 13, 15, 18, 24, 30, 36, 42, and 48 mo **Age of introduction:** 6-7 mo: 36.2% **Outcome(s):** BMIZ **Outcome assessment methods:** Weight and length/height collected at WIC sites or from child's health care provider. BMIZ based on CDC age- and sex-specific growth charts **Age(s) at outcome assessment:** 2, 3, 4 y	**BMIZ @ 2, 3, 4 y** 2 y: Data NR, p>0.10 3 y: Data NR, p>0.10 4 y: Data NR, p>0.10	**Key confounders accounted for:** SEP; sex; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; milk feeding practices; baseline anthropometry **Model adjustments:** None **Funding:** NHLBI; USDA/NIFA

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, and Funding
Carruth, 2000[3] PCS, U.S. Analytic N = 94 (Reasons for attrition NR) Adequately powered: Yes **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: White: 100% Maternal education: College degree: 50% Other SEP measure(s): Hollingshead Index: 54 (9) – all "middle or upper SES families" Maternal age: 31 y Milk feeding practices: Ever BF: 83%, EBF at 4 mo: 33%, Mixed feeding at 4 mo: 33%, EBF at 6 mo: 12% Child sex (female): 46% Birth weight: Males: 7.8 (1.2) lb, Females: 7.6 (1.1) lb Gestational age: 100% full-term	**Exposure(s) and comparator(s):** Cereal (Continuous) **Dietary assessment methods:** 24-h recall (maternal report) with dietitian **Age(s) at dietary assessment**: 2, 3, 4, 6, 8, 10, 12, 16, 20, 24 mo (interviewed 3-5x from 2-10 mo, 2-4x from 12-24 mo) **Age of introduction:** Median (range): 4.0 (0.5-6.5) mo **Outcome(s):** Weight, length, Change in weight slope relative to length slope **Outcome assessment methods:** Weight and length measured by research staff **Age(s) at outcome assessment:** 2, 3, 4, 6, 8, 10, 12, 16, 20, 24 mo (measured 3-5x from 2-10 mo, 2-4x from 12-24 mo)	**Change in weight @ 2-8 mo, 12-24 mo (β (SE))** Change from 2-8 mo: Data NR, p>0.05 Change from 12-24 mo: Data NR, p>0.05 **Change in length @ 2-8 mo, 12-24 mo (β (SE))** Change from 2-8 mo: Data NR, p>0.05 Change from 12-24 mo: Data NR, p>0.05 **Change in weight slope relative to length slope @ 2-8 mo, 12-24 mo (β (SE))** Change from 2-8 mo: Data NR, p>0.05 Change from 12-24 mo: Data NR, p>0.05	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** None **Model adjustments:** NA (cereal not retained in model) **Funding:** NR
D'Hollander, 2022[7] PCS, TARGet Kids!, Canada Analytic N = 8,943 (Excluded children who were never introduced to infant cereal (too young at survey) or were introduced to a different solid food first.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: European: 62.8%, Asian: 19.6%, Other (mixed, Arab): 8.7%, African: 5.7%, Latin American: 3.2% Maternal education: NR Other SEP measure(s): Family income (Canadian $): ≤29,999: 7.7%; 30,000-79,999: 18.3%; 80,000-149,999: 32.2%; ≥150,000: 41.8% Maternal age: NR	**Exposure(s) and comparator(s):** Infant cereal (4 mo, 5 mo, 6 mo) **Dietary assessment methods:** Caregiver report via nutrition questionnaire adapted from Canadian Community Health Survey **Age(s) at dietary assessment:** Surveyed 2x/y until age 2 y, annually until age 10 y; first response after introduction of infant cereal used (mean = 2.2 y) **Age of introduction:** 4 mo: 18.8%, 5 mo: 21.6%, 6 mo: 44.7% **Outcome(s):** BMIZ, zHeight, underweight, overweight, obesity **Outcome assessment methods:** Height	**BMIZ @ 1 y, 5 y, 10 y (β (95% CI))** Infant cereal at 4 mo vs 6 mo (ref) **1 y: 0.06 (0.01, 0.12), p=0.03** 5 y: 0.03 (-0.03, 0.08), p=0.39 **10 y: 0.17 (0.06, 0.28), p=0.002** Infant cereal at 5 mo vs 6 mo (ref) 1 y: Data NR, p=NS 5 y: Data NR, p=NS 10 y: Data NR, p=NS Infant cereal at 4 mo vs 5 mo (ref) 1 y: Data NR, p=NS 5 y: Data NR, p=NS 10 y: Data NR, p=unclear **zHeight @ 1 y, 5 y, 10 y (β (95% CI))** Infant cereal at 4 mo vs 6 mo (ref) **1 y: 0.09 (0.04, 0.15), p=0.002** 5 y: -0.02 (-0.08, 0.04), p=0.53 10 y: 0.03 (-0.08, 0.14), p=0.63	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** Predominant feeding type in first year of life (breast milk, formula, or mixed), birth weight, child sex, gestational age, parental ethnicity, family income, sugar-sweetened beverage intake, cow's milk volume, bottle feeding and nonlinear time introduced to infant cereal (restricted cubic splines, 5 knots), child age (restricted cubic splines, 5

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, and Funding
Milk feeding practices: During first y – Predominantly BF: 59.9%; Predominantly formula fed: 17.2%; Mixed: 22.9% Child sex (female): 48% Birth weight: 3.3 (0.6) kg Gestational age: ≥37 wk: 89.2%	and weight measured by trained research assistants. BMIZ and zHeight scores and categories determined using WHO growth standards and cut-offs; underweight, BMIZ < -2; normal weight, -2 ≤ BMIZ ≤ 1, overweight, 1 < BMIZ ≤2; obesity, BMIZ > 2. **Age(s) at outcome assessment:** Measured 2x/y until age 2 y, annually until age 10 y	Infant cereal at 5 mo vs 6 mo (ref) **1 y: 5mo > 6mo (Data NR), p<0.05** 5 y: Data NR, p=NS 10 y: Data NR, p=NS Infant cereal at 4 mo vs 5 mo (ref) 1 y: Data NR, p=NS 5 y: Data NR, p=NS 10 y: Data NR, p=NS **Underweight @ 1 y, 5 y, 10 y (OR (95% CI))** Infant cereal at 4 mo vs 6 mo (ref) 1 y: 1.08 (0.85, 1.38), p=0.54 5 y: 0.72 (0.43, 1.22), p=0.22 10 y: 0.32 (0.08, 1.23), p=0.10 **Overweight @ 1 y, 5 y, 10 y (OR (95% CI))** Infant cereal at 4 mo vs 6 mo (ref) 1 y: 1.03 (0.87, 1.22), p=0.70 5 y: 1.05 (0.89, 1.24), p=0.55 10 y: 1.12 (0.80, 1.62), p=0.54 **Obesity @ 1 y, 5y, 10 y (OR (95% CI))** Infant cereal at 4 mo vs 6 mo (ref) 1 y: 1.25 (0.93, 1.69), p=0.14 5 y: 1.28 (0.96, 1.71), p=0.10 **10 y: 1.82 (1.18, 2.80), p=0.006**	knots; effect modifier; zHeight and weight status only), maternal BMI (BMIZ and weight status only), maternal height (zHeight only) **Funding:** Canadian Institutes of Health Research (CIHR) Institute of Human Development, Child and Youth Health

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, and Funding
<u>Gingras, 2019</u>[4] PCS, Project Viva, U.S. <u>Analytic N</u> = 1,013 (Excluded participants who did not have complete exposure data, did not have outcomes measured, and children born <34 wk gestation) <u>Adequately powered:</u> NR **Participant Characteristics** (Mean (SD) unless otherwise noted) <u>Race and/or ethnicity:</u> NR (Child race and/or ethnicity: White: 69%, Black or African American: 12%, Other: 12%, Hispanic: 4%, Asian: 3%) <u>Maternal education:</u> College graduate: 74% Other SEP measure(s): Household income >$70,000/y: 66% <u>Maternal age:</u> 32.6 (4.8) y <u>Milk feeding practices:</u> Any BF at 4 mo: 69% <u>Child sex (female):</u> 51% <u>Birth weight:</u> 3.53 (0.52) kg <u>Birth weight for gestational age z score:</u> 0.23 (0.97) <u>Gestational age:</u> 39.7 (1.4) wk	**<u>Exposure(s) and comparator(s):</u>** Infant cereal (<4 mo, 4-<6 mo (ref), ≥6 mo) **<u>Dietary assessment methods:</u>** Maternal questionnaire **<u>Age(s) at dietary assessment:</u>** 6, 12 mo **<u>Age of introduction:</u>** <4 mo: 15.3%, 4-<6 mo: 69.4%, ≥6 mo 15.3% **<u>Outcome(s):</u>** BMIZ, WC **<u>Outcome assessment methods:</u>** All outcomes measured by trained research staff. Age- and sex-specific BMIZ calculated using U.S. national reference data. **<u>Age(s) at outcome assessment:</u>** Mean (SD): 7.9 (0.8) y; 13.2 (0.9) y	**<u>BMIZ @ ~8 y (β (95% CI))</u>** Among infants BF ≥4 mo: **<4 mo vs 4-<6 mo (ref): 0.28 (0.03, 0.53)** ≥6 mo vs 4-<6 mo (ref): -0.08 (-0.26, 0.11) Among infants FF (never BF or stopped BF by 4 mo): **<4 mo vs 4-<6 mo (ref): 0.33 (0.09, 0.57)** ≥6 mo vs 4-<6 mo (ref): 0.35 (-0.02, 0.73) **<u>BMIZ @ ~13 y (β (95% CI))</u>** Among infants BF ≥4 mo: <4 mo vs 4-<6 mo (ref): 0.20 (-0.08, 0.47) ≥6 mo vs 4-<6 mo (ref): -0.04 (-0.24, 0.16) Among infants FF (never BF or stopped BF by 4 mo): **<4 mo vs 4-<6 mo (ref): 0.31 (0.02, 0.59)** ≥6 mo vs 4-<6 mo (ref): 0.17 (-0.27, 0.60) **<u>WC (cm) @ ~8 y (β (95% CI))</u>** Among infants BF ≥4 mo: **<4 mo vs 4-<6 mo (ref): 2.24 (0.46, 4.01)** ≥6 mo vs 4-<6 mo (ref): 0.12 (-1.18, 1.42) Among infants FF (never BF or stopped BF by 4 mo): **<4 mo vs 4-<6 mo (ref): 2.58 (0.49, 4.66)** ≥6 mo vs 4-<6 mo (ref): 2.33 (-0.82, 5.48) **<u>WC (cm) @ ~13 y (β (95% CI))</u>** Among infants BF ≥4 mo: **<4 mo vs 4-<6 mo (ref): 3.02 (0.21, 5.82)** ≥6 mo vs 4-<6 mo (ref): 0.67 (-1.35, 2.68) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): 3.10 (-0.39, 6.58) ≥6 mo vs 4-<6 mo (ref): 1.77 (-3.38, 6.92)	**<u>Key confounders accounted for:</u>** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry **<u>Key confounders NOT accounted for:</u>** None **<u>Model adjustments:</u>** child sex, child age, maternal education level, marital status, household income, maternal prepregnancy BMI, paternal BMI, child's race and/or ethnicity, gestational age at delivery, change in WAZ score from 0 to 4 mo. **<u>Funding</u>:** NIH, CIHR

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, and Funding
Schack-Nielsen, 2010[5] PCS, Copenhagen Perinatal Cohort, Denmark Analytic N = 5,068 (N for individual analyses ranged from 367-1,675) (Excluded participants without information on BF, introduction of spoon feeding, birth weight, and/or at least 1 BMI measurement from 1-42 y.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR Maternal education: NR Other SEP measure(s): Social class: ~4.0 (1-8 point scale; 8=highest); Breadwinner's education: ~2.4 (1-4 point scale; 4=highest) Maternal age: ~26 y Milk feeding practices: Duration of any BF (median (10th, 90th percentile)): 2.50 (0.23, 6.50) mo Child sex (female): NR Birth weight: 3,232 (588) g Gestational age: ~18% preterm (≤37 wk) Other relevant characteristics: Participants were recruited from a hospital that preferentially admitted mothers with previous or expected pregnancy/delivery complications and mothers where a home delivery was not advised (primarily single mothers).	**Exposure(s) and comparator(s):** Firm food (also described as "soaked bread and biscuits") (Continuous (mo); ≥4 mo vs <4 mo (ref)) **Dietary assessment methods:** Maternal interview **Age(s) at dietary assessment:** 1 y **Age of introduction:** 8.10 (2.08) mo **Outcome(s):** BMIZ, overweight, obesity **Outcome assessment methods:** Weight and height at 1, 3, and 6 y measured by study personnel. Weight and height from 7-14 y measured at school health examinations. Weight and height for men from 16-23 y measured at draft board examinations. Weight and height at 20-34 y measured by study personnel. Weight and height at 42 y was self-reported. Childhood BMIZ calculated using British 1990 growth references adjusted for sex and age. Internal, sex-specific BMIZ were created for adults (20-34 y and 42 y). **Age(s) at outcome assessment:** 1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16-23 (draft board; men), 20-34, 42 y	**BMIZ @ 1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16-23 (draft board; men only), 20-34, 42 y (β (95% CI))** Age at introduction to firm food (continuous) 3, 6, 7, 8, 9, 12, 13, 14, 16-23 (draft board; men only), 20-34 y: All data NR, p=NS **1 y: -0.053 (-0.082, -0.024)** **10 y: -0.054 (-0.096, -0.012)** **11 y: -0.057 (-0.101, -0.013)** 42 y: -0.022 (-0.048, 0.004) **Overweight @ 42 y (OR (95% CI)** Age at introduction to firm food **Continuous: 0.92 (0.86, 0.98)** Categorical: Data NR, p=NS **Obesity @ 42 y (OR (95% CI)** Age at introduction to firm food Continuous: 1.00 (0.90, 1.11) Categorical: Data NR, p=NR	**Key confounders accounted for:** SEP; sex; milk feeding practices; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; baseline anthropometry **Model adjustments:** Duration of BF, sex, maternal age at birth, prepregnancy BMI, gestational weight gain, smoking during pregnancy, social class, breadwinner's education, single mother status, prematurity, birth weight, weight at 1 y (analysis of BMIZ for timing of any only), BMI (analysis of WC only) **Funding:** NICHD; NIDA; The Danish Research Council; Danish National Board of Health; The National Danish Science Foundation; The National Danish Agricultural and Veterinary Research Council

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, and Funding
Woo, 2013[8] PCS, GEHM, China, Mexico, U.S. Analytic N = 285 (Excluded participants who were lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR (Country: China: ~36%, Mexico: ~31%, U.S.: ~32%) Maternal education: China, Mexico, U.S., respectively: ≤HS graduate: 18.3%, 93.2%, 5.0%, Attended or graduated from college: 72.5%, 5.9%, 78.3%, Post-college education: 9.2%, 0.8%, 16.7% Other SEP measure(s): Employed at time of pregnancy: 71.4% (China), 40.7% (Mexico), 80.8% (U.S.); WIC (U.S.): ~34%, Nutrisano supplemental food program (Mexico): 0%, Supplemental food programs in Shanghai (China): 0% Maternal age: 29.3 (3.7) y (China), 24.4 (5.6) y (Mexico), 31.5 (5.2) y (U.S.) Milk feeding practices: EBF duration (median (IQR)): China: 4.9 (1.6, 11.9) wk, Mexico: 7.1 (0.0, 18.0) wk, U.S.: 13.7 (4.6, 19.3) wk. BF duration (median): China: 37.1 wk, Mexico: 52.0 wk, U.S.: 49.5 wk Child sex (female): 49% Birth weight: ~3.4 kg Gestational age: 100% ≥37 wk gestation	**Exposure(s) and comparator(s):** Cereals (e.g., bread, tortillas, rice, cereal, pasta) (Continuous; mo) **Dietary assessment methods:** Maternal 24 h food frequency recall via telephone. **Age(s) at dietary assessment:** 2-52 wk, weekly **Age of introduction:** Median (IQR) for China, Mexico, and U.S., respectively (mo): Bread or cereal: 4.3 (4.1, 4.6), 6.7 (6.2, 7.6), 5.4 (4.4, 6.1) **Outcome(s):** WAZ, LAZ, BMIZ **Outcome assessment methods:** Weight and length measured by trained study personnel. WAZ, LAZ, and BMIZ calculated using age- and sex-specific z-scores from the 2005 WHO infant growth standards. **Age(s) at outcome assessment:** 1 y	**WAZ @ 1 y** Data NR, p≥0.20 **LAZ @ 1 y** Data NR, p≥0.20 **BMIZ @ 1 y** Data NR, p≥0.20	**Key confounders accounted for:** SEP; sex; milk feeding practices; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; baseline anthropometry **Model adjustments:** Cohort site **Funding:** Mead Johnson Nutrition Inc; NIH/NICHD; NIH/NCRR (Institutional Clinical and Translational Science Award)

[a] Abbreviations: @: at; β: beta; BF: breast feeding; BMI: body mass index; BMIZ: BMI z-score; CI: confidence interval; cm: centimeter; d: day; DXA: Dual-energy X-ray absorptiometry; EBF: exclusive breast feeding; FF: formula fed; g: gram; GEHM: Global Exploration of Human Milk; h: hour; HS: high school; IQR: interquartile range; kg: kilogram; LAZ: length-for-age z-score; mm: millimeter; mo: month; NR: not reported; NS: non-significant; OR: odds ratio; PCS: prospective cohort study; ref: reference; SD: standard deviation; SE: standard error; SEP: socioeconomic position; SES: Socioeconomic status; TARGet Kids: The Applied research Group for Kids!; U.S.: United States; WAZ: weight-for-age z-score; WC: waist circumference; WHO: World Health Organization; WIC: Special Supplemental Nutrition Program for Women, Infants, and Children; WC: waist circumference; wk: week; y: year

Table 16. Risk of bias for observational studies examining timing of introduction to grains and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Au, 2023[6]	HIGH	LOW	LOW	LOW	SOME CONCERNS	LOW	SOME CONCERNS	HIGH
Carruth, 2000[3]	LOW	LOW	LOW	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
D'Hollander, 2022[7]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Gingras, 2019[4]	LOW	SOME CONCERNS	LOW	LOW	SOME CONCERNS	LOW	SOME CONCERNS	SOME CONCERNS
Schack-Nielsen, 2010[5] (all time points except 42 y)	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Schack-Nielsen, 2010[5] (42 y time point)	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	SOME CONCERNS	SOME CONCERNS	HIGH
Woo, 2013[8]	VERY HIGH	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH	VERY HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Protein foods

Description of the evidence

Four studies met inclusion criteria and examined the relationship between timing of introduction of foods from the protein foods group among infants and young children, up to age 24 months, and growth, body composition, and risk of obesity (**Table 18**).[5,8-10] All 4 studies were PCS, using data from the following cohorts: the Copenhagen Perinatal Cohort,[5] GEHM,[8] Infant Feeding Practices Study II (IFPS II),[10] and Project Viva.[9]

Population

Two studies were conducted in the United States,[9,10] 1 study was conducted in Denmark,[5] and 1 study included participants from China, Mexico, and the United States.[8] The analytic sample sizes ranged from 285[8] to 1,675.[5] No studies reported whether the samples were sufficiently powered to detect differences in growth, body composition, and risk of overweight or obesity outcomes by age of introduction of protein foods.

Among the 2 studies that provided information on the racial and/or ethnic background of participants, both studies reported that greater than 70% of participants were non-Hispanic White.[9,10] Average maternal age ranged from mid-twenties to early-thirties.[5,8-10] Human milk and formula feeding practices were reported in 2 studies: the first study reported a median duration of any breastfeeding of 2.5 months,[5] and the second study reported a median duration of any and exclusive breastfeeding that ranged from 37.1 to 52.0 weeks and 4.9 weeks to 13.7 weeks, respectively, with the longest median durations in the United States and the shortest median durations in China.[8] Maternal education was reported across 3 studies,[8-10] 1 which reported that 44.8% had a college degree or higher,[10] 1 which reported that 75.9% had a college degree or higher,[9] and a third which reported that 72.5%, 5.9%, and 78.3% attended or graduated from college in China, Mexico, and the United States, respectively.[8] Other measures of SEP were provided in all 4 studies. One study reported that 68% of participants had a household income greater than $70,000 per year,[9] 1 study reported that 61% of participants had family incomes above 185% of the federal poverty level (FPL),[10] a third reported that about 34% of the sample participated in WIC,[8] and the fourth study reported that participants had an average social class score of about 4 on an 8-point scale.[5] This final study also recruited participants from a hospital that preferentially admitted mothers with previous or expected pregnancy or delivery complications and mothers where a home delivery was not advised.[5]

Regarding the characteristics of the infants and young children, approximately 50% of participants were female[8-10] and the mean birth weight ranged from 3.2 to 3.5 kilograms.[5,8-10] Regarding gestational age, 1 study enrolled only term infants,[8] 1 study reported that most infants (95.7%) were born term,[10] another study reported that approximately 18% of infants were born preterm, and the last study reported that the mean gestational age was 39.5 weeks.[9] No studies reported baseline growth, body composition, or risk of obesity.

Exposures and comparators

Of the studies that assessed timing of introduction of foods from the protein foods group, 3 examined eggs,[5,9,10] 1 examined meat,[5] and 1 examined high protein foods (e.g., egg, meat, fish, and legumes).[8] The exposure variable was analyzed continuously in 3 studies[5,8,10] and categorically in 2 studies, examining cut points at 4 months[5] and 12 months.[9] To measure timing of introduction of foods from the protein foods group, 2 studies used a questionnaire,[9,10] 1 study conducted maternal interviews,[5] and 1 study collected 24-hour food frequency recalls.[8] Half of the studies assessed timing of introduction of foods from the protein foods group multiple times up to age 1 year,[8,10] and the other half measured the exposure at age 1 year only.[5,9] The age at which the exposure was measured varied from 2 weeks[8] to 1 year.[5,8-10]

Outcomes

All 4 studies assessed growth,[5,8-10] 1 study assessed body composition,[9] and 3 studies assessed risk of overweight or obesity.[5,9,10] BMIZ was the most common outcome measure, having been assessed in all 4 studies. Other growth parameters included WAZ,[8] LAZ,[8] weight-for-height z-score (WHZ),[10] HAZ,[10] wasting,[10] and stunting.[10] Measures of body composition included total fat mass, trunk fat mass and lean mass.[9] Z-scores were calculated based on WHO,[8-10] CDC,[10] or British growth standards.[5] The age at which the outcomes were examined ranged widely from age 12 months to age 42 years, although most studies assessed the outcomes prior to adulthood. Research staff or nurses measured all outcomes, except for 1 timepoint (age 42 years) in 1 study which relied on self-report of weight, height, and waist circumference.[5]

Synthesis of the evidence

Among the 4 studies that met inclusion criteria,[5,8-10] findings were mixed with all 4 studies reporting null associations between the timing of introduction of protein foods and growth, body composition, and risk of obesity, 3 of which also reported significant associations between the age of introduction of protein foods and outcomes related to growth and body composition (**Table 18**). Among the null associations, all 4 studies reported non-significant associations between timing of introduction of eggs[5,9,10] and high-protein foods[8] and growth outcomes, most commonly BMIZ, across ages 1 to 42 years, body composition at various timepoints,[9] and risk of obesity.[5,9,10] The effect sizes were small and the directionality of results was mixed. Among the significant associations, eggs (1 study[10]) and meat (1 study[5] tended to be significantly associated with lower growth[5,10] and body composition[9] outcomes.

The ability to draw conclusions from this body of evidence were limited by inconsistency of the exposures and how they were categorized. Specifically, the foods examined varied including eggs, meat, and high-protein foods more broadly. Additionally, the exposure variables were analyzed in multiple ways, either continuously up to age 12 months or categorically at ages 4 or 12 months.

Conclusion statement and grade

The Committee did not draw a conclusion statement about the relationship between timing of introduction of foods from the protein foods group in infants and young children, up to age 24 months, and growth, body composition, and risk of obesity because of substantial concerns with consistency (**Table 17**). The foods examined as part of timing of introduction of the protein foods group varied from eggs, meat, to high-protein foods, including eggs, meat, fish, and legumes. Additionally, the exposure variable was analyzed in various ways, either measured continuously up to 12 months, or categorically at 12 months. Publication bias may be a limitation, but the small body of evidence makes it difficult to assess. However, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias. The risk of bias assessments for this body of evidence are documented in **Table 19**.

Table 17. Conclusion statement, grade for foods from the protein foods group consumption and growth, body composition, and risk of obesity

Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to foods from the protein foods group and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency in the body of evidence.**
Grade	Grade Not Assignable
Body of Evidence	4 articles: 4 prospective cohort studies
Rationale	The studies were not consistent in the exposures measured and there was variability in how timing was categorized.

Table 18. Evidence examining the relationship between the timing of introduction to protein foods and growth, body composition, and risk of obesity [a]

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Choudhary, 2023[9] PCS, Project Viva, U.S. Analytic N = 1,089 (Excluded participants with missing data on infant age at egg introduction and BMIZ at all time points.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Non-Hispanic White: 76.8%, non-Hispanic Black: 9.2%, Hispanic: 5.6%, Asian: 5.0%, >1 race or other: 3.4% Maternal education: No college degree: 24.1%, College degree or above: 75.9% Other SEP measure(s): Household annual income: ≤$70,000: 32.3%, >$70,000: 67.7% Maternal age: 32.7 (4.5) y Milk feeding practices: NR Child sex (female): 51% Birth weight: 3,502 (561) g Gestational age: 39.5 (1.8) wk	**Exposure(s) and comparator(s):** Egg (≤12 mo vs >12 mo (ref)) **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 1 y **Age of introduction:** ≤12 mo: 88.7%, >12 mo: 11.3% **Outcome(s):** Risk of obesity, BMIZ, fat mass, trunk fat mass, lean mass **Outcome assessment methods:** Weight and height measured by trained research assistants. Age- and sex-specific BMIZ and percentiles were based on WHO Child Growth Standards. Child obesity defined as sex- and age-specific BMI ≥95th percentile. Fat mass and lean mass measured using DXA. **Age(s) at outcome assessment:** 3 y, 7-10 y, 12-13 y	**BMIZ @ 3, 7-10, 12-13 y (mean difference (95% CI))** ≤12 mo vs >12 mo (ref) 3 y: 0.04 (-0.14, 0.23), p=0.651 7-10 y: 0.12 (-0.11, 0.35), p=0.320 12-13 y: -0.04 (-0.29, 0.21), p=0.756 Across all: 0.01 (-0.16, 0.17), p=0.948 Females: 3 y: 0.01 (-0.23, 0.25), p=0.962 7-10 y: 0.00 (-0.30, 0.29), p=0.974 12-13 y: -0.27 (-0.60, 0.06), p=0.112 Across all: -0.09 (-0.30, 0.13), p=0.423 Males: 3 y: 0.09 (-0.20, 0.37), p=0.548 7-10 y: 0.28 (-0.08, 0.64), p=0.132 12-13 y: 0.20 (-0.16, 0.57), p=0.272 Across all: 0.13 (-0.12, 0.38), p=0.304 **Total fat mass @ 7-10, 12-13 y (mean difference (95% CI))** ≤12 mo vs >12 mo (ref) 7-10 y: -0.05 (-0.46, 0.36), p=0.801 12-13 y: -0.34 (-1.03, 0.36), p=0.343 Across both: -0.20 (-0.69, 0.28), p=0.411 Females: 7-10 y: -0.41 (-0.96, 0.15), p=0.152 **12-13 y: -1.23 (-2.14, -0.31), p=0.009** **Across both: -0.75 (-1.44, -0.07), p=0.032** Males: 7-10 y: 0.44 (-0.15, 1.03), p=0.146 12-13 y: 0.68 (-0.36, 1.71), p=0.199 Across both: 0.49 (-0.12, 1.11), p=0.115	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; gestational age **Key confounders NOT accounted for:** milk feeding practices; baseline anthropometry **Model adjustments:** Obesity and BMIZ: Maternal age, prepregnancy BMI, household annual income; Total, trunk, and lean mass: Maternal age, prepregnancy BMI, household annual income, child age at outcome assessment, child sex **Funding:** Egg Nutrition Center/American Egg Board; NIH

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Choudhary, 2023[9] (continued) PCS, Project Viva, U.S. Analytic N = 1,089 (Excluded participants with missing data on infant age at egg introduction and BMIZ at all time points.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Non-Hispanic White: 76.8%, non-Hispanic Black: 9.2%, Hispanic: 5.6%, Asian: 5.0%, >1 race or other: 3.4% Maternal education: No college degree: 24.1%, College degree or above: 75.9% Other SEP measure(s): Household annual income: ≤$70,000: 32.3%, >$70,000: 67.7% Maternal age: 32.7 (4.5) y Milk feeding practices: NR Child sex (female): 51% Birth weight: 3,502 (561) g Gestational age: 39.5 (1.8) wk	**Exposure(s) and comparator(s):** Egg (≤12 mo vs >12 mo (ref)) **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 1 y **Age of introduction:** ≤12 mo: 88.7%, >12 mo: 11.3% **Outcome(s):** Risk of obesity, BMIZ, fat mass, trunk fat mass, lean mass **Outcome assessment methods:** Weight and height measured by trained research assistants. Age- and sex-specific BMIZ and percentiles were based on WHO Child Growth Standards. Child obesity defined as sex- and age-specific BMI ≥95th percentile. Fat mass and lean mass measured using DXA. **Age(s) at outcome assessment:** 3 y, 7-10 y, 12-13 y	**Trunk fat mass @ 7-10, 12-13 (mean difference (95% CI))** ≤12 mo vs >12 mo (ref) 7-10 y: 0.03 (-0.15, 0.22), p=0.716 12-13 y: -0.18 (-0.52, 0.16), p=0.293 Across both: -0.07 (-0.30, 0.15), p=0.523 Females: 7-10 y: -0.10 (-0.35, 0.16), p=0.460 **12-13 y: -0.57 (-1.01, -0.12), p=0.013** Across both: -0.30 (-0.61, 0.01), p=0.058 Males: 7-10 y: 0.22 (-0.04, 0.48), p=0.102 12-13 y: 0.29 (-0.21, 0.78), p=0.254 Across both: 0.22 (-0.09, 0.52), p=0.162 **Lean mass @ 7-10, 12-13 (mean difference (95% CI))** ≤12 mo vs >12 mo (ref) 7-10 y: 0.05 (-0.25, 0.35), p=0.731 12-13 y: -0.17 (-0.62, 0.28), p=0.453 Across both: -0.04 (-0.36, 0.28), p=0.795 Females: 7-10 y: 0.07 (-0.33, 0.48), p=0.716 12-13 y: -0.44 (-1.04, 0.16), p=0.153 Across both: -0.07 (-0.48, 0.33), p=0.721 Males: 7-10 y: 0.07 (-0.38, 0.53), p=0.749 12-13 y: 0.27 (-0.40, 0.94), p=0.427 Across both: 0.06 (-0.44, 0.55), p=0.814	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; gestational age **Key confounders NOT accounted for:** milk feeding practices; baseline anthropometry **Model adjustments:** Obesity and BMIZ: Maternal age, prepregnancy BMI, household annual income; Total, trunk, and lean mass: Maternal age, prepregnancy BMI, household annual income, child age at outcome assessment, child sex **Funding:** Egg Nutrition Center/American Egg Board; NIH

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Choudhary, 2023[9] (continued) PCS, Project Viva, U.S. Analytic N = 1,089 (Excluded participants with missing data on infant age at egg introduction and BMIZ at all time points.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Non-Hispanic White: 76.8%, non-Hispanic Black: 9.2%, Hispanic: 5.6%, Asian: 5.0%, >1 race or other: 3.4% Maternal education: No college degree: 24.1%, College degree or above: 75.9% Other SEP measure(s): Household annual income: ≤$70,000: 32.3%, >$70,000: 67.7% Maternal age: 32.7 (4.5) y Milk feeding practices: NR Child sex (female): 51% Birth weight: 3,502 (561) g Gestational age: 39.5 (1.8) wk	**Exposure(s) and comparator(s):** Egg (≤12 mo vs >12 mo (ref)) **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 1 y **Age of introduction:** ≤12 mo: 88.7%, >12 mo: 11.3% **Outcome(s):** Risk of obesity, BMIZ, fat mass, trunk fat mass, lean mass **Outcome assessment methods:** Weight and height measured by trained research assistants. Age- and sex-specific BMIZ and percentiles were based on WHO Child Growth Standards. Child obesity defined as sex- and age-specific BMI ≥95th percentile. Fat mass and lean mass measured using DXA. **Age(s) at outcome assessment:** 3 y, 7-10 y, 12-13 y	**Risk of obesity @ 3, 7-10, 12-13 y (OR (95% CI))** ≤12 mo vs >12 mo (ref) 3 y: 1.05 (0.59, 1.86), p=0.864 7-10 y: 1.23 (0.63, 2.44), p=0.543 12-13 y: 1.33 (0.67, 2.63), p=0.417 Across all: 1.11 (0.70, 1.78), p=0.657 Females: 3 y: 0.67 (0.31, 1.48), p=0.328 7-10 y: 0.84 (0.35, 1.97), p=0.681 12-13 y: 0.64 (0.26, 1.55), p=0.319 Across all: 0.68 (0.38, 1.24), p=0.210 Males: 3 y: 1.56 (0.67, 3.62), p=0.304 7-10 y: 2.39 (0.70, 8.12), p=0.163 12-13 y: 3.23 (0.95, 11.00), p=0.061 Across all: 1.97 (0.90, 4.30), p=0.090	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; gestational age **Key confounders NOT accounted for:** milk feeding practices; baseline anthropometry **Model adjustments:** Obesity and BMIZ: Maternal age, prepregnancy BMI, household annual income; Total, trunk, and lean mass: Maternal age, prepregnancy BMI, household annual income, child age at outcome assessment, child sex **Funding:** Egg Nutrition Center/American Egg Board; NIH

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Mi, 2022[10] PCS, IFPS II, U.S. Analytic N = 993 (Excluded participants with missing data on exposure and outcomes, or with extreme z-score values.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Non-Hispanic White: 86.5%, Hispanic: 5.5%, Asian/Pacific Islander and others: 4.2%, Non-Hispanic Black: 3.8% Maternal education: 3 y college or lower: 55.2%, College graduate or higher: 44.8% Other SEP measure(s): Family income (% of the US federal poverty level): >185%: 61.3%, ≤185%: 38.7% Maternal age: 18-24 y: 17.3%, 25-29 y: 34.5%, 30-34 y: 30.0%, ≥35 y: 18.3% Milk feeding practices: NR Child sex (female): 51% Birth weight: 3,442.9 (472.0) g Birth length: 50.9 (2.6) cm Gestational age: 95.7% full term (≥37 wk)	**Exposure(s) and comparator(s):** Eggs (Continuous (mo)) **Dietary assessment methods:** Maternal questionnaire of infant food intake in past 7 d **Age(s) at dietary assessment:** 2, 3, 4, 5, 6, 7, 9, 10, 12 mo **Age of introduction:** 2 mo: 0.12%, 3 mo: 0.23%, 4 mo: 0.29%, 5 mo: 0.47%, 6 mo: 1.86%, 7 mo: 5.42%, 9 mo: 12.59%, 10 mo: 18.53%, 12 mo: 36.01%, >12 mo: 24.48% **Outcome(s):** BMIZ, WHZ, HAZ, Obesity, Wasting, Stunting **Outcome assessment methods:** Weight, height at their most recent doctor's visit reported by mother. Z-scores calculated using WHO growth charts (0-2 y) and CDC growth charts (≥2 y). Obesity defined as WHZ ≥3 at 12 mo or BMIZ ≥2 at 6 y, wasting defined as WHZ < -2 at 12 mo and 6 y, and stunting defined as HAZ < -2 at 12 mo and 6 y. **Age(s) at outcome assessment:** 12 mo, 6 y	**BMIZ @ 12 mo, 6 y (Mean difference (95% CI))** 12 mo: -0.01 (-0.06, 0.04), p=0.664 6 y: 0.00 (-0.04, 0.04), p=0.952 Females: 12 mo: -0.06 (-0.13, 0.00), p=0.060 6 y: 0.00 (-0.05, 0.06), p=0.952 Males: 12 mo: 0.04 (-0.03, 0.11), p=0.281 6 y: 0.00 (-0.06, 0.06), p=0.975 Sex x Timing of introduction interaction: **12 mo: p=0.036** 6 y: p=0.874 **WHZ @ 12 mo, 6 y (Mean difference (95% CI))** 12 mo: -0.01 (-0.05, 0.04), p=0.761 6 y: 0.02 (-0.03, 0.06), p=0.396 Females: **12 mo: -0.06 (-0.12, 0.00), p=0.045** 6 y: 0.01 (-0.04, 0.07), p=0.658 Males: 12 mo: 0.05 (-0.02, 0.11), p=0.176 6 y: 0.03 (-0.04, 0.09), p=0.763 Sex x Timing of introduction interaction: **12 mo: p=0.018** 6 y: p=0.763 **HAZ @ 12 mo, 6 y (Mean difference (95% CI))** 12 mo: 0.01 (-0.05, 0.07), p=0.738 **6 y: -0.08 (-0.12, -0.03), p<0.001** Females: 12 mo: 0.07 (-0.03, 0.16), p=0.182 **6 y: -0.08 (-0.14, -0.02), p=0.006** Males: 12 mo: -0.05 (-0.12, 0.03), p=0.198 **6 y: -0.07 (-0.13, -0.01), p=0.017** Sex x Timing of introduction interaction: 12 mo: p=0.069 6 y: p=0.827	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** Maternal sociodemographic characteristics (e.g., age, education level, family income, race/ethnicity, and marital status), health behaviours/status during pregnancy (e.g., preconception BMI, gestational weight gain, and gestational duration), child sex, corresponding growth measurement at birth, infant age at introducing other complementary foods **Funding:** Egg Nutrition Centre/American Egg Board; Health Resources and Services Administration of HHS; Chinese National Key Research and Development Programme of China; National Natural Science Foundation of China; Natural Science Basic Research Plan of the Shaanxi Province; Fundamental Research Funds for the Central Universities; Xi'an Special Science and Technology Projects

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Mi, 2022[10] (Continued) PCS, IFPS II, U.S. Analytic N = 993 (Excluded participants with missing data on exposure and outcomes, or with extreme z-score values.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Non-Hispanic White: 86.5%, Hispanic: 5.5%, Asian/Pacific Islander and others: 4.2%, Non-Hispanic Black: 3.8% Maternal education: 3 y college or lower: 55.2%, College graduate or higher: 44.8% Other SEP measure(s): Family income (% of the US federal poverty level): >185%: 61.3%, ≤185%: 38.7% Maternal age: 18-24 y: 17.3%, 25-29 y: 34.5%, 30-34 y: 30.0%, ≥35 y: 18.3% Milk feeding practices: NR Child sex (female): 51% Birth weight: 3,442.9 (472.0) g Birth length: 50.9 (2.6) cm Gestational age: 95.7% full term (≥37 wk)	**Exposure(s) and comparator(s):** Eggs (Continuous (mo)) **Dietary assessment methods:** Maternal questionnaire of infant food intake in past 7 d **Age(s) at dietary assessment:** 2, 3, 4, 5, 6, 7, 9, 10, 12 mo **Age of introduction:** 2 mo: 0.12%, 3 mo: 0.23%, 4 mo: 0.29%, 5 mo: 0.47%, 6 mo: 1.86%, 7 mo: 5.42%, 9 mo: 12.59%, 10 mo: 18.53%, 12 mo: 36.01%, >12 mo: 24.48% **Outcome(s):** BMIZ, WHZ, HAZ, Obesity, Wasting, Stunting **Outcome assessment methods:** Weight, height at their most recent doctor's visit reported by mother. Z-scores calculated using WHO growth charts (0-2 y) and CDC growth charts (≥2 y). Obesity defined as WHZ ≥3 at 12 mo or BMIZ ≥2 at 6 y, wasting defined as WHZ < -2 at 12 mo and 6 y, and stunting defined as HAZ < -2 at 12 mo and 6 y. **Age(s) at outcome assessment:** 12 mo, 6 y	**Wasting (RR (95% CI))** 12 mo: 0.84 (0.68, 1.04), p=0.105 6 y: 0.96 (0.82, 1.11), p=0.562 Females: 12 mo: 0.86 (0.58, 1.13), p=0.302 6 y: 0.95 (0.74, 1.16), p=0.655 Males: 12 mo: 0.82 (0.55, 1.10), p=0.208 6 y: 0.96 (0.76, 1.16), p=0.698 Sex x Timing of introduction interaction: 12 mo: p=0.819 6 y: p=0.997 **Stunting (RR (95% CI))** 12 mo: 0.95 (0.86, 1.05), p=0.331 **6 y: 1.17 (1.03, 1.33), p=0.016** Females: 12 mo: 0.91 (0.78, 1.03), p=0.147 6 y: 1.16 (0.99, 1.33), p=0.063 Males: 12 mo: 1.02 (0.86, 1.17), p=0.821 6 y: 1.18 (0.99, 1.37), p=0.064 Sex x Timing of introduction interaction: 12 mo: p=0.526 6 y: p=0.988 **Obesity @ 12 mo, 6 y (RR (95% CI))** 12 mo: 0.99 (0.84, 1.16), p=0.868 6 y: 0.96 (0.88, 1.05), p=0.388 Females: 12 mo: 0.83 (0.64, 1.01), p=0.067 6 y: 0.98 (0.85, 1.11), p=0.783 Males: 12 mo: 1.24 (0.95, 1.54), p=0.108 6 y: 0.94 (0.83, 1.06), p=0.336 Sex x Timing of introduction interaction: **12 mo: p=0.015** 6 y: p=0.64	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** Maternal sociodemographic characteristics (e.g., age, education level, family income, race/ethnicity, and marital status), health behaviours/status during pregnancy (e.g., preconception BMI, gestational weight gain, and gestational duration), child sex, corresponding growth measurement at birth, infant age at introducing other complementary foods **Funding:** Egg Nutrition Centre/American Egg Board; Health Resources and Services Administration of HHS; Chinese National Key Research and Development Programme of China; National Natural Science Foundation of China; Natural Science Basic Research Plan of the Shaanxi Province; Fundamental Research Funds for the Central Universities; Xi'an Special Science and Technology Projects

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Schack-Nielsen, 2010[5] PCS, Copenhagen Perinatal Cohort, Denmark Analytic N = 5,068 (N for individual analyses ranged from 367-1,675; Excluded participants without information on BF, introduction of spoon feeding, birth weight, and/or at least 1 BMI measurement from 1-42 y.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR Maternal education: NR Other SEP measure(s): Social class: ~4.0 (1-8 point scale; 8=highest); Breadwinner's education: ~2.4 (1-4 point scale; 4=highest) Maternal age: ~26 y Milk feeding practices: Duration of any BF (median (10th, 90th percentile)): 2.50 (0.23, 6.50) mo Child sex (female): NR Birth weight: 3,232 (588) g Gestational age: ~18% preterm (≤37 wk) Other relevant characteristics: Participants were recruited from a hospital that preferentially admitted mothers with previous or expected pregnancy/delivery complications and mothers where a home delivery was not advised (primarily single mothers).	**Exposure(s) and comparator(s):** Eggs, Meat (continuous (mo); ≥4 mo vs <4 mo (ref)) **Dietary assessment methods:** Maternal interview **Age(s) at dietary assessment:** 1 y **Age of introduction:** Eggs: 6.08 (1.84) mo; Meat: 6.87 (1.92) mo **Outcome(s):** BMIZ, overweight, obesity, WC **Outcome assessment methods:** Weight and height at 1, 3, and 6 y measured by study personnel. Weight and height from 7-14 y measured at school health examinations. Weight and height for men from 16-23 y measured at draft board examinations. Weight and height at 20-34 y measured by study personnel. Weight, height, and WC at 42 y was self-reported. Childhood BMIZ calculated using British 1990 growth references adjusted for sex and age. Internal, sex-specific BMIZ were created for adults (20-34 y and 42 y). **Age(s) at outcome assessment:** 1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16-23 (draft board; men), 20-34, 42 y	**BMIZ @ 1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16-23 (draft board; men only), 20-34, 42 y (β (95% CI))** Age at introduction to eggs (continuous) 1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16-23 (draft board; men only), 20-34, 42 y: All data NR, p=NS Age at introduction to meat (continuous) 1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16-23 (draft board; men only), 20-34 y: All data NR, p=NS **42 y: -0.032 (-0.059, -0.005)** **Overweight @ 42 y (OR (95% CI)** Age at introduction to eggs Continuous: 0.98 (0.91, 1.05) Categorical: Data NR, p=NS Age at introduction to meat Continuous: 0.93 (0.87, 1.00) Categorical: Data NR, p=NS **Obesity @ 42 y (OR (95% CI)** Age at introduction to eggs Continuous: 1.06 (0.96, 1.18) Categorical: Data NR, p=NR Age at introduction to meat Continuous: 0.97 (0.87, 1.08) Categorical: Data NR, p=NR	**Key confounders accounted for:** SEP; sex; milk feeding practices; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; baseline anthropometry **Model adjustments:** Duration of BF, sex, maternal age at birth, prepregnancy BMI, gestational weight gain, smoking during pregnancy, social class, breadwinner's education, single mother status, prematurity, birth weight, weight at 1 y (analysis of BMIZ for timing of any only), BMI (analysis of waist circumference only) **Funding:** NICHD; NIDA; The Danish Research Council; Danish National Board of Health; The National Danish Science Foundation; The National Danish Agricultural and Veterinary Research Council

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Woo, 2013[8] PCS, GEHM, China, Mexico, U.S. Analytic N = 285 (Excluded participants who were lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR (Country: China: ~36%, Mexico: ~31%, U.S.: ~32%) Maternal education: China, Mexico, U.S., respectively: ≤HS graduate: 18.3%, 93.2%, 5.0%, Attended or graduated from college: 72.5%, 5.9%, 78.3%, Post-college education: 9.2%, 0.8%, 16.7% Other SEP measure(s): Employed at time of pregnancy: 71.4% (China), 40.7% (Mexico), 80.8% (U.S.); WIC (U.S.): ~34%, Nutrisano supplemental food program (Mexico): 0%, Supplemental food programs in Shanghai (China): 0% Maternal age: 29.3 (3.7) y (China), 24.4 (5.6) y (Mexico), 31.5 (5.2) y (U.S.) Milk feeding practices: EBF duration (median (IQR)): China: 4.9 (1.6, 11.9) wk, Mexico: 7.1 (0.0, 18.0) wk, U.S.: 13.7 (4.6, 19.3) wk; BF duration (median): China: 37.1 wk, Mexico: 52.0 wk, U.S.: 49.5 wk Child sex (female): 49% Birth weight: ~3.4 kg Gestational age: 100% ≥37 wk gestation	**Exposure(s) and comparator(s):** High-protein foods (e.g., egg, meat, fish, legumes; continuous (mo)) **Dietary assessment methods:** Maternal 24 h food frequency recall via telephone. **Age(s) at dietary assessment:** 2-52 wk, weekly **Age of introduction:** Median (IQR) for China, Mexico, and U.S., respectively (mo): 4.8 (4.3, 5.4), 7.0 (6.3, 7.5), 9.3 (8.1, 10.5) **Outcome(s):** WAZ, LAZ, BMIZ **Outcome assessment methods:** Weight and length measured by trained study personnel. WAZ, LAZ, and BMIZ calculated using age- and sex-specific z-scores from the 2005 WHO infant growth standards. **Age(s) at outcome assessment:** 1 y	**WAZ @ 1 y** -0.04 (0.02), p>0.05 in adjusted model **LAZ @ 1 y** Data NR, p>0.05 in adjusted model **BMIZ @ 1 y** Data NR, p>0.05 in adjusted model	**Key confounders accounted for:** SEP; sex; milk feeding practices; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; baseline anthropometry **Model adjustments:** EBF duration, mother's age, gestational weight gain, infant sex, birth weight, cohort site **Funding:** Mead Johnson Nutrition Inc; NIH/NICHD; NIH/NCRR (Institutional Clinical and Translational Science Award)

[a] Abbreviations: @: at; β: beta; BF: breast feeding; BMI: body mass index; BMIZ: BMI z-score; CDC: Centers for Disease Control and Prevention; CI: confidence interval; cm: centimeter; d: day; EBF: exclusive breast feeding; EAT: Enquiring About Tolerance; FFQ: food frequency questionnaire; g: gram; GEHM: Global Exploration of Human Milk; h: hour; HAZ: height-for-age z-score; HC: head circumference; HCZ: head circumference z-score; HS: high school; IFPS II: Infant Feeding Practices Study II; IQR: interquartile range; kg: kilogram; LAZ: length-for-age z-score; mm: millimeter; mo: month; MUAC: mid-upper arm circumference; MUACZ: MUAC z-score; NR: not reported; NS: non-significant; OR: odds ratio; PCS: prospective cohort study; RCT: randomized controlled trial; ref: reference; RR: relative risk; SD: standard deviation; SEP: socioeconomic position; U.K.: United Kingdom; U.S.: United States; WAZ: weight-for-age z-score; WC: waist circumference; WHO: World Health Organization; WHZ: weight-for-height z-score; WIC: Special Supplemental Nutrition Program for Women, Infants, and Children; wk: week; WLZ: weight-for-length z-score; y: year

Table 19. Risk of bias for observational studies examining timing of protein foods and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Choudhary, 2023[9]	SOME CONCERNS	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Mi, 2022[10]	SOME CONCERNS	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS	SOME CONCERNS	HIGH
Schack-Nielsen, 2010[5] (All time points except 42 y)	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Schack-Nielsen, 2010[5] (42 y time point)	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	SOME CONCERNS	SOME CONCERNS	HIGH
Woo, 2013[8]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH	HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Dairy and fortified soy alternatives

Description of the evidence

Eleven studies from 13 articles[1,6,8,11-20] met the inclusion criteria and examined the relationship between timing of the first introduction of dairy among infants and young children, up to age 24 months, and growth, body composition, or risk of obesity (**Table 21**). All 11 studies were PCS, using data from the following cohorts: Better Beginnings, Better Futures,[17,19] Bogalusa Heart Study,[14], Early Childhood Longitudinal Study,[15,16] GEHM,[8] Småbørns Kost og Trivsel,[13] TARGet Kids!,[20] Western Australian Pregnancy Cohort Study (Raine) cohort,[11] WIC ITFPS-2,[6] and 3 unnamed cohorts.[1,12,18].

Population

Six studies were conducted in the United States,[1,6,8,12,14-16] 2 were conducted in Canada,[17,19,20], and 1 each were conducted in Australia,[11] Denmark,[13] Chile,[18] China,[8] and Mexico.[8] The analytic sample sizes ranged from 68[1] to 8,373,[18] with the majority of studies having a sample size of 2,000 or less.[1,6,8,11-14,17,19,20] One study reported that the analysis did not have sufficient power,[13] while the remaining studies did not report power calculations related to timing of introduction of dairy and the relevant outcomes.[1,6,8,11,12,14-20]

Six studies provided information on the racial and/or ethnic background of participants; this varied across studies.[1,6,12,14-16,20] Specifically, 100% of participants were Hispanic in 1 study,[1] 41% Hispanic, 29% non-Hispanic White, 25% non-Hispanic African American, and 6% non-Hispanic other in another,[6] 72% White, 15% Hispanic, 9% Black, 4% Asian in another,[12] approximately 59% White and 41% Black in another,[14] approximately 54% White, 25% Latino, and 14% African American, 4% multiracial, 3% Asian/Pacific Islander, and 0.4% American Indian/Alaska Native in another,[15,16] and 67% European, 14% Asian, 5% mixed, 3% Hispanic, and 3% African in the last study.[20] Across the 5 studies that reported maternal age,[1,6,8,12,17,19] average age of the mothers ranged from mid-twenties to early thirties. Human milk and formula feeding practices were reported in 8 studies[1,6,8,12-17,19] and tended to vary. First, breast feeding initiation was 75%[17,19] and 81.9%[6] in the 2 studies that reported this measure. Exclusive breastfeeding was assessed across infancy in 5 studies: in 1 study 51% were exclusively breast feeding at 1 month,[1] 27% were exclusively breast feeding at 3 months in a second study,[17] and at 4 months 53%[12] and 68%[13] of participants were exclusively breast feeding in a third and fourth study; the median duration of exclusive breastfeeding in the fifth study was 4.9 weeks in China, 7.1 weeks in Mexico, and 13.7 weeks in the U.S.[8] Finally, any breastfeeding rates at 3 months ranged from 33.3%[17] to 44%,[19] at 6 months was 1%,[14] 9 months was 42.5%,[13] at 10 months was 20.8%,[1] and mean or median duration ranged from approximately 3.7 months[15] to 52 weeks.[8]

A variety of measures of SEP were reported across the studies. Maternal education was reported across 7 studies,[1,6,8,11-13,17,19] showing that participants tended to have greater than a high school education level in most studies,[1,6,8,11,13,19] although two studies included participants that tended to have less than a high school education level.[8,17] One of these studies analyzed a subset of a larger sample[19] of those who had a household income below the Statistics Canada low income cutoff.[17] Two studies exclusively enrolled individuals participating in WIC,[1,6] while 8 additional studies reported on family income,[6,8,11-13,15-17,19,20] with several studies including a large proportion of participants with lower income.[6,15-17,19]

Regarding the characteristics of the infants and young children, the studies noted that approximately 50% of participants were female.[1,6,8,11-13,15-20] Mean birth weight ranged from approximately 3.3 to 3.5 kilograms in 5 studies,[8,12,15-17,19,20] while 1 study reported that 93.4% weighed between 2.5 and 4.5 kilograms at birth.[6] Baseline anthropometry was reported in 3 studies[13-16]: average WHZ at age 5 months was -0.40 in 1 study,[13] weight at age 6 months was significantly lower among infants consuming soy formula compared to infants consuming either cow's milk or milk formula in a second study,[14] and approximately 29% of the sample had a weight-for-length greater than or equal to the 85th percentile at age 9 months.[15,16] Among the 7 studies that reported gestational age, 5 exclusively enrolled term infants,[6,8,11-13] 1 study reported a mean gestational age of approximately 39 weeks,[15,16] and 1 study exclusively enrolled infants born at least 32 weeks gestation.[20]

Exposures and comparators

Eight studies[1,6,13-20] examined timing of introduction of cow's milk, including 1 study that examined timing of introduction of powdered and fortified whole cow's milk.[18] The remaining studies examined timing of introduction of nonhuman milk more broadly, including "any milk other than breast milk",[11] "other" milks (including cow's milk),[12] and nonhuman milk (e.g., cow or soy milk),[8] as well as nonmilk dairy foods (e.g., yogurt, fermented milk, cheese).[8] Timing of introduction of dairy was analyzed in various ways across the studies. Three studies examined timing of introduction continuously,[11,15,16,20] 6 studies examined timing of introduction categorically,[1,6,8,14,17-19] and 2 studies did not report whether timing was analyzed as a continuous or categorical variable.[12,13] Among the studies analyzing timing of introduction categorically, 3 studies used a cut point at age 12 months,[1,6,8] 1 study compared the duration of consuming cow's milk assessed at age 6 months (1, 3, 4.5 or 5.5 months duration),[14] 1 study compared introduction between age 3 and 6 months or introduction after age 6 months to introduction before age 3 months,[18] and a final study examined adherence to cow's milk recommendations including both introduction of whole cow's milk at or later than age 9 months and low-fat cow's milk at or later than age 2 years.[17,19] The studies used a variety of assessment methods to measure timing of introduction of dairy. The most common dietary assessment method was parental interview or questionnaire which was used 7 studies,[1,11,13-17,19,20] while the remaining studies used a 24-hour dietary recall,[6] 24-hour food frequency recall,[8] 3-day food records and infant feeding history,[12] and parental report at medical check-ups.[18] Nine of the studies assessed timing of introduction of dairy multiple times from birth up to age 24 months.[1,6,8,11-14,17-19] The assessments were conducted through age 12 months in 9 studies,[1,6,8,11-14,17-19] while 7 studies included assessments beyond age 12 months.[1,6,12,13,17-20]

Outcomes

Seven studies assessed growth,[6,8,11,12,14,18,20] 3 studies assessed body composition,[12-14] and 4 studies assessed risk of obesity.[1,15-18] A variety of outcomes related to growth were measured across the studies including BMIZ,[6,20] BMI,[11] WLZ,[12] weight,[14] WAZ,[8,12] length,[14] LAZ,[8,12], HAZ,[20] and circumferences of the head, chest, arm, and thighs.[12] The measures of body composition also varied across the studies and included skinfold thickness,[12,14] fat and fat-free mass percentages,[12] and fat and fat-free mass index scores.[13] The age at which the outcomes were assessed ranged from birth through age 8 years. The outcomes were measured by research staff or nurses across all studies.

Synthesis of the evidence

Across the 11 studies (**Table 21**), most reported predominantly or exclusively null associations between the timing of introduction of dairy with measures of growth, body composition, and risk of overweight or obesity, although 3 of these studies also reported significant associations between later introduction and lower levels of growth or risk of obesity in addition to null associations.[6,18,20] Among the null findings, studies reported null associations between timing of introduction of cow's milk,[1,6,13-16,20] adherence to milk recommendations,[17,19] any milk other than breast milk,[11] "other" milks including cow's milk,[12] nonhuman milk,[8] and nonmilk dairy foods[8] and a variety of outcomes related to growth,[6,8,11,12,14,20] body composition,[12-14] and risk of overweight or obesity.[1,15-17,19] Of these, only 3 studies reported the directionality of the null associations; the direction of these results tended to show greater BMIZ or greater odds of overweight or obesity with earlier introduction to cow's milk.[14,19,20]

Although 11 studies examined the relationship between timing of introduction of dairy and growth, body composition, or risk of obesity, there were important concerns related to consistency that limited the ability to draw conclusions. Specifically, there was considerable heterogeneity in the exposures and comparators, particularly the timing of the exposures. The studies examined a wide range of time points of introduction from birth up to age 24 months, including 2 studies that specifically examined introduction cow's milk early in infancy.[14,18] Additionally, while some studies examined categories of introduction, some studies considered timing of introduction continuously. Several studies did not report how the timing variable was analyzed, be it categorically or continuously. In addition to the issues of consistency, there was minimal evidence for certain exposures and outcomes; in particular, dairy foods beyond cow's milk as an exposure and body composition as an outcome.

Conclusion statement and grade

The Committee did not draw a conclusion statement about the relationship between timing of introduction of dairy in infants and young children, up to age 24 months, and growth, body composition, and risk of obesity because there is not enough evidence, and the evidence that is available has substantial concerns with consistency (**Table 20**). Studies assessed timing of the introduction of dairy, including cow's milk at various time points, including 3, 6, and 12 months, and continuously. Several studies did not report how they analyzed the exposure timing variable. Therefore, it was difficult to compare across studies. There was minimal evidence for certain exposures and outcomes. Publication bias was also a consideration; however, this was not assessed as a serious concern because the body of evidence predominantly included studies that reported only nonsignificant findings, as well as studies that reported a mix of both significant and nonsignificant results, across a range of analytic sample sizes. However, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias. The risk of bias assessments for this body of evidence are documented in **Table 22**.

Table 20. Conclusion statement, grade for timing of introduction of dairy and growth, body composition, and risk of obesity

Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to the dairy food group and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available, and the evidence that is available has substantial concerns with consistency.**
Grade	Grade Not Assignable
Body of Evidence	13 articles (11 studies): 11 prospective cohort studies
Rationale	The studies varied in the exposures and comparators, particularly the timing of the exposures.

Table 21. Evidence examining the relationship between the timing of introduction to dairy and growth, body composition, and risk of obesity[a]

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Amaro-Rivera, 2019[1] PCS, U.S. (Puerto Rico) Analytic N = 68 (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Hispanic: 100% Maternal education: ≤HS: 32.5%, >HS: 67.5% Other SEP measure(s): WIC participation: 100% Maternal age: Parent's age: <30 y: 55.8%, ≥30 y: 44.2% Milk feeding practices: EBF for ≥1 mo: 51%, Ever FF: 70.1%, Any BF at ~10 mo: 20.8% Child sex (female): 47% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Timing of introduction to cow's milk: <12 mo vs ≥12 mo **Dietary assessment methods:** Interviewer-administered questionnaire completed by caregivers. Diet Quality Index Score based on semi-quantitative FFQ. **Age(s) at dietary assessment:** 0-24 mo **Age of introduction:** Cow's milk: <12 mo: 18.2% **Outcome(s):** WLZ (≥1) **Outcome assessment methods:** Weight and length measured by trained research staff. Weight status assessed using WHO age- and sex-specific WLZ growth charts. Relative risk for WLZ (≥1 z-score vs <1 z-score), with underweight defined as WLZ ≤-2 SD, healthy weight status defined as WLZ >-2 and <1 SD, risk of overweight defined as WLZ between 1-<2, and overweight or obesity defined as WLZ ≥2 SD. **Age(s) at outcome assessment:** 11-36 mo (Median: 21 mo, 11-23 mo: 61.0%, 24-36 mo: 39.0%)	**WLZ (≥1 vs <1) @ 11-36 mo** <12 mo vs ≥12 mo: Data NR, NS	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry **Key confounders NOT accounted for:** gestational age **Model adjustments:** WLZ at baseline **Funding:** University of Puerto Rico Central Administration Grant; Capacity Advancement in Research Infrastructure; National Institute on Minority Health and Health Disparities

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Au, 2023[6] PCS, WIC ITFPS-2, U.S. Analytic N = 1,523 (24 mo), 1,680 (36 mo), 1,872 (48 mo) (Excluded participants with missing data on HEI-2015 or BMI at 2, 3, or 4 y, born prematurely, had very low birth weight, or had long-term medical problems that could affect eating.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Hispanic: 40.6%, Non-Hispanic White: 29.1%, Non-Hispanic African American: 24.8%, Non-Hispanic Other: 5.5% Maternal education: <HS: 24.4%, HS: 37.7%, >HS: 37.5% Other SEP measure(s): Participating in WIC: 100%; Maternal employment at 6 mo: Full-time: 21.5%, Part-time: 20.2%, Not working for pay: 58.2%; Poverty level at enrollment: ≤75% of poverty guideline: 64.0%, >75-<130%: 26.3%, >130% poverty: 9.7% Maternal age: 16-19 y: 11.7%, 20-25 y: 41.1%, ≥26 y: 47.3% Milk feeding practices: Any BF: 81.9%; Any formula use: 95.5% Child sex (female): 49% Birth weight: Low (<2.5 kg): 5.3%, Normal (2.5-≤4.5 kg): 93.4%, High (>4.5 kg): 1.3% Gestational age: Excluded infants born prematurely	**Exposure(s) and comparator(s):** Cow's milk (Categorical, Infant Diet Quality Index component score from 0-1 based on degree of adherence to guidelines; max score: introduced at ≥12 mo, min score: introduced at <12 mo) **Dietary assessment methods:** 24-h dietary recall via telephone interview with caregiver **Age(s) at dietary assessment:** 1, 3, 5, 7, 9 11, 13, 15, 18, 24, 30, 36, 42, and 48 mo **Age of introduction:** ≥12 mo: 61.5% **Outcome(s):** BMIZ **Outcome assessment methods:** Weight and length/height collected at WIC sites or from child's health care provider. BMIZ based on CDC age- and sex-specific growth charts **Age(s) at outcome assessment:** 2, 3, 4 y	**BMIZ @ 2, 3, 4 y** 2 y: Data NR, $p>0.10$ 3 y: Data NR, $p>0.10$ **4 y: greater adherence associated with lower BMIZ, $p<0.05$**	**Key confounders accounted for:** SEP; sex; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; milk feeding practices; baseline anthropometry **Model adjustments:** None **Funding:** NHLBI; USDA/NIFA

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Burke, 2005[11] PCS, Western Australian Pregnancy Cohort Study (Raine), Australia Analytic N = 1,430 (Excluded participants from multiple births, born before 37 wk gestation, with congenital abnormalities, and/or with missing outcome data at 8 y.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR Maternal education: Secondary: 46%, Diploma/other: 33%, Tertiary: 21% Other SEP measure(s): Family income: ≤$40,000: 45%, >$40,000: 55% Maternal age: NR Milk feeding practices: NR Child sex (female): 48% Birth size: NR Gestational age: 100% ≥37 wk	**Exposure(s) and comparator(s):** Age of introduction to any milk other than breast milk (Continuous (mo)) **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 1 y, 3 y **Age of introduction:** NR **Outcome(s):** BMI **Outcome assessment methods:** Weight and height measured by research staff. **Age(s) at outcome assessment:** 8 y	**BMI @ 8 y** Not retained in final model via backwards selection, p=NS	**Key confounders accounted for:** sex; SEP; milk feeding practices; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; baseline anthropometry **Model adjustments:** NA (not retained in final model via backwards selection; model adjusted for sex, maternal education and additional variables tested included birth weight, BF duration, mother's BMI, father's BMI, mother smoking status, mother diabetes, mother gestational diabetes, time watching TV, physical activity, fat intake, saturated fat intake, takeaways factor, bread, cereals factor) **Funding:** Raine Foundation and Healthway

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Butte, 2000[12] PCS, U.S. Analytic N = 72 (Excluded participants who relocated outside of the study area.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: White: 72.4%, Hispanic: 14.5%, Black: 9.2%, Asian: 3.9% Maternal education: ~15.5 y Other SEP measure(s): Family income: <$20,000: 8%, $20,000-34,999: 24%, $35,000-49,999: 17%, ≥$50,000: 51% Maternal age: ~28.7 y Milk feeding practices: EBF at 4 mo: ~53%; Exclusive FF at 4 mo: ~47%; BF duration (among those who BF): 11.4 (5.8) mo Child sex (female): 57% Birth weight: ~3.4 kg; Birth length: ~50 cm Gestational age: ~39 wk (100% born term)	**Exposure(s) and comparator(s):** "Other" milks (including cow's milk) (continuous or categorical NR) **Dietary assessment methods:** Caretaker report of infant feeding history and weighed 3-d food records **Age(s) at dietary assessment:** 3, 6, 12, 24 mo **Age of introduction:** NR **Outcome(s):** Fat mass, fat-free mass, skinfold thickness (triceps, subscapular, flank, quadriceps), circumferences (head, chest, arm, thigh), WAZ, LAZ, WLZ **Outcome assessment methods:** Weight, length, circumferences measured by trained study personnel. WAZ, LAZ, and WLZ calculated using NCHS growth curves for children. Fat-free mass, fat mass, and % fat mass estimated using multicomponent body composition model, total body electric conductivity (0.5 and 24 mo only), and DXA (0.5, 12, 24 mo only) **Age(s) at outcome assessment:** 0.5, 3, 6, 9, 12, 18, 24 mo	**WAZ @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS **LAZ @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS **WLZ @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS **HC @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS **Chest circumference @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS **Arm circumference @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS **Thigh circumference @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS **Triceps skinfold thickness @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS **Subscapular skinfold thickness @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS	**Key confounders accounted for:** sex; milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** SEP; race and/or ethnicity **Model adjustments:** Baseline values of outcome (0.5 mo), feeding mode (BF or formula fed), sex, age at measurement, interactions between feeding mode, sex and age, current weight and length (analyses of fat mass, % fat mass, and fat-free mass only) **Funding:** USDA/ARS; Ross Laboratories donated formula

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Butte, 2000[12] (Continued) PCS, U.S. Analytic N = 72 (Excluded participants who relocated outside of the study area.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: White: 72.4%, Hispanic: 14.5%, Black: 9.2%, Asian: 3.9% Maternal education: ~15.5 y Other SEP measure(s): Family income: <$20,000: 8%, $20,000-34,999: 24%, $35,000-49,999: 17%, ≥$50,000: 51% Maternal age: ~28.7 y Milk feeding practices: EBF at 4 mo: ~53%; Exclusive FF at 4 mo: ~47%; BF duration (among those who BF): 11.4 (5.8) mo Child sex (female): 57% Birth weight: ~3.4 kg; Birth length: ~50 cm Gestational age: ~39 wk (100% born term)	**Exposure(s) and comparator(s):** "Other" milks (including cow's milk) (continuous or categorical NR) **Dietary assessment methods:** Caretaker report of infant feeding history and weighed 3-d food records **Age(s) at dietary assessment:** 3, 6, 12, 24 mo **Age of introduction:** NR **Outcome(s):** Fat mass, fat-free mass, skinfold thickness (triceps, subscapular, flank, quadriceps), circumferences (head, chest, arm, thigh), WAZ, LAZ, WLZ **Outcome assessment methods:** Weight, length, circumferences measured by trained study personnel. WAZ, LAZ, and WLZ calculated using NCHS growth curves for children. Fat-free mass, fat mass, and % fat mass estimated using multicomponent body composition model, total body electric conductivity (0.5 and 24 mo only), and DXA (0.5, 12, 24 mo only) **Age(s) at outcome assessment:** 0.5, 3, 6, 9, 12, 18, 24 mo	**Flank skinfold thickness @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS **Quadriceps skinfold thickness @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS **Fat mass @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS **% fat mass @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS **Fat-free mass @ 3, 6, 9, 12, 18, 24 mo** (FF infants; NR if BF infants analyzed) Data NR, p=NS	**Key confounders accounted for:** sex; milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** SEP; race and/or ethnicity **Model adjustments:** Baseline values of outcome (0.5 mo), feeding mode (BF or formula fed), sex, age at measurement, interactions between feeding mode, sex and age, current weight and length (analyses of fat mass, % fat mass, and fat-free mass only) **Funding:** USDA/ARS; Ross Laboratories donated formula

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Ejlerskov, 2015[13] PCS, SKOT, Denmark Analytic N = 233 (Excluded participants who did not have complete BIA, height, and weight data at 3 y) Adequately powered: No **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR Maternal education: No education above school level: 4.3%, Trainee or vocational education: 7.7%, Short academic education <3 y: 12.0%, Academic education 3-4 y: 35.2%, Long academic education >4 y: 40.8% Other SEP measure(s): Family income (Danish Kroner): <200,000: 4.3%, 200,000-399,999: 15.0%, 400,000-599,999: 15.0%, 600,000-799,999: 30.5%, >800,000: 33.0%, Unknown: 2.1% Maternal age: NR Milk feeding practices: Fully BF for 4 mo: 67.8%, Partially BF at 9 mo: 42.5% Child sex (female): 52% WHO z-scores at birth (mean (range)): WAZ: 0.48 (-1.98, 2.71), HAZ: 1.39 (-3.84, 4.29), WFH: -0.95 (-4.71, 2.54), BMIZ: -0.35 (-3.99, 2.63) Gestational age: 100% born term (37-42 wk)	**Exposure(s) and comparator(s):** Timing of introduction to cow's milk (continuous or categorical NR) **Dietary assessment methods:** Maternal interview **Age(s) at dietary assessment:** 9, 18, 36 mo **Age of introduction:** NR **Outcome(s):** FMI, FFMI **Outcome assessment methods:** Fat mass index and fat free mass index measured using BIA. FMI and FFMI grouped into sex-specific quartiles **Age(s) at outcome assessment:** 3 y	**FMI @ 3 y** Data NR, p>0.05 **FFMI @ 3 y** Data NR, p>0.05	**Key confounders accounted for:** SEP; sex; milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** race and/or ethnicity **Model adjustments:** sex, birth weight z-score, WAZ change from 0 to 5 mo, educational level of mother, gestational weight gain, maternal BMI, duration of full BF **Funding:** The Danish Directorate for Food, Fisheries and Agri Business

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Farris, 1982[14] PCS, Bogalusa Heart Study, U.S. Analytic N = 160 (Excluded participants without outcome measurements at 6 mo or 1 y and consuming multiple milk sources) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: White: ~59%, Black: ~41% Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: BM at 6 mo: 1%, Soy-based formula at 6 mo: 7%, Milk-based formula at 6 mo: 42% Child sex (female): NR Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Duration of consuming cow's milk at 6 mo: 1 mo vs 3 mo vs 4.5 mo vs 5.5 mo) **Dietary assessment methods:** Infant Feeding Practices Questionnaires and dietary questionnaires completed by mothers **Age(s) at dietary assessment:** 1, 2, and 4 mo (infant feeding practices questionnaires); 6 mo and 1 y (dietary questionnaires) **Age of introduction:** Duration of consuming cow's milk at 6 mo: 1, 3, 4.5, 5.5 mo, respectively: 55%, 29%, 11%, 5% **Outcome(s):** Length, weight, skinfold (subscapular) **Outcome assessment methods:** Weight, length and skinfolds measured by trained personnel **Age(s) at outcome assessment:** 6 mo, 1 y	**Weight (kg) @ 6 mo (mean (2 SE))** Duration of cow's milk consumption at 6 mo (among infants consuming cow's milk): 1 mo vs 3 mo vs 4.5 mo vs 5.5 mo 7.7 (0.2) vs 7.6 (0.3) vs 7.8 (0.4) vs 7.5 (0.5), p=NS **Length (cm) @ 6 mo (mean (2 SE))** Duration of cow's milk consumption at 6 mo (among infants consuming cow's milk): 1 mo vs 3 mo vs 4.5 mo vs 5.5 mo 66.8 (0.6) vs 66.2 (0.8) vs 67.0 (1.4) vs 65.6 (1.6), p=NS **Subscapular skinfold (mm) @ 6 mo (mean (2 SE))** Duration of cow's milk consumption at 6 mo (among infants consuming cow's milk): 1 mo vs 3 mo vs 4.5 mo vs 5.5 mo 7.8 (0.4) vs 7.5 (0.7) vs 7.4 (0.8) vs 7.6 (1.4), p=NS	**Key confounders accounted for:** sex; race and/or ethnicity **Key confounders NOT accounted for:** SEP; milk feeding practices; gestational age; baseline anthropometry **Model adjustments:** None **Funding:** National Heart and Lung Institute of the U.S. Public Health Service; Specialized Center of Research-Arteriosclerosis at Louisana State University Medical Center

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Flores, 2013a[15] PCS, ECLS-B, U.S. Analytic N = 6,800 (Excluded participants who did not complete data collection during kindergarten or did not have complete age- and sex-specific BMI data.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: White: ~54%, Latino: ~25%, African American: ~14%, Multiracial: ~3.8%, Asian/Pacific Islander: ~2.7%, American Indian/Alaska Native: ~0.4% Maternal education: NR (Highest educational attainment in household: Not a HS graduate: ~13%, HS graduate: ~25%, At least some college: ~62%) Other SEP measure(s): Family income ever below poverty threshold: ~69%; Child's insurance coverage: Uninsured: ~4%, Private: ~57%, Medicaid: ~34%, CHIP: ~4%, Military health care: ~1%, Indian health service: ~0.1%, Other government program: ~1% Maternal age: NR Milk feeding practices: BF duration: ~3.7 mo Child sex (female): ~49% Birth weight: ~3,300 g Gestational age: ~38.7 wk	**Exposure(s) and comparator(s):** Age first fed cow's milk (Continuous) **Dietary assessment methods:** Maternal interview **Age(s) at dietary assessment:** NR **Age of introduction:** NR **Outcome(s):** Overweight **Outcome assessment methods:** Height and weight measured by study field interviewers. Overweight defined as BMI ≥85th percentile according to CDC growth charts. **Age(s) at outcome assessment:** At entry to kindergarten (~5.7 y)	**Overweight @ entry to kindergarten** Data NR, p=NS	**Key confounders accounted for:** sex **Key confounders NOT accounted for:** SEP; race/ethnicity; milk feeding practices; gestational age; baseline anthropometry **Model adjustments:** NA (only examined in bivariate analyses) **Funding:** No funding received for study

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Flores, 2013b[16] PCS, ECLS-B, U.S. Analytic N = 6,800 (Reasons for attrition NR) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: White: ~54%, Latino: ~25%, African American: ~14%, Multiracial: ~3.8%, Asian/Pacific Islander: ~2.7%, American Indian/Alaska Native: ~0.4% Maternal education: NR (Highest educational attainment in household: Not a HS graduate: ~13%, HS graduate: ~25%, At least some college: ~62%) Other SEP measure(s): Family income ever below poverty threshold: ~69%; Child's insurance coverage: Uninsured: ~4%, Private: ~57%, Medicaid: ~34%, CHIP: ~4%, Military health care: ~1%, Indian health service: ~0.1%, Other government program: ~1% Maternal age: NR Milk feeding practices: Age first fed formula: ~3.6 mo Child sex (female): ~49% Birth weight: ~3,300 g Gestational age: ~38.7 wk	**Exposure(s) and comparator(s):** Age first fed cow's milk (Continuous) **Dietary assessment methods:** Maternal interview **Age(s) at dietary assessment:** NR **Age of introduction:** NA **Outcome(s):** Severe obesity **Outcome assessment methods:** Height and weight measured by study field interviewers. Definition of severe obesity not provided. **Age(s) at outcome assessment:** At entry to kindergarten (~5.7 y)	**Severe obesity @ entry to kindergarten** Data NR, p=NS	**Key confounders accounted for:** sex **Key confounders NOT accounted for:** SEP; race/ethnicity; milk feeding practices; gestational age; baseline anthropometry **Model adjustments:** NA (only examined in bivariate analyses) **Funding:** NR

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Kuperberg, 2006[17] PCS, Better Beginnings, Better Futures, Canada Analytic N = 71 (Excluded participants without outcome data, and potentially without exposure data. Excluded infants with birth weight <2,500 g.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR (100% of children living in First Nations community – Ojibwa, Potawatom, and Ottawa bands) Maternal education: <HS education: 63.4% Other SEP measure(s): 100% with household income below Statistics Canada low income cutoff Maternal age: 25.4 (6.8) y Milk feeding practices: Initiated BF: 75%, EBF at 3 mo: 27.0%, partially BF at 3 mo: 33.3% Child sex (female): 49% Birth weight: 3,396 (652) g Gestational age: NR	**Exposure(s) and comparator(s):** Adherence to cow's milk recommendations (whole cow's milk ≥9 mo, low-fat cow's milk ≥2 y) vs non-adherence to cow's milk recommendations (ref)) **Dietary assessment methods:** Maternal interview **Age(s) at dietary assessment:** 3 mo, 18 mo, 33 mo **Age of introduction:** Whole cow's milk <9 mo: 11.6%, Low-fat cow's milk <2 y: 59.4% **Outcome(s):** Overweight **Outcome assessment methods:** Weight and height measured using standard procedures. Overweight defined as BMI at or above 85th percentile according to age- and sex-specific reference data (NCHS). **Age(s) at outcome assessment:** 48 mo	**Overweight @ 48 mo** Adherence to cow's milk recommendations (whole cow's milk ≥9 mo, low-fat cow's milk ≥2 y) Data NR, p=NS	**Key confounders accounted for:** race and/or ethnicity; SEP; sex; milk feeding practices **Key confounders NOT accounted for:** gestational age; baseline anthropometry **Model adjustments:** NR (unclear whether univariate or multivariate regression was completed) **Funding:** Ontario Ministries of Health and Long-Term Care, Community and Social Services, and Education

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Retamal, 2020[18] RCS, Chile Analytic N = 8,373 (Excluded participants with missing data.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: NR Child sex (female): 49% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Whole cow's milk (powdered and fortified with vitamin C, iron, zinc, and copper): <3 mo (ref), 3-6 mo, >6 mo **Dietary assessment methods:** Parental report at routine medical check-ups **Age(s) at dietary assessment:** Birth-3 y (~every 6 mo) **Age of introduction:** NR **Outcome(s):** Change in WHZ, overweight, obesity **Outcome assessment methods:** Height and weight from routine medical check-ups. WHZ based on WHO data and categorized as normal (WHZ > -1 and <1 SD), overweight (WHZ ≥1 and <2 SD), and obese (WHZ ≥2 SD). **Age(s) at outcome assessment:** Birth, 6, 12, 18, 24, 30, 36 mo	**Change in WHZ from birth-12 mo, 18-36 mo, and birth-36 mo (mean)** <3 vs 3-6 vs >6 mo **Birth-12 mo: 0.556 vs 0.486 vs 0.638, p<0.001** **18-36 mo: 0.968 vs 0.852 vs 0.860, p<0.001** **Birth-36 mo: 0.791 vs 0.695 vs 0.765, p<0.001** **Overweight (>1 and <2 SD WHZ) @ birth-12 mo, 18-36 mo, and birth-36 mo (OR (95% CI))** Birth-12 mo: 3-6 mo vs <3 mo (ref): 0.919 (0.830, 1.016), p=NS **>6 mo vs <3 mo (ref): 1.104 (1.011, 1.206), p=0.027** 18-36 mo: **3-6 mo vs <3 mo (ref): 0.851 (0.759, 0.954), p=0.005** **>6 mo vs <3 mo (ref): 0.843 (0.761, 0.935), p=0.001** Birth-36 mo: **3-6 mo vs <3 mo (ref): 0.886 (0.809, 0.970), p=0.009** >6 mo vs <3 mo (ref): 0.947 (0.873, 1.027), p=NS	**Key confounders accounted for:** SEP; sex; milk feeding practices **Key confounders NOT accounted for:** race and/or ethnicity; gestational age; baseline anthropometry **Model adjustments:** County of birth, household occupation, birth order, sex, year of birth, age of giving other types of food, age of the mother at birth of child, age of BF cessation **Funding:** Becas Chile Scholarship Program

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Retamal, 2020[18] (Continued) RCS, Chile Analytic N = 8,373 (Excluded participants with missing data.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: NR Child sex (female): 49% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Whole cow's milk (powdered and fortified with vitamin C, iron, zinc, and copper): <3 mo (ref), 3-6 mo, >6 mo **Dietary assessment methods:** Parental report at routine medical check-ups **Age(s) at dietary assessment:** Birth-3 y (~every 6 mo) **Age of introduction:** NR **Outcome(s):** Change in WHZ, overweight, obesity **Outcome assessment methods:** Height and weight from routine medical check-ups. WHZ based on WHO data and categorized as normal (WHZ > -1 and <1 SD), overweight (WHZ ≥1 and <2 SD), and obese (WHZ ≥2 SD). **Age(s) at outcome assessment:** Birth, 6, 12, 18, 24, 30, 36 mo	**Obesity (>2 SD WHZ) @ birth-12 mo, 18-36 mo, and birth-36 mo (OR (95% CI))** Birth-12 mo: **3-6 mo vs <3 mo (ref): 0.759 (0.633, 0.911), p=0.003** **>6 mo vs <3 mo (ref): 1.267 (1.092, 1.470), p=0.002** 18-36 mo: **3-6 mo vs <3 mo (ref): 0.749 (0.633, 0.887), p=0.001** **>6 mo vs <3 mo (ref): 0.823 (0.710, 0.956), p=0.011** Birth-36 mo: **3-6 mo vs <3 mo (ref): 0.775 (0.666, 0.901), p=0.001** >6 mo vs <3 mo (ref): 0.962 (0.847, 1.093), p=NS	**Key confounders accounted for:** SEP; sex; milk feeding practices **Key confounders NOT accounted for:** race and/or ethnicity; gestational age; baseline anthropometry **Model adjustments:** County of birth, household occupation, birth order, sex, year of birth, age of giving other types of food, age of the mother at birth of child, age of BF cessation **Funding:** Becas Chile Scholarship Program

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Rossiter, 2013[19] PCS, Better Beginnings, Better Futures, Canada Analytic N = 350 (Excluded participants lost to follow-up.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR (Born outside Canada: 29%) Maternal education: Less than HS education: 39% Other SEP measure(s): Living below low income cut-offs (Statistics Canada): 72% Maternal age: 27 (5.9) y Milk feeding practices: BF initiation: 75%, BF at 3 mo: 44% Child sex (female): ~43% Birth weight: ~3475 g (all >2,500 g) Gestational age: NR	**Exposure(s) and comparator(s):** Adherence to cow's milk recommendations (whole cow's milk ≥9 mo, low-fat cow's milk ≥2 y), non-adherence to cow's milk recommendations (ref)) **Dietary assessment methods:** Maternal interview **Age(s) at dietary assessment:** 3, 18, 33, 48 mo **Age of introduction:** Adherence to cow's milk recommendations: ~39%, non-adherence to cow's milk recommendations: ~61% **Outcome(s):** Overweight/obesity **Outcome assessment methods:** Height and weight measured using established guidelines. Overweight/obesity classified based on CDC sex- and age- specific growth tables. **Age(s) at outcome assessment:** 48 mo	**Overweight/obesity @ 48 mo (%)** Adherence to milk recommendations (introduction to cow's milk >9 mo, introduction to low-fat milk >24 mo) vs not (ref) 1.81 (0.76, 4.30)	**Key confounders accounted for:** SEP; sex **Key confounders NOT accounted for:** race/ethnicity; milk feeding practices; gestational age; baseline anthropometry **Model adjustments:** sex, maternal age, poverty, smoking status, maternal BMI, single-parent household, birth weight **Funding:** Ontario Ministries of Health and Long-Term Care, Community and Social Services, and Education

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Soczynska, 2021[20] PCS, TARGet Kids!, Canada Analytic N = 1,981 (Excluded participants who were not 3-5 y for outcome assessment, lost to follow-up, had not yet been introduced to cow's milk at follow-up (3-5 y), or had missing data for age of cow milk introduction.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: European: 66.8%, Asian: 14.2%, Mixed: 4.7%, Hispanic: 3.1%, African: 2.9% Maternal education: NR Other SEP measure(s): After tax family income (CAD): <$30,000: 3.4%, $30,000-79,999: 12.4%, $80,000-149,999: 32.9%, ≥$150,000: 47.2% Maternal age: NR Milk feeding practices: NR Child sex (female): 46% Birth weight: 3.31 (0.57) kg Gestational age: 100% >32 wk	**Exposure(s) and comparator(s):** Timing of introduction to cow's milk (Continuous (mo)) **Dietary assessment methods:** Parental questionnaire **Age(s) at dietary assessment:** ≤2 y (Mean (SD): 16.9 (4.2) mo) **Age of introduction:** Mean (SD): 11.7 (2.1) mo (min: 4 mo, max: 30 mo); <9 mo: 3.6%, 9-11.9 mo: 28.4%, 12-12.9 mo: 56.9%, 13-17.9 mo: 8.6%, ≥18 mo: 2.4% **Outcome(s):** HAZ, BMIZ **Outcome assessment methods:** Height and weight measured by trained research assistants. Z-scores were calculated using 2006 WHO child growth standards. **Age(s) at outcome assessment:** 3-5 y (Mean (SD): 46.9 (7.5) mo)	**HAZ @ 3-5 y (β (95% CI))** **-0.03 (-0.05, -0.02), p<0.001** **Exploration of nonlinearity showed that age of cow milk introduction was associated with HAZ beginning after age 9 mo, p<0.05** **BMIZ @ 3-5 y (β (95% CI))** 0.02 (0.00, 0.04), p=0.13	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry **Key confounders NOT accounted for:** gestational age **Model adjustments:** Age, sex, birth weight, BF duration, maternal ethnicity, household income, maternal height, SSB consumption, BMI and length-for-age z-score prior to the introduction of cow milk **Funding:** No external funding

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Woo, 2013[8] PCS, GEHM, China, Mexico, U.S. Analytic N = 285 (Excluded participants who were lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR (Country: China: ~36%, Mexico: ~31%, U.S.: ~32%) Maternal education: China, Mexico, U.S., respectively: ≤HS graduate: 18.3%, 93.2%, 5.0%, Attended or graduated from college: 72.5%, 5.9%, 78.3%, Post-college education: 9.2%, 0.8%, 16.7% Other SEP measure(s): Employed at time of pregnancy: 71.4% (China), 40.7% (Mexico), 80.8% (U.S.); WIC (U.S.): ~34%, Nutrisano supplemental food program (Mexico): 0%, Supplemental food programs in Shanghai (China): 0% Maternal age: 29.3 (3.7) y (China), 24.4 (5.6) y (Mexico), 31.5 (5.2) y (U.S.) Milk feeding practices: EBF duration (median (IQR)): China: 4.9 (1.6, 11.9) wk, Mexico: 7.1 (0.0, 18.0) wk, U.S.: 13.7 (4.6, 19.3) wk. BF duration (median): China: 37.1 wk, Mexico: 52.0 wk, U.S.: 49.5 wk Child sex (female): 49% Birth weight: ~3.4 kg Gestational age: 100% ≥37 wk gestation	**Exposure(s) and comparator(s):** Nonhuman milk (e.g., cow or soy milk): Ever vs never introduced in the first y Nonmilk dairy foods (e.g., yogurt, fermented milk, cheese): Ever vs never introduced in the first year **Dietary assessment methods:** Maternal 24 h food frequency recall via telephone. **Age(s) at dietary assessment:** 2-52 wk, weekly **Age of introduction:** Median (IQR) for China, Mexico, and U.S., respectively (mo): Nonhuman milk: 11.8 (8.4, 12.1), 9.8 (8.1, 11.9), 11.7 (11.3, 12.1), Nonmilk dairy foods: 11.2 (7.3, 11.9), 8.9 (7.0, 11.1), 9.4 (8.1, 10.8) **Outcome(s):** WAZ, LAZ, BMIZ **Outcome assessment methods:** Weight and length measured by trained study personnel. WAZ, LAZ, and BMIZ calculated using age- and sex-specific z-scores from the 2005 WHO infant growth standards. **Age(s) at outcome assessment:** 1 y	**WAZ @ 1 y** Nonhuman milk: Data NR, p≥0.20 Nonmilk dairy foods: Data NR, p≥0.20 **LAZ @ 1 y** Nonhuman milk: Data NR, p≥0.20 Nonmilk dairy foods: Data NR, p≥0.20 **BMIZ @ 1 y** Nonhuman milk: Data NR, p≥0.20 Nonmilk dairy foods: Data NR, p≥0.20	**Key confounders accounted for:** SEP; sex; milk feeding practices; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; baseline anthropometry **Model adjustments:** Cohort site **Funding:** Mead Johnson Nutrition Inc; NIH/NICHD; NIH/NCRR (Institutional Clinical and Translational Science Award)

[a] Abbreviations: @: at; β: beta; BF: breast feeding; BIA: bioelectrical impedance analysis; BM: breast milk; BMI: body mass index; BMIZ: BMI z-score; CAD: Canadian Dollar; CDC: Centers for Disease Control and Prevention; CHIP: Children's Health Insurance Program; CI: confidence interval; cm: centimeter; d: day; EBF: exclusive breast feeding; ECLS-B: Early Childhood Longitudinal Study; g: gram; FF: formula feeding; FFMI: fat-free mass index; FFQ: food frequency questionnaire; FMI: fat mass index; g: gram; GEHM: Global Exploration of Human Milk; h: hour; HAZ: height-for-age z-score; HS: high school; IQR: interquartile range; kg: kilogram; LAZ: length-for-age z-score; mm: millimeter; mo: month; NR: not reported; NS: non-significant; OR: odds ratio; PCS: prospective cohort study; ref: reference; SD: standard deviation; SE: standard error; SEP: socioeconomic position; SKOT: Småbørns Kost og Trivsel; SSB: sugar-sweetened beverage; TARGet Kids: The Applied research Group for Kids!; U.S.: United States; WAZ: weight-for-age z-score; WFH:

weight-for-height/length z-score; WHO: World Health Organization; WHZ: weight-for-height z-score; WIC: Special Supplemental Nutrition Program for Women, Infants, and Children; WIC ITFPS-2: WIC Infant and Toddler Feeding Practices Study-2; wk: week; WLZ: weight-for-length z-score; y: year

Table 22. Risk of bias for observational studies examining timing of introduction to dairy and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Amaro-Rivera, 2019[1]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Au, 2023[6]	HIGH	LOW	LOW	LOW	SOME CONCERNS	LOW	SOME CONCERNS	HIGH
Burke, 2005[11]	SOME CONCERNS	HIGH	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Butte, 2000[12]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH	HIGH
Ejlerskov, 2015[13]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	SOME CONCERNS	LOW	SOME CONCERNS	HIGH
Farris, 1982[14]	VERY HIGH	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	VERY HIGH
Flores, 2013a[15]	LOW	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Flores, 2013b[16]	LOW	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Kuperberg, 2006[17]	SOME CONCERNS	HIGH	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Retamal, 2020[18]	HIGH	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Rossiter, 2013[19]	HIGH	HIGH	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Soczynska, 2020[20]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	SOME CONCERNS	LOW	SOME CONCERNS	HIGH
Woo, 2013[8]	VERY HIGH	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH	VERY HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Sugar-sweetened beverages

Description of the evidence

Nine articles met inclusion criteria and examined the relationship between the timing of introduction of SSBs in infants and young children, up to age 24 months, and growth, body composition, and risk of obesity (**Table 24**).[3,4,6,8,21-25] All 9 studies were PCS, using data from the following cohorts: Born in Bradford,[25] Early Life Exposure in Mexico to Environmental Toxicants,[22] GEHM,[8] Impact of Perinatal Environmental Variations in the First 6 Months of Life,[21] IFPS II,[23] Project Viva,[4] Upstate KIDS,[24] WIC ITFPS-2,[6] and 1 unnamed study.[3]

Population

Six studies were conducted in the United States,[3,4,6,8,23,24] while the remaining studies were conducted in Brazil,[21] China,[8] Mexico,[8,22] and the United Kingdom.[25] The analytic sample sizes of the studies ranged from 94[3] to 2,056.[24] The studies did not provide information regarding statistical power.

Race and/or ethnicity varied across the 7 studies that reported this information. Individuals who were White or non-Hispanic White were commonly included across studies, representing 29% to 100% of participants in all 7 studies.[3,4,6,21,23-25] Individuals of other races and/or ethnicities were also included, but in generally smaller proportions, including individuals who were Hispanic (4% to 41% across 3 studies),[4,6,23] Black or African American (3% to 25% across 4 studies),[4,6,21,23] Asian (3%),[4] and Pakistani (49%).[25] Average maternal age tended to range from the mid-twenties to the early-thirties.[4,6,8,21-25] Human milk feeding practices, and the metrics reported, varied across the studies. Three studies reported rates of ever breast feeding which ranged from 78% to 82%.[3,6,21] Regarding human milk feeding duration, 3 studies provided information on breast feeding at 4 months with rates ranging from 59% to 69%,[3,4,24] 2 studies provided information on breast feeding at 6 months with rates of 51% for any breast feeding[23] and 12% for exclusive breast feeding,[3] and 1 study provided information on partial breast feeding at 12 months reporting a rate of 31%.[22] An additional study reported median durations of exclusive and any breast feeding which ranged from 4.9 to 13.7 weeks and 37.1 to 52.0 weeks, respectively, depending on the country the participants hailed from.[8] Finally, 1 study noted that 32% of participants continued to breast feed after introducing solid foods.[25] Measures of SEP were reported across all studies. The most common SEP measure was maternal education: several studies reported that relatively high percentages of individuals who attended college, graduated from college, or had an advanced degree,[3,4,8,23,24] while some reported relatively lower levels of maternal education.[6,21,25]

The children enrolled in these studies were approximately 50% female. Three studies reported mean birth weight which ranged from 3.4 to 3.5 kilograms.[3,4,8] Other studies reported that only a small proportion of participants had low[6,25] or high[6,23] birth weight. In 3 studies the participants were limited to those born term,[3,6,8] while a fourth reported an average gestational age of 39.7 weeks,[4] and a fifth reported that only 5% of participants were born preterm.[25]

Exposures and comparators

The beverages examined were in 2 primary categories: SSBs excluding 100% juice (such as sodas, soft drinks, and fruit drinks)[6,8,22,23,25] and juice that was not defined by the study as 100% juice.[3,4,8,21,24] Two studies examined age of introduction as a continuous variable,[3,8] but most examined age of introduction as a categorical variable.[4,6,8,21-25] The most common age cut points examined were 6 months[4,21,23,24] and 12 months.[6,8,22-24] Timing of introduction to SSBs was assessed primarily through maternal questionnaires,[4,21,23-25] but other methods included 24-hour recalls,[3,6] 24-hour food frequency recall,[8] and a semi-quantitative food-frequency questionnaire (FFQ).[22]

Outcomes

Growth, body composition, and risk of obesity were assessed using a variety of measures. Outcomes related to growth were reported in 7 studies,[3,4,6,8,21,24,25] with the most common outcome being BMIZ. Additional outcomes included weight, length, change in weight slope relative to length slope, WAZ, HAZ, and LAZ. Two studies examined measures of body composition, including waist circumference, body fat percentage, truncal fat mass, and skinfold thickness,[4,22] and 4 studies examined the risk of overweight and/or obesity.[21-24] Most studies reported that the outcomes were measured by study personnel,[3,4,6,8,21,22,25] however 2 studies relied on maternal report of height and weight.[23,24] Z-scores were calculated using growth standards from the WHO[8,21,22,25] and the CDC.[4,6,23,24] The outcomes were assessed at a variety of timepoints from infancy to adolescence: 2 studies assessed outcomes among infants and young children up to age 24 months,[3,8] 6 studies assessed outcomes among children,[4,6,21-25] and 2 studies assessed outcomes among adolescents.[4,22]

Synthesis of the evidence

Of the 9 studies that examined timing of introduction of SSBs (**Table 24**), 4 reported statistically significant, indirect associations between age at introduction and growth, body composition, or risk of obesity, although all also reported null associations between the exposure and outcomes depending on the specific outcome measure or timepoint analyzed.[4,6,23,24] Of these, 2 assessed SSBs excluding juice, with 1 study reporting that introduction to SSBs at age 12 months or later was associated with lower BMIZ at age 4 years, but not at earlier ages (2 and 3 years),[6] and the other reporting that introduction to SSBs prior to age 6 months compared to after age 12 months was associated with higher odds of obesity at age 6 years, while comparisons between introduction from age 6 to 12 months and after age 12 months in this study did not achieve statistical significance but were in the same direction.[23] The other 2 studies examined juice that was not defined as being 100%. One reported that introduction to juice before age 6 months, compared to age 12 months or later, was associated with higher WAZ, BMIZ, and risk of obesity at age 7 to 9 years, while associations tended to be null at age 2 to 3 years and for the outcomes of risk of overweight and HAZ.[24] The other reported that introduction to juice prior to age 4 months, compared to between age 4 and 6 months, was associated with greater BMIZ and waist circumference at age 8 years, but only among infants breastfed for at least 4 months; differences in these outcomes at age 13 years were not detected.[4]

The remaining 5 studies did not detect differences in outcomes related to growth, body composition, and risk of obesity by age of introduction to SSBs, 3 which assessed SSBs such as sweetened drinks and soft drinks[8,22,25] and 3 which assessed juice which was not defined or could not be confirmed to be 100% juice.[3,8,21] Two studies did not provide information on the direction or magnitude of the results beyond statistical significance,[3,8] while the remaining studies reported non-significant associations that were both consistent[21,22] and inconsistent[25] with those of the statistically significant findings showing greater BMIZ, WAZ, and odds of obesity with earlier introduction, but these studies generally had a small magnitude or wide confidence intervals. A wide range of relationships were analyzed across these studies, including: introduction to SSBs at or before age 12 months and both obesity and abdominal obesity at age 8 to 14 years[22]; introduction to sweetened drinks prior to age 17 weeks and BMIZ at age 3 years[25]; introduction to soft drinks by age 1 year, as well as introduction to juice modeled continuously, and WAZ, LAZ, and BMIZ at age 1 year [8]; introduction to juice prior to age 6 months and BMIZ and weight status at age 3 to 6 years[21]; and age of juice introduction modeled continuously and change in weight, length, and weight relative to length from age 2 to 8 months and age 12 to 24 months[3]

There was considerable heterogeneity in this body of evidence across multiple domains, limiting the ability to make meaningful comparisons and draw conclusions. First, although 9 studies were categorized as examining timing of introduction to SSBs, only 5 studies examined SSBs such as soda, soft drinks, and/or fruit drinks[6,22,23,25] while 5 studies assessed timing of introduction to juice that was not defined as 100% juice or could not be confirmed to be querying introduction to 100% juice[3,4,8,21,24]; it is unknown to what extent the results of these studies reflect timing of introduction to 100% juice versus juice with added sugars. Second, timing of introduction was assessed both continuously[3,8] and using a variety of categorical cut points across the studies, including at approximately age 4 months,[4,25] age 6 months,[4,21,23,24] and age 12 months.[6,8,22-24] None of the studies examined timing cut points beyond age 12 months. Finally, the outcomes related to growth, body composition, and risk of obesity were assessed across a large range of ages, as young as 8 months[3] and as old as 14 years.[22]

Conclusion statement and grade

The Committee did not draw a conclusion statement about the relationship between the timing of introduction of SSBs in infants and young children, birth up to 24 months, and growth, body composition, and risk of obesity (**Table 23**). This was due to considerable heterogeneity across the studies regarding the beverages included in the exposures and comparators, the timing cut points examined, and the age at which the outcomes were assessed. Publication bias was also a consideration; however, this was not assessed as a serious concern because the body of evidence included studies that reported only nonsignificant findings as well as studies that reported a mix of both significant and nonsignificant results, across a range of analytic sample sizes. However, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias. The risk of bias assessments for the studies that addressed this question are documented in **Table 25**.

Table 23. Conclusion statement, grade for timing of introduction of sugar-sweetened beverages and growth, body composition, and risk of obesity

Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to sugar-sweetened beverages and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency in the body of evidence.**
Grade	Grade Not Assignable
Body of Evidence	9 articles: 9 prospective cohort studies
Rationale	The studies had inconsistent exposures and comparators, including the timing cut points examined, as well as varied ages at outcome assessment

Table 24. Evidence examining the relationship between timing of introduction to sugar-sweetened beverages and growth, body composition, and risk of obesity[a]

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Au, 2023[6] PCS, WIC ITFPS-2, U.S. Analytic N = 1,523 (24 mo), 1,680 (36 mo), 1,872 (48 mo) (Excluded participants with missing data on HEI-2015 or BMI at 2, 3, or 4 y, born prematurely, had very low birth weight, or had long-term medical problems that could affect eating.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Hispanic: 40.6%, Non-Hispanic White: 29.1%, Non-Hispanic African American: 24.8%, Non-Hispanic Other: 5.5% Maternal education: <HS: 24.4%, HS: 37.7%, >HS: 37.5% Other SEP measure(s): Participating in WIC: 100%; Maternal employment at 6 mo: Full-time: 21.5%, Part-time: 20.2%, Not working for pay: 58.2%; Poverty level at enrollment: ≤75% of poverty guideline: 64.0%, >75-<130%: 26.3%, >130% poverty: 9.7% Maternal age: 16-19 y: 11.7%, 20-25 y: 41.1%, ≥26 y: 47.3% Milk feeding practices: Any BF: 81.9%; Any formula use: 95.5% Child sex (female): 49% Birth weight: Low (<2.5 kg): 5.3%, Normal (2.5-≤4.5 kg): 93.4%, High (>4.5 kg): 1.3% Gestational age: Excluded infants born prematurely	**Exposure(s) and comparator(s):** Age of first introduction of SSB (soda, soft drinks or other sweetened beverages (Kool Aid, Hi-C, Fruit Punch, sweetened juice, sweetened or flavored water, Gatorade, or sweet tea) but excluding 100% juice): categorical (Infant Diet Quality Index component score from 0-1 based on degree of adherence to guidelines; max score: introduced at ≥12 mo) **Dietary assessment methods:** 24-h dietary recall via telephone interview with caregiver **Age(s) at dietary assessment:** 1, 3, 5, 7, 9 11, 13, 15, 18, 24, 30, 36, 42, and 48 mo **Age of introduction:** ≥12 mo: 34.0% **Outcome(s):** BMIZ **Outcome assessment methods:** Weight and length/height collected at WIC sites or from child's health care provider. BMIZ based on CDC age- and sex-specific growth charts **Age(s) at outcome assessment:** 2, 3, 4 y	**BMIZ @ 2, 3, 4 y** 2 y: Data NR, p>0.10 3 y: Data NR, p>0.10 **4 y: greater adherence associated with lower BMIZ, p<0.05**	**Key confounders accounted for:** SEP; sex; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; milk feeding practices; baseline anthropometry **Model adjustments:** None **Funding:** NHLBI; USDA/NIFA

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Becker, 2023[21] PCS, IVAPSA, Brazil Analytic N = 103 (Excluded participants with missing data on exposure and/or outcome.) Adequately powered: No **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Maternal race/skin color: White: 58.3%, Black: 23.3%, Other (yellow and brown): 18.4% Maternal education: Maternal education level (y): 0-8: 29.1%, 9-11: 57.3%, >11: 13.6% Other SEP measure(s): Family income (reais, Median (25th, 75th percentile)): 1,950 (1,200, 3,000) Maternal age: Median (25th, 75th percentile): 28 (21, 33) y Milk feeding practices: Ever BF: 77.7% Child sex (female): 59% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Age of introduction to fruit juice (including natural fruit juice, concentrated fruit juice, diluted fruit juice, and artificial fruit juices - powdered juices, nectars, and fruit drinks): <6 mo vs ≥6 mo **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 6 mo **Age of introduction:** <6 mo: 72.8%, ≥6 mo: 27.2% **Outcome(s):** BMIZ, Risk of overweight **Outcome assessment methods:** Weight and height measured by research staff. BMIZ calculated based on WHO growth curves. **Age(s) at outcome assessment:** Preschool age (3-6 y)	**BMIZ @ 3-6 y (Mean)** Juice <6 mo vs ≥6 mo 0.88 vs 0.55, p=0.282 **Change in BMIZ from 6 mo to 3-6 y (Mean)** Juice <6 mo vs ≥6 mo 0.5 vs 0.4, p=0.824 **Weight status @ 3-6 y (%)** Juice <6 mo vs ≥6 mo Thinness: 5.3% vs 3.6% Normal weight and risk of overweight: 66.7% vs 75.0% Overweight/obese: 28.0% vs 21.4% p=0.843	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry **Key confounders NOT accounted for:** gestational age **Model adjustments:** None **Funding:** PAPERGS/CNPq; FIPE/HCPA; PRONEX 2009

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Cantoral, 2016[22] PCS, ELEMENT, Mexico Analytic N = 227 (Excluded participants who did not enroll in follow-up study and who were not selected for new study centre, or had incomplete data for relevant variables (socio-demographic, dietetic, anthropometric, and physical activity variables)) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR Maternal education: NR Other SEP measure(s): SES level (pesos/mo): E ($0-2,699): 8%, D ($2,700-6,799): 20%, D+ ($6,800-11,599): 51.3%, C ($11,600-34,999): 19.3%, C+ ($35,000-84,999): 1.4%, A/B (>$85,000): 0% Maternal age: NR Milk feeding practices: Partial BF until 12 mo: 31% Child sex (female): 54% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Age of introduction to SSB (sodas, commercial fruit drinks, flavored water with sugar; does not include natural fruit or vegetable juice): ≤12 mo vs >12 mo (ref) **Dietary assessment methods:** Semi-quantitative FFQ (child diet previous 3 mo) administered by trained personnel to mother **Age(s) at dietary assessment:** 12 mo **Age of introduction:** ≤12 mo: 73%, >12 mo: 27% **Outcome(s):** Obesity, Abdominal obesity **Outcome assessment methods:** Weight, height, and WC measured by trained personnel. Obesity classified using WHO criteria (>2 SD of the z-score for BMI). Abdominal obesity defined as waist circumference ≥90th percentile for age and sex **Age(s) at outcome assessment:** 8-14 y (8-9y: 47%, 10-11y: 31%, 12-14y: 22%)	**Abdominal obesity @ 8-14 y (OR (95% CI))** 1.70 (0.70, 4.09) **Obesity @ 8-14 y (OR (95% CI))** 2.00 (0.87, 4.59)	**Key confounders accounted for:** SEP; sex; milk feeding practices; baseline anthropometry **Key confounders NOT accounted for:** race and/or ethnicity; gestational age **Model adjustments:** sex, any BF up to age 12 mo, maternal obesity at 12 mo postpartum, concurrent age, non-SSB energy intake, physical activity, TV watching **Funding:** NIEHS; Consejo Nacional de Ciencia y Tecnologia; NIEHS/US EPA Formative Children's Center for Environmental Health and Disease Prevention Research

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Carruth, 2000[3] PCS, U.S. Analytic N = 94 (Reasons for attrition NR) Adequately powered: Yes **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: White: 100% Maternal education: College degree: 50% Other SEP measure(s): Hollingshead Index: 54 (9) - all "middle or upper SES families" Maternal age: 31 y Milk feeding practices: Ever BF: 83%, EBF at 4 mo: 33%, Mixed feeding at 4 mo: 33%, EBF at 6 mo: 12% Child sex (female): 46% Birth weight: Males: 7.8 (1.2) lb, Females: 7.6 (1.1) lb Gestational age: 100% full-term	**Exposure(s) and comparator(s):** Age introduced to juice (not defined): Continuous **Dietary assessment methods:** 24-h recall (maternal report) with dietitian **Age(s) at dietary assessment:** 2, 3, 4, 6, 8, 10, 12, 16, 20, 24 mo (interviewed 3-5x from 2-10 mo, 2-4x from 12-24 mo) **Age of introduction:** Median (range): 4.5 (1-11) mo **Outcome(s):** Weight, length, Change in weight slope relative to length slope **Outcome assessment methods:** Weight and length measured by research staff **Age(s) at outcome assessment:** 2, 3, 4, 6, 8, 10, 12, 16, 20, 24 mo (measured 3-5x from 2-10 mo, 2-4x from 12-24 mo)	**Change in weight @ 2-8 mo, 12-24 mo (β (SE))** Change from 2-8 mo: Data NR, $p>0.05$ Change from 12-24 mo: Data NR, $p>0.05$ **Change in length @ 2-8 mo, 12-24 mo (β (SE))** Change from 2-8 mo: Data NR, $p>0.05$ Change from 12-24 mo: Data NR, $p>0.05$ **Change in weight slope relative to length slope @ 2-8 mo, 12-24 mo (β (SE))** Change from 2-8 mo: Data NR, $p>0.05$ Change from 12-24 mo: Data NR, $p>0.05$	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** None **Model adjustments:** NA (variable not retained in model) **Funding:** NR

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Gingras, 2019[4] PCS, Project Viva, U.S. Analytic N = 1,013 (Excluded participants who did not have complete exposure data, did not have outcomes measured, and children born <34 wk gestation) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR (Child race and/or ethnicity: White: 69%, Black or African American: 12%, Other: 12%, Hispanic: 4%, Asian: 3%) Maternal education: College graduate: 74% Other SEP measure(s): Household income >$70,000/y: 66% Maternal age: 32.6 (4.8) y Milk feeding practices: Any BF at 4 mo: 69% Child sex (female): 51% Birth weight: 3.53 (0.52) kg Birth weight for gestational age z score: 0.23 (0.97) Gestational age: 39.7 (1.4) wk	**Exposure(s) and comparator(s):** Timing of introduction to fruit juice (not defined): <4 mo, 4-<6 mo (ref), ≥6 mo **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 6, 12 mo **Age of introduction:** <4 mo: 5.6%, 4-<6 mo: 23.7%, ≥6 mo: 70.8% **Outcome(s):** BMIZ, WC, DXA whole-body fat percentage, DXA truncal fat mass, sum of skinfolds (subscapular plus triceps), skinfold ratio (subscapular/triceps) **Outcome assessment methods:** All outcomes measured by trained research staff. Age- and sex-specific BMIZ calculated using U.S. national reference data. Whole-body fat percentage and truncal fat mass measured via DXA. **Age(s) at outcome assessment:** Mean (SD): 7.9 (0.8) y; 13.2 (0.9) y	**BMIZ @ ~8 y (β (95% CI))** Among infants BF ≥4 mo: **<4 mo vs 4-<6 mo (ref): 0.46 (0.04, 0.88)** ≥6 mo vs 4-<6 mo (ref): 0.03 (-0.14, 0.21) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): 0.12 (-0.30, 0.53) ≥6 mo vs 4-<6 mo (ref): -0.10 (-0.37, 0.16) **BMIZ @ ~13 y (β (95% CI))** Among infants BF ≥4 mo: <4 mo vs 4-<6 mo (ref): 0.21 (-0.24, 0.67) ≥6 mo vs 4-<6 mo (ref): 0.03 (-0.16, 0.22) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): 0.34 (-0.11, 0.79) ≥6 mo vs 4-<6 mo (ref): -0.04 (-0.35, 0.26) **WC (cm) @ ~8 y (β (95% CI))** Among infants BF ≥4 mo: **<4 mo vs 4-<6 mo (ref): 3.44 (0.48, 6.40)** ≥6 mo vs 4-<6 mo (ref): 0.10 (-1.14, 1.35) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): 1.33 (-2.16, 4.82) ≥6 mo vs 4-<6 mo (ref): -1.01 (-3.24, 1.23) **WC (cm) @ ~13 y (β (95% CI))** Among infants BF ≥4 mo: <4 mo vs 4-<6 mo (ref): 2.71 (-1.93, 7.35) ≥6 mo vs 4-<6 mo (ref): -0.00 (-1.96, 1.96) Among infants FF (never BF or stopped BF by 4 mo): <4 mo vs 4-<6 mo (ref): 3.63 (-1.73, 8.99) ≥6 mo vs 4-<6 mo (ref): -2.43 (-6.05, 1.18)	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** None **Model adjustments:** child sex, child age, maternal education level, marital status, household income, maternal prepregnancy BMI, paternal BMI, child's race and/or ethnicity, gestational age at delivery, change in WAZ from 0 to 4 mo. **Funding:** NIH, CIHR

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Pan, 2014[23] PCS, IFPS II, U.S. Analytic N = 1,189 (Excluded participants that were lost to follow-up, were >13 mo at IFPS II survey, did not have anthropometric measurements at 6 y, had height, weight, or BMI at follow-up that was biologically implausible, or did not have data on SSBs.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: White, non-Hispanic: 88.0%, Hispanic: 4.8%, Other, non-Hispanic: 3.9%, Black, non-Hispanic: 3.4% Maternal education: HS or less: 16.1%, Some college: 34.8%, College graduate: 49.0% Other SEP measure(s): Income-to-poverty ratio: <185%: 33.6%, 185%-349%: 37.9%, ≥350%: 28.5% Maternal age: 18-24 y: 13.5%, 25-29 y: 33.2%, 30-34 y: 32.3%, ≥20.9% Milk feeding practices: BF <6 mo: 48.6%, BF ≥6 mo: 51.4% Child sex (female): 50% Birth weight: ≤4,000 g: 87.1%, >4,000 g: 12.9% Gestational age: NR	**Exposure(s) and comparator(s):** Age at introduction to SSBs (juice drinks, soft drinks, soda, sweet tea, Kool-Aid [Kraft foods, West Plains, NY]): Never during infancy (ref), ≥6 mo, <6 mo, Any during infancy (≥6 mo and <6 mo combined) **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12 mo **Age of introduction:** Never during infancy: 74.1%, ≥6 mo: 18.8%, <6 mo: 8.5% **Outcome(s):** Obesity **Outcome assessment methods:** Height and weight measured and reported by mothers; given instructions in questionnaire on how to complete measurements. Obesity defined as sex-specific BMI-for-age ≥95th percentile according to 2000 CDC growth charts **Age(s) at outcome assessment:** 6 y	**Obesity @ 6 y (OR (95% CI))** Age of SSB introduction **Any during infancy vs none (ref): 1.71 (1.09, 2.68)** ≥6 mo vs never (ref): 1.61 (0.96, 2.71) **<6 mo vs never (ref): 1.92 (1.01, 3.66)**	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices **Key confounders NOT accounted for:** gestational age; baseline anthropometry **Model adjustments:** Sex, birth weight, age at solid food introduction, BF duration, maternal age, maternal race/ethnicity, maternal education, marital status, income-to-poverty ratio, prepregnancy weight status **Funding:** FDA; CDC; Office of Women's Health; NIH; Maternal and Child Health Bureau

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Robinson, 2022[24] PCS, Upstate KIDS, U.S. Analytic N = 1,713-2,056 (at 2-3 y), 1,283-1,373 (at 7-9 y) (Excluded participants without data on the exposure or outcome, and 1 randomly selected twin from twin pairs.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Non-Hispanic White: ~86% Maternal education: Less than high school: ~2%, HS or GED equivalent: ~7%, Some college: ~23%, College: ~27%, Advanced degree: ~40% Other SEP measure(s): Household income: $10,000-24,999: ~8%, $25,000-49,999: ~14%, $50,000-74,999: ~21%, $75,000-99,999: ~22%, ≥$100,000" ~35%; WIC participation: ~15%; Private insurance: ~87% Maternal age: ~31 y Milk feeding practices: BF at 4 mo: ~59% Child sex (female): ~48% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Timing of juice introduction (does not distinguish between 100% juice vs juice drinks [e.g., juice with added water, artificial sweeteners, or sugar]): <6 mo, 6-<12 mo, ≥12 mo (ref); <6 mo, 6-<9 mo, 9-<12 mo, ≥12 mo (ref) **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 4, 8, 12, 18 mo **Age of introduction:** <6 mo: ~15%, 6-<12 mo: ~49%, ≥12 mo: ~33% **Outcome(s):** BMIZ, WAZ, HAZ, overweight/obesity; obesity **Outcome assessment methods:** Height/length and weight measured via maternal report. Age- and sex-standardized WAZ, HAZ, and BMIZ calculated using CDC reference. Overweight/obesity defined as ever having BMIZ ≥85th %ile during age range. Obesity defined as ever having BMIZ ≥95th %ile during age range. **Age(s) at outcome assessment:** 2-3 y, 7-9 y	**WAZ @ 2-3 y and 7-9 y (Mean difference (95% CI))** 2-3 y **<6 mo vs ≥12 mo (ref): 0.21 (0.04, 0.37)** 6-<12 mo vs ≥12 mo (ref): -0.03 (-0.14, 0.08) **p-trend: 0.02** 7-9 y **<6 mo vs ≥12 mo (ref): 0.27 (0.06, 0.49)** 6-<12 mo vs ≥12 mo (ref): -0.01 (-0.14, 0.15) **p-trend: 0.02** **HAZ @ 2-3 y and 7-9 y (Mean difference (95% CI))** 2-3 y <6 mo vs ≥12 mo (ref): 0.32 (-0.14, 0.79) 6-<12 mo vs ≥12 mo (ref): 0.03 (-0.33, 0.39) p-trend: 0.32 7-9 y <6 mo vs ≥12 mo (ref): -0.02 (-0.27, 0.22) 6-<12 mo vs ≥12 mo (ref): 0.05 (-0.11, 0.22) p-trend: 0.91 **BMIZ @ 2-3 y and 7-9 y (Mean difference (95% CI))** 2-3 y <6 mo vs ≥12 mo (ref): -0.23 (-0.45, 0.35) 6-<12 mo vs ≥12 mo (ref): -0.16 (-0.45, 0.07) p-trend: 0.40 7-9 y **<6 mo vs ≥12 mo (ref): 0.38 (0.12, 0.64)** 6-<12 mo vs ≥12 mo (ref): -0.02 (-0.19, 0.15) **p-trend: 0.01**	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices **Key confounders NOT accounted for:** gestational age; baseline anthropometry **Model adjustments:** Child age at time of assessment, maternal age at baseline, pre-pregnancy BMI, race/ethnicity, education, WIC participation, fertility treatment use, smoking during pregnancy, gestational hypertension, residence type, household income, paternal BMI, child's sex, twin status, age at solid food introduction (midpoint), and any breastfeeding at 4 mo **Funding:** NICHD

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Robinson, 2022[24] (Continued) PCS, Upstate KIDS, U.S. Analytic N = 1,713-2,056 (at 2-3 y), 1,283-1,373 (at 7-9 y) (Excluded participants without data on the exposure or outcome, and 1 randomly selected twin from twin pairs.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Non-Hispanic White: ~86% Maternal education: Less than high school: ~2%, HS or GED equivalent: ~7%, Some college: ~23%, College: ~27%, Advanced degree: ~40% Other SEP measure(s): Household income: $10,000-24,999: ~8%, $25,000-49,999: ~14%, $50,000-74,999: ~21%, $75,000-99,999: ~22%, ≥$100,000" ~35%; WIC participation: ~15%; Private insurance: ~87% Maternal age: ~31 y Milk feeding practices: BF at 4 mo: ~59% Child sex (female): ~48% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Timing of juice introduction (does not distinguish between 100% juice vs juice drinks [e.g., juice with added water, artificial sweeteners, or sugar]): <6 mo, 6-<12 mo, ≥12 mo (ref); <6 mo, 6-<9 mo, 9-<12 mo, ≥12 mo (ref) **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 4, 8, 12, 18 mo **Age of introduction:** <6 mo: ~15%, 6-<12 mo: ~49%, ≥12 mo: ~33% **Outcome(s):** BMIZ, WAZ, HAZ, overweight/obesity; obesity **Outcome assessment methods:** Height/length and weight measured via maternal report. Age- and sex-standardized WAZ, HAZ, and BMIZ calculated using CDC reference. Overweight/obesity defined as ever having BMIZ ≥85th %ile during age range. Obesity defined as ever having BMIZ ≥95th %ile during age range. **Age(s) at outcome assessment:** 2-3 y, 7-9 y	**Overweight/obesity @ 2-3 y and 7-9 y (RR (95% CI))** 2-3 y <6 mo vs ≥12 mo (ref): 1.09 (0.73, 1.63) 6-<12 mo vs ≥12 mo (ref): 0.84 (0.62, 1.15) p-trend: 0.53 7-9 y <6 mo vs ≥12 mo (ref): 1.54 (0.99, 2.38) 6-<12 mo vs ≥12 mo (ref): 0.94 (0.65, 1.37) **p-trend: 0.005** **Obesity @ 2-3 y and 7-9 y (RR (95% CI))** 2-3 y <6 mo vs ≥12 mo: 1.16 (0.62, 2.16) 6-<12 mo vs ≥12 mo: 1.11 (0.69, 1.78) p-trend: 0.29 7-9 y **<6 mo vs ≥12 mo: 2.17 (1.11, 4.23)** 6-<12 mo vs ≥12 mo: 1.10 (0.62, 1.95) **p-trend: 0.001** Examining data with the 6-<12 mo group broken into 6-<9 mo and 9-<12 mo did not change results.	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices **Key confounders NOT accounted for:** gestational age; baseline anthropometry **Model adjustments:** Child age at time of assessment, maternal age at baseline, pre-pregnancy BMI, race/ethnicity, education, WIC participation, fertility treatment use, smoking during pregnancy, gestational hypertension, residence type, household income, paternal BMI, child's sex, twin status, age at solid food introduction (midpoint), and any breastfeeding at 4 mo **Funding:** NICHD

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Santorelli, 2014[25] PCS, Born in Bradford, U.K. Analytic N = 743 (Excluded participants without information on infant feeding, had missing obstetric or covariate data, were from multiple births, or were not of White British or Pakistani ethnicity.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Pakistani: 49%, White British: 38%, Other South Asian: 7%, Other: 6% (Note - Other South Asian and Other were excluded from analyses) Maternal education: <5 GCSE equivalent: ~22%, ≥5 GCSE equivalent: ~33%, A-level equivalent: ~25%, > A-level equivalent: 25%, Foreign unknown/other: ~6% Other SEP measure(s): NR Maternal age: ~27 y Milk feeding practices: Replaced BM with formula milk before introducing solid foods: ~39%; Continued BF after introducing solid foods: ~32% Child sex (female): NR Low birth weight (<2,500 g): ~8% Gestational age: Preterm (<37 wk): ~5%	**Exposure(s) and comparator(s):** Introduction to sweetened drinks (e.g., cola, squash, lemonade, sweetened tea, prepared "baby" drinks): <17 wk vs ≥17 wk (ref) **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 6 mo, 12 mo **Age of introduction:** Sweetened drinks <17 wk: ~10% **Outcome(s):** BMIZ **Outcome assessment methods:** Weight and height measured. BMI converted into age- and sex-adjusted BMIZ according to WHO 2006 growth standards. **Age(s) at outcome assessment:** 3 y **Outcome(s):** BMIZ **Outcome assessment methods:** Weight and height measured. BMI converted into age- and sex-adjusted BMIZ according to WHO 2006 growth standards. **Age(s) at outcome assessment:** 3 y	**BMIZ @ 3 y (mean difference (95% CI))** <17 wk vs >17 wk (ref): -0.10 (-0.36, 0.16)	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** Ethnicity, maternal age, educational level, marital status, maternal smoking during pregnancy, maternal BMI, parity, preterm birth, low birth weight, mode of delivery, duration of BF, all other infant feeding practices (early introduction to solid foods, sweetened foods given as a first food, sweetened drinks given at <17 wk of age, replaced BM with formula milk before introducing solid foods, continuing BF after introducing solid foods) **Funding:** NIHR

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Woo, 2013[8] PCS, GEHM, China, Mexico, U.S. Analytic N = 285 (Excluded participants who were lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR (Country: China: ~36%, Mexico: ~31%, U.S.: ~32%) Maternal education: China, Mexico, U.S., respectively: ≤HS graduate: 18.3%, 93.2%, 5.0%, Attended or graduated from college: 72.5%, 5.9%, 78.3%, Post-college education: 9.2%, 0.8%, 16.7% Other SEP measure(s): Employed at time of pregnancy: 71.4% (China), 40.7% (Mexico), 80.8% (U.S.); WIC (U.S.): ~34%, Nutrisano supplemental food program (Mexico): 0%, Supplemental food programs in Shanghai (China): 0% Maternal age: 29.3 (3.7) y (China), 24.4 (5.6) y (Mexico), 31.5 (5.2) y (U.S.) Milk feeding practices: EBF duration (median (IQR)): China: 4.9 (1.6, 11.9) wk, Mexico: 7.1 (0.0, 18.0) wk, U.S.: 13.7 (4.6, 19.3) wk. BF duration (median): China: 37.1 wk, Mexico: 52.0 wk, U.S.: 49.5 wk Child sex (female): 49% Birth weight: ~3.4 kg Gestational age: 100% ≥37 wk gestation	**Exposure(s) and comparator(s):** Timing of introduction to fruit/vegetable juice (not defined as 100%), soft drinks: Continuous (fruit/vegetable juice), Ever vs never introduced in the first year (soft drinks) **Dietary assessment methods:** Maternal 24 h food frequency recall via telephone. **Age(s) at dietary assessment:** 2-52 wk, weekly **Age of introduction:** Median (IQR) for China, Mexico, and U.S., respectively (mo): Juice (fruit or vegetable): 4.3 (3.5, 5.3), 6.8 (6.2, 7.6), 9.1 (7.1, 10.4); Soft drinks: 0, 9.6 (8.8, 11.1), 11.1 (10.1, 12.0) **Outcome(s):** WAZ, LAZ, BMIZ **Outcome assessment methods:** Weight and length measured by trained study personnel. WAZ, LAZ, and BMIZ calculated using age- and sex-specific z-scores from the 2005 WHO infant growth standards. **Age(s) at outcome assessment:** 1 y	**WAZ @ 1 y** Fruit/vegetable juice: Data NR, p≥0.20 Soft drinks: Data NR, p≥0.20 **LAZ @ 1 y** Fruit/vegetable juice: Data NR, p≥0.20 Soft drinks: Data NR, p≥0.20 **BMIZ @ 1 y** Fruit/vegetable juice: Data NR, p≥0.20 Soft drinks: Data NR, p≥0.20	**Key confounders accounted for:** SEP; sex; milk feeding practices; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; baseline anthropometry **Model adjustments:** Cohort site **Funding:** Mead Johnson Nutrition Inc; NIH/NICHD; NIH/NCRR (Institutional Clinical and Translational Science Award)

[a] Abbreviations: @: at; β: beta; BF: breastfeeding; BM: breast milk; BMI: body mass index; BMIZ: BMI z-score; CDC: Centers for Disease Control and Prevention; CI: confidence interval; cm: centimeter; DXA: dual-energy X-ray absorptiometry; EBF: exclusive breastfeeding; ELEMENT: Early Life Exposure in Mexico to Environmental Toxicants; FF: formula feeding; FFQ: food frequency questionnaire; g: gram; GCSE: General Certificate of Secondary Education; GED: General Educational Development; GEHM: Global Exploration of Human Milk; h: hour; HAZ: height-for-age z-score; HS: high school; IFPS II: Infant Feeding Practices Study II; IQR: interquartile range; IVAPSA: Impact of Perinatal Environmental Variations in the First 6 Months of Life; kg: kilogram; LAZ: length-for-age z-score; lb: pound; mo: month; NR: not reported; OR: odds ratio; PCS: prospective cohort study; ref: reference; RR: risk ratio; SD: standard deviation; SE: standard error; SEP: socioeconomic position; SES: socioeconomic status; SSB: sugar-sweetened beverage; U.K.: United

Kingdom; U.S.: United States; WAZ: weight-for-age z-score; WC: waist circumference; WHO: World Health Organization; WIC: Special Supplemental Nutrition Program for Women, Infants, and Children; WIC ITFPS-2: WIC Infant and Toddler Feeding Practices Study-2; wk: week; x: times; y: year

Table 25. Risk of bias for observational studies examining timing of introduction to sugar-sweetened beverages and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Au, 2023[6]	HIGH	LOW	LOW	LOW	SOME CONCERNS	LOW	SOME CONCERNS	HIGH
Becker, 2023[21]	SOME CONCERNS	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Cantoral, 2016[22]	SOME CONCERNS	LOW	LOW	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Carruth, 2000[3]	LOW	LOW	LOW	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Gingras, 2019[4]	LOW	SOME CONCERNS	LOW	LOW	SOME CONCERNS	LOW	SOME CONCERNS	SOME CONCERNS
Pan, 2014[23]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	SOME CONCERNS	SOME CONCERNS	SOME CONCERNS	HIGH
Robinson, 2022[24]	SOME CONCERNS	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS	SOME CONCERNS	HIGH
Santorelli, 2014[25]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Woo, 2013[8]	VERY HIGH	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH	VERY HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Food sources of added sugars

Description of the evidence

One PCS met inclusion criteria and examined the relationship between the timing of introduction of food sources of added sugars among infants and young children, up to age 24 months, and growth, body composition, or risk of obesity (**Table 27**).[25]

Population

The study was conducted in the United Kingdom as part of the Born in Bradford cohort. The analytic sample size was 743 and the study did not report power. Forty-nine percent of the participants were Pakistani and 38% were White British, while the remaining participants were reported as Other South Asian (7%) and Other (6%). Only participants who were Pakistani or White British were included in the analyses. The average age of the mothers were about 27 years. Regarding SEP, the study reported a range of educational levels across the mothers: approximately 22% had the equivalent of less than 5 General Certificate of Secondary Education, approximately 33% had at least 5 General Certificate of Secondary Education, approximately 25% had an A-level equivalent, and approximately 25% had greater than an A-level equivalent. About 39% replaced breast milk with formula milk before introducing solid foods and 32% continued to breastfeed after introducing solid foods. Only 8% of the infants had low birth weight and 5% were born preterm. Growth, body composition, or risk of obesity at baseline was not reported.

Exposure and comparator

This study assessed introduction of sweetened foods (e.g., egg custard, rice pudding, sweetened rusks, biscuits, cakes) as a first food dichotomously (yes versus no). The exposure variable was assessed using a maternal questionnaire at ages 6 and 12 months.

Outcome

This study examined BMIZ at age 3 years, which was measured by research personnel. Age- and sex-adjusted BMIZ were based on WHO growth standards.

Synthesis of the evidence

The single study that met inclusion criteria and assessed timing of food sources of added sugars reported that sweetened foods introduced as a first food was not associated with BMIZ at age 3 years, but trended towards greater BMIZ (**Table 27**).[25]

Conclusion statement and grade

The Committee did not draw a conclusion statement about the relationship between the timing of introduction of food sources of added sugars in infants and young children, up to age 24 months, and growth, body composition, and risk of obesity because there is not enough evidence (**Table 26**). Publication bias may be a limitation, but the small body of evidence makes it difficult to assess. However, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias. The risk of bias for the study that addressed this question is documented in **Table 28**.

Table 26. Conclusion statement, grade for timing of introduction of food sources of added sugars and growth, body composition, and risk of obesity

Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to food sources of added sugars and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available.**
Grade	Grade Not Assignable
Body of Evidence	1 article: 1 prospective cohort study.
Rationale	There was not enough evidence to synthesize this body of evidence.

Table 27. Evidence examining the relationship between timing of introduction to food sources of added sugars and growth, body composition, and risk of obesity[a]

Study and Participant Characteristics	Exposure, Comparator, Outcome	Results	Key Confounders, Model Adjustments, Funding
Santorelli, 2014[25] PCS, Born in Bradford, U.K. Analytic N = 743 (Excluded participants without information on infant feeding, had missing obstetric or covariate data, were from multiple births, or were not of White British or Pakistani ethnicity.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Pakistani: 49%, White British: 38%, Other South Asian: 7%, Other: 6% (Note - Other South Asian and Other were excluded from analyses) Maternal education: <5 GCSE equivalent: ~22%, ≥5 GCSE equivalent: ~33%, A-level equivalent: ~25%, > A-level equivalent: 25%, Foreign unknown/other: ~6% Other SEP measure(s): NR Maternal age: ~27 y Milk feeding practices: Replaced BM with formula milk before introducing solid foods: ~39%; Continued BF after introducing solid foods: ~32% Child sex (female): NR Low birth weight (<2,500 g): ~8% Gestational age: Preterm (<37 wk): ~5%	**Exposure(s) and comparator(s):** Sweetened foods (e.g., egg custard, rice pudding, sweetened rusks, biscuits, cake): Introduced as a first food vs Not (ref)) **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 6 mo, 12 mo **Age of introduction:** Sweetened foods introduced as a first food: ~50% **Outcome(s):** BMIZ **Outcome assessment methods:** Weight and height measured. BMI converted into age- and sex-adjusted BMIZ according to WHO 2006 growth standards. **Age(s) at outcome assessment:** 3 y	**BMIZ @ 3 y (mean difference (95% CI))** Sweetened foods given as first food vs not (ref): 0.03 (-0.12, 0.19)	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** Ethnicity, maternal age, educational level, marital status, maternal smoking during pregnancy, maternal BMI, parity, preterm birth, low birth weight, mode of delivery, duration of BF, all other infant feeding practices (early introduction to solid foods, sweetened foods given as a first food, sweetened drinks given at <17 wk of age, replaced BM with formula milk before introducing solid foods, continuing BF after introducing solid foods) **Funding:** NIHR

[a] Abbreviations: @: at; BF: breastfeeding; BM: breast milk; BMI: body mass index; BMIZ: BMI z-score; CI: confidence interval; GCSE: General Certificate of Secondary Education; g: gram; mo: month; NR: not reported; PCS: prospective cohort study; ref: reference; SEP: socioeconomic position; U.K.: United Kingdom; WHO: World Health Organization; wk: week; y: year

Table 28. Risk of bias for observational studies examining timing of introduction to food sources of added sugars and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Santorelli, 2014[25]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Types and amounts of complementary foods and beverages

100% juice

Description of the evidence

Four studies (4 articles) met inclusion criteria and examined the relationship between 100% juice consumption by infants and young children, up to 24 months, and growth, body composition, and risk of obesity (**Table 30**).[1,26-28] All 4 studies were PCS, using data from the following cohorts: IFPS II,[26] Born in Bradford 1000,[27] Study of Women, Infant Feeding, and Type 2 Diabetes after Gestational Diabetes Mellitus pregnancy,[28] and 1 unnamed cohort.[1]

Population

The studies were conducted in the United States[1,26,28] (including 1 study conducted in Puerto Rico)[1] and the United Kingdom.[27] The analytic sample sizes of the studies ranged from 68[1] to 835.[28] None of the studies reported power calculations related to 100% juice consumption and the relevant outcomes.

All studies provided information on the racial and/or ethnic background of participants. This varied across the studies: 100% Hispanic in 1 study,[1] approximately 95% White, 4% Hispanic, and 2% Black in another,[26] approximately 56% Pakistani and 44% White British in the third,[27] and 37% non-Hispanic Asian, 30% Hispanic, 23% non-Hispanic White, 8% non-Hispanic Black, and 2% "mixed race/other" in the final study.[28] Across the 3 studies that reported maternal age, the women tended to be in their mid-twenties and early thirties.[1,26,28] Human milk and formula feeding practices were reported in 3 studies and tended to vary: 1 study reported an average duration of breastfeeding of 9 months,[28] a second reported that 21% of participants were breastfeeding at 10 months,[1] and the third reported that 52% of mothers had low breastfeeding intensity from 6-12 months.[26] SEP was reported for 3 studies.[1,26,28] Maternal education was reported across all 3 of these studies, showing that participants tended to have greater than a high school education level.[1,26,28] WIC participation was reported in 2 studies: 1 study exclusively enrolled individuals participating in WIC,[1] while the other reported that 25% of the women participated in WIC.[28] Finally, 1 study assessed income in relationship to the FPL, reporting that approximately 25% of participants had an income less than 185% of the FPL while about 44% of participants had an income greater than 349% of the FPL.[26] One study was conducted exclusively with women who had gestational diabetes.

Regarding the characteristics of the infants and young children, the studies noted that approximately 50% of participants were female (3 studies),[1,26,28] mean birth weight ranged from approximately 3.2 to 3.5 kg (3 studies),[26-28] and gestational age was approximately 39 weeks in 1 study[28] and greater than 35 weeks for all participants in a second study.[26] Growth, body composition, and risk of obesity at baseline were not reported.

Exposures and comparators

The studies used a variety of assessment methods to measure 100% juice consumption. Two studies used a FFQ,[1,27] while the remaining 2 studies used a survey or questionnaire other than an FFQ.[26,28] Regarding how the exposures were analyzed, 2 studies examined frequency of consumption, 2 studies compared consumers to non-consumers, and 1 study examined changes in the Diet Quality Index Score component score for 100% fruit juice which was based on amounts consumed per day. All of the studies assessed 100% juice consumption multiple times from birth up to age 24 months, all of which included assessments up to age 12 months[1,26-28] and 2 included assessments beyond age 12 months.[1,27]

Outcomes

Each study assessed a unique outcome measure related to growth or risk of overweight or obesity; none of the studies assessed a measure of body composition. Specifically, the 4 studies analyzed: WAZ,[26] BMIZ,[27] odds of WLZ ≥1 at follow-up,[1] and the risk of overweight and risk of obesity based on BMIZ percentiles.[28] All studies used CDC[26,28] or WHO growth standards[1,27] to calculate z-scores. Research staff or nurses measured weight and height/length in 3 studies,[1,27,28] while 1 study relied on maternal report of infant weight.[26] The age at which the outcomes were measured varied from approximately age 12 months[26] to 5 years.[28]

Synthesis of the evidence

Among the 4 articles that met inclusion criteria, 2 studies reported that consumption of 100% juice was significantly associated with a measure of growth or risk of obesity,[26,28] while 2 did not detect an association[1,27] (**Table 30**). First, Gaffney et al.[26] found that a higher intake frequency of 100% juice (greater than 1 feeding of juice per 2 days versus none) from age 6 to 12 months was significantly associated with higher WAZ at age 12 months; the comparison between the 2 lowest frequency groups (1 feeding of juice per 2 days versus none) was in the same direction but was statistically non-significant. Vandyousefi et al.[28] found that consumption of any 100% fruit juice up to age 1 year was significantly associated with higher odds of obesity at age 2 to 5 years when compared to no consumption of either 100% fruit juice or SSBs; when overweight was examined as an outcome, the results were statistically non-significant but had the same directionality. The remaining 2 studies did not detect a statistically significant association between 100% juice consumption up to age 24 months and outcomes.[1,27] While 1 study reported a non-significant higher risk of WLZ ≥1 at age 11-36 months with greater increases in 100% juice consumption,[1] the other study reported minimal differences in BMIZ at age 36 months by 100% juice consumption.[27]

These 4 articles were also included as part of a larger systematic review with meta-analysis on 100% juice intake and growth, body composition, and risk of obesity[*] throughout the lifespan. Contribution of these studies in infants and young children, up to age 24 months, to the meta-analyses were relatively minimal due to the small number of studies and/or lack of data compatibility. Ultimately, 1 article[27] was included in a single meta-analysis that examined 100% juice intake at baseline (analyzed categorically) and BMIZ at follow-up. Details on the full quantitative synthesis are presented in the systematic review report for 100% juice intake and growth, body composition, and risk of obesity.

Conclusion statement and grade

The Committee did not draw a conclusion statement about the relationship between 100% juice consumption by infants and young children, up to age 24 months, and growth, body composition, and risk of obesity (**Table 29**). This was primarily due to substantial concerns with consistency and precision in the body of evidence. First, the available evidence had inconsistent results, which was further exacerbated by the use of different outcome measures for each study. Additionally, the available evidence was limited by imprecision, due to the small number of studies and lack of information on power. Publication bias may be a limitation, but the small body of evidence makes it difficult to assess. Additionally, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias. The risk of bias assessments for the included studies are presented in **Table 31**. Several risk of bias concerns were noted across all or most studies including risk of bias due to confounding, exposure measurement, missing data, and selection of reported results due to a lack of available pre-registered protocols or analysis plans.

[*] Deierlein AL, Raynor HA, Andres A, et al. 100% Juice and Growth, Body Composition, and Risk of Obesity: A Systematic Review with Meta-Analysis U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2024. https://doi.org/10.52570/NESR.DGAC2025.SR05

Table 29. Conclusion statement, grade for 100% juice consumption by infants and young children and growth, body composition, and risk of obesity

Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between 100% juice consumption by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency and precision in the body of evidence.**
Grade	Grade Not Assignable
Body of Evidence	4 articles: 4 prospective cohort studies
Rationale	A small number of studies examined this exposure-outcome relationship. The study results were inconsistent and difficult to compare due to different outcome measures.

Table 30. Evidence examining the relationship between 100% juice consumption and growth, body composition, and risk of obesity[a]

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Amaro-Rivera, 2019[1] PCS, U.S. (Puerto Rico) Analytic N = 68 (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Hispanic: 100% Maternal education: ≤HS: 32.5%, >HS: 67.5% Other SEP measure(s): WIC participation: 100% Maternal age: Parent's age: <30 y: 55.8%, ≥30 y: 44.2% Milk feeding practices: EBF for ≥1 mo: 51%, Ever FF: 70.1%, Any BF at ~10 mo: 20.8% Child sex (female): 47% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Annual change in 100% juice Diet Quality Index Score; continuous **Dietary assessment methods:** Interviewer-administered questionnaire completed by caregivers. Diet Quality Index Score based on semi-quantitative FFQ. **Age(s) at dietary assessment:** 0-5, 8-36 mo **Amounts consumed:** NR **Outcome(s):** WLZ (≥1) **Outcome assessment methods:** Weight and length measured by trained research staff. Weight status assessed using WHO age- and sex-specific WLZ growth charts. Relative risk for WLZ (≥1 z-score vs <1 z-score), with underweight defined as WLZ ≤-2 SD, healthy weight status defined as WLZ >-2 and <1 SD, risk of overweight defined as WLZ between 1-<2, and overweight or obesity defined as WLZ ≥2 SD. **Age(s) at outcome assessment:** 11-36 mo (Median: 21 mo, 11-23 mo: 61.0%, 24-36 mo: 39.0%)	**WLZ (≥1 vs <1) @ 11-36 mo (RR (95% CI))** 100% Juices score: 1.15 (0.98, 1.34)	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry **Key confounders NOT accounted for:** gestational age **Model adjustments:** WLZ at baseline **Funding:** University of Puerto Rico Central Administration Grant; Capacity Advancement in Research Infrastructure; NIMHD

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Gaffney, 2012[26] PCS, IFPS II, U.S. Analytic N = 691 (Excluded participants without weight data from 12 mo survey, with missing data for essential variables, or with biologically impossible observations for WAZ) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: White: ~95%, Hispanic: ~4%, Black: ~2% Maternal education: HS or less: 14.6%, Some college: 34.3%, 4-y college or more: 51.1% Other SEP measure(s): Household income (% of poverty line): <185%: 24.7%, 185-349%: 31.4%, >349%: 43.8% Maternal age: 18-24 y: 10.1%, 25-34 y: 69.6%, >34 y: 20.3% Milk feeding practices: BF intensity 6-12 mo: Low (<20% milk feedings from BM): 52.1%, Medium (20-80% milk feedings from BM): 24.3%, High (>80% milk feeding from BM): 23.6% Child sex (female): 49% Birth weight: 7.65 (1.02) lb Gestational age: 100% born after 35 wk	**Exposure(s) and comparator(s):** Juice (100% fruit or 100% vegetable juice)[b] consumption frequency in late infancy (6-12 mo): 0 (ref), 1 feeding of juice per 2 d, >1 feeding of juice per 2 d **Dietary assessment methods:** Maternal questionnaire **Age(s) at dietary assessment:** 6, 7, 9, 10, and 12 mo (types/amounts) **Amounts consumed:** 0: 21.3%, 1 per 2 d: 35.2%, >1 per 2 d: 43.6% **Outcome(s):** WAZ **Outcome assessment methods:** Maternal report of weight and age at most recent doctor's visit. WAZ calculated using age and sex-specific growth reference data from CDC. **Age(s) at outcome assessment:** 12 mo	**WAZ @ 12 mo (β)** None (ref) 1 per 2 d: 0.21, p=NS **>1 per 2 d: 0.25, p<0.05**	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices **Key confounders NOT accounted for:** gestational age; baseline anthropometry **Model adjustments:** Bottle-to-bed behavior, BF intensity in late infancy, birth weight, mother's smoking status, weight gain during pregnancy, mother's age, mother's pregravid BMI, mother's education, mother's race/ethnicity, household income, juice consumption intensity (for timing of any), introduction to complementary foods (for types/amounts) **Funding:** NR

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Mahoney, 2018[27] PCS, Born in Bradford 1000, U.K. Analytic N = 12 mo: 722; 18 mo: 779 (Excluded participants with multiple births, missing child dietary data or outcome data, and not of White British or Pakistani ethnicity) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Pakistani: 56%, White British: 44% Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: NR Child sex (female): NR Birth weight: 3,234.15 (521.97) g Gestational age: NR	**Exposure(s) and comparator(s):** Pure fruit juices and baby fruit juices (Consumer vs non-consumer at 12 mo, ≤ vs > Median at 18 mo) **Dietary assessment methods:** FFQ completed by parents **Age(s) at dietary assessment:** 12, 18 mo **Amounts consumed:** Frequency at 12, 18 mo, respectively (Median, IQR): Pure fruit juice per wk: 0.0 (0.0, 0.5), 7.0 (0.0, 7.0) **Outcome(s):** BMIZ **Outcome assessment methods:** Height, weight measured by trained researchers. Age- and sex-adjusted BMI calculated based on WHO 2006 standards. **Age(s) at outcome assessment:** 36 mo	**BMIZ @ 36 mo (β (95% CI))** Intake @ 12 mo: Consumer vs non-consumer (ref): -0.05 (-0.20, 0.10), p=0.53 Intake @ 18 mo: >7.0/wk vs ≤7.0/wk (ref): -0.07 (-0.21, 0.08), p=0.37	**Key confounders accounted for:** Sex; race and/or ethnicity; baseline anthropometry **Key confounders NOT accounted for:** SEP; milk feeding practices; gestational age **Model adjustments:** Ethnicity, sex, birth weight, other key indicator food groups (formula milk; commercial savoury baby foods; commercial sweet baby foods; chips, roast and potato shapes; processed meat products; vegetables; fruit; cakes, biscuits, chocolate and sweets; crisps and savoury snacks; sugar-sweetened drinks; pure fruit juice; low-sugar drinks; water) **Funding:** NIHR

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Vandyousefi, 2021[28] PCS, SWIFT, U.S. Analytic N = 835 (Excluded participants with missing data on BF, infant dietary intake variables from birth to 1 y, sociodemographics, prenatal and newborn clinical outcomes, and child weight and height measures at 2-5 y, and mothers who had overt diabetes at study baseline) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Non-Hispanic Asian: 37%, Hispanic: 30%, Non-Hispanic White: 23%, Non-Hispanic Black: 8%, Mixed race/other: 2% Maternal education: 14.9 (2.9) y Other SEP measure(s): Private insurance: 100%; WIC recipient: 25% Maternal age: 33.4 (4.8) y Milk feeding practices: Any BF duration: 9 (7.2) mo; BF duration <6 mo: 40%, ≥6 mo: 60%; BF intensity at 6-9 wk: EBF: 22%, Mostly BF: 41%, Mixed/inconsistent FF: 21%, Exclusively or mostly FF: 16%; BF intensity and duration at 12 mo: <6: 53%, ≥6: 47% Child sex (female): 48% Birth weight: 3,397 (499) g Birth length: 50.5 (2.4) cm Size-at-birth percentile: LGA: 21%, AGA: 77%, SGA: 2% Gestational age: 39 (1.2) wk Other relevant characteristics: GDM: 100%; Pre-pregnancy BMI: child normal weight: 28.5 (6.8), child overweight: 31.7 (8.3), child obesity: 33.6 (7.1), p<0.001	**Exposure(s) and comparator(s):** 100% fruit juice (unsweetened/with no added sugar) only, SSB (any sugary drinks, Pedialyte, water or juices with added sugar) only, SSB or 100% fruit juice, no SSB/100% juice intake (ref) from birth to 1 y **Dietary assessment methods:** Maternal surveys of date of introduction of solids, fruit juice, sweetened beverages, water, sugar water, and other beverages, including types and amounts of each item. **Age(s) at dietary assessment:** 6-9 wk, 1 y, 2 y post baseline (in-person surveys); Monthly from delivery to 1 y (mailed surveys) **Amounts consumed:** Beverage intake from birth to 1 y: No SSB/no 100% fruit juice: 33%, 100% fruit juice: 51%, SSB: 16% **Outcome(s):** Overweight, Obesity **Outcome assessment methods:** Weight and length obtained from Electronic Health Records during well check visits. Age- and sex-standardized BMI percentiles calculated based on CDC growth percentiles. Overweight defined as BMI-for-age 85th-<95th percentile. Obesity defined as BMI-for-age ≥95th percentile. **Age(s) at outcome assessment:** 2-5 y	**Overweight @ 2-5 y (OR (95% CI))** No SSB/no 100% fruit juice (ref) 100% fruit juice: 1.24 (0.78, 1.98), p=0.48 SSB: 1.31 (0.69, 2.50), p=0.67 **Overweight @ 2-5 y, Adequate BF (OR (95% CI))** No SSB/no 100% fruit juice (ref) 100% fruit juice: 1.23 (0.73, 2.34), p=0.65 SSB: 1.31 (0.51, 2.94), p=0.65 SSB or 100% fruit juice: 1.28 (0.71, 2.18), p=0.38 **Overweight @ 2-5 y, Adequate EBF (OR (95% CI))** No SSB/no 100% fruit juice (ref) 100% fruit juice: 1.28 (0.73, 2.27), p=0.39 SSB: 1.26 (0.73, 2.18), p=0.72 SSB or 100% fruit juice: 1.05 (0.55, 1.99), p=0.43 **Obesity @ 2-5 y (OR (95% CI))** No SSB/no 100% fruit juice (ref) **100% fruit juice: 2.18 (1.17, 4.06), p=0.02** **SSB: 3.22 (1.55, 6.67), p<0.01** **Obesity @ 2-5 y, Adequate BF (OR (95% CI))** No SSB/no 100% fruit juice (ref) **100% fruit juice: 3.13 (1.11, 7.29), p=0.03** **SSB: 3.35 (1.32, 8.50), p=0.01** **SSB or 100% fruit juice: 3.32 (1.29, 8.25), p<0.01** **Obesity @ 2-5 y, Adequate EBF (OR (95% CI))** No SSB/no 100% fruit juice (ref) **100% fruit juice: 4.17 (1.55, 11.17), p<0.01** **SSB: 4.71 (1.43, 15.01), p<0.01** **SSB or 100% fruit juice: 4.45 (1.40, 8.47), p<0.01**	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices **Key confounders NOT accounted for:** gestational age; baseline anthropometry **Model adjustments:** Maternal education level, race/ethnicity, gestational weight gain, prenatal 3 h 100 g OGTT sum of 4 z-scores, GDM treatment type, gestational age at GDM diagnosis, WIC participation, parity, infant sex, infant size for gestational age, sex at birth, and age at BMI measurement **Funding:** NIDDK; NICHD; ADA

[a] Abbreviations: @: at; AGA: appropriate for gestational age; β: beta; BF: breastfeeding; BM: breast milk; BMI: body mass index; BMIZ, BMI z-score; CDC: Centers for Disease Control and Prevention; CI: confidence interval; cm: centimeter; d: day; EBF: exclusive breastfeeding; FF: formula feeding; FFQ: food frequency questionnaire; g: gram; GDM: gestational diabetes mellitus; HS: high school; IFPS II: Infant Feeding Practices Study II; IQR: interquartile range; LGA: large for gestational age; mo: month; NR: not reported; OGTT: oral glucose tolerance test; OR: odds ratio; oz: ounce; PCS: prospective cohort study; ref: reference; RR: risk ratio; SD: standard deviation; SEP: socioeconomic position; SGA: small for gestational age; SSB: sugar-sweetened beverage; SWIFT: Study of Women, Infant Feeding and Type 2 Diabetes after GDM; U.K.: United Kingdom; U.S.: United States; vs: versus; WAZ: weight-for-age z-score; WIC: Special Supplemental Nutrition Program for Women, Infants, and Children; WHO: World Health Organization; wk: week; WLZ: weight-for-length z-score; y: year

[b] Questionnaires: Infant Feeding Practices Study II and Its Year Six Follow-Up. Centers for Disease Control and Prevention. Updated April 4, 2023. Accessed December 15, 2023. https://www.cdc.gov/breastfeeding/data/ifps/questionnaires.htm

Table 31. Risk of bias for observational studies examining 100% juice consumption and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Amaro-Rivera, 2019[1]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Gaffney, 2012[26]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	SOME CONCERNS	SOME CONCERNS	HIGH
Mahoney, 2018[27]	HIGH	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Vandyousefi, 2021[28]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Fruit

Description of the evidence

Five studies (from 6 articles) met inclusion criteria and examined the relationship between fruit consumption up to age 24 months and growth, body composition, and risk of obesity (**Table 33**).[1,6,27,29-31] All studies were PCS, using data from the following cohorts: Born in Bradford 1000 study,[27] Childhood Asthma Prevention Study (CAPS),[29,30] the Longitudinal Twin Study (LoTiS),[31] WIC ITFPS-2,[6] and 1 unnamed cohort.[1] One study that was a secondary analysis of an RCT testing the effect of dust mite avoidance and omega-3 supplementation on asthma prevention.[29,30]

Population

Two studies were conducted in the United States,[1,6] including 1 study conducted in Puerto Rico,[1] and 1 study each was conducted in Australia,[29,30] China,[31] the United Kingdom.[27] The analytic sample sizes ranged from 68[1] to 1,872.[6] No studies reported having sufficient power related to fruit intake and the relevant outcomes.

Race and/or ethnicity varied across studies, including 1 study with 100% Hispanic participants,[1] 2 studies with approximately half Caucasian[29,30] or White British[27] participants, and 1 study with approximately 41% Hispanic, 29% non-Hispanic White, and 25% non-Hispanic African American participants.[6] A variety of measures of SEP were reported across the studies. Maternal education varied with 37.5%[6] and 67.5%[1] completing high school in 2 studies, and 52% receiving tertiary education in a third, Australian study.[29] Two studies exclusively included mothers who were participating in WIC,[1,6] 1 of which also reported that 64% of participants had an income less than or equal to 75% of the poverty guideline.[6] Another study reported that 87% of fathers and 49% of mothers had full-time employment,[29] while another study reported 22% of mothers were employed at 6 months.[6] Maternal age was, on average, approximately 30 years in 2 studies,[29,31] while 1 study reported that 44% of participants were age 30 years or older[1] and 47% of mothers were age 26 years or older in another.[6] Human milk and infant formula feeding practices varied across studies: 51% of infants were exclusively breastfed at 1 month in 1 study,[1] 82% received any breast milk in another,[6] 42% of children were breastfed at 6 months in a third study,[29,30] and the mean breastfeeding duration was 7.6 months in a fourth.[31]

The studies noted that approximately 50% were female.[1,6,29-31] Regarding birth weight, 1 study noted that the majority of infants were born weighing between 2.5 and 4.5 kilograms,[6] while the mean birth weight was 3.2[27] and 3.5 kilograms[30] in 2 additional studies. The average birth weight was 2.5 kilograms in a fourth study conducted exclusively among twins[31] Gestational age was reported in 3 studies, with 2 excluding infants born preterm while the third, conducted exclusively with twins, reported that 53.2% of the infants were born preterm.[31] Among the 2 studies that reported baseline anthropometry, 1 reported that 12.7% had overweight at age 12 months,[31] while the other reported that the average weight was 11.6 kilograms at age 18 months.[30]

Exposures and comparators

All studies assessed the amounts or frequency of fruit consumption up to 24 months,[1,6,27,29-31] none of which specified the types of fruit that were included in the measure. Most studies analyzed a continuous measure of the amount or frequency of fruit consumption,[1,6,29-31] except for 1 study that compared fruit consumption greater than, to less than or equal to, the median frequency.[27] The studies used a variety of assessment methods to measure fruit consumption. Three studies used a FFQ,[1,27,31] 1 study used a 3-day weighed food record,[29,30] and 1 study used a 24-hour recall.[6] Half of the studies assessed fruit intake multiple times up to age 24 months,[1,6,27] with 2 studies assessing fruit intake before age 12 months,[1,6] and all studies assessing fruit intake at age 12 months or older.[1,6,27,29-31]

Outcomes

Four studies examined growth,[6,27,29-31] 2 studies examined body composition,[30,31] and 1 study examined risk of overweight.[1] The outcomes were measured by trained personnel in all studies. The most common outcome measure was BMIZ or BMI (including trajectories or measures of change), which were assessed in all 4 studies. Other outcomes examined included weight and length increment,[31] WAZ,[31] HAZ,[31] waist circumference,[30] body fat mass and percentage,[31] and the odds of having a WLZ greater than or equal to 1.[1] BMIZ were based on WHO growth standards[27] and the CDC growth charts.[6,29] The age at outcome assessment ranged from age 11 months[1] to 11.5 years.[29]

Synthesis of the evidence

All 4 studies that examined growth reported exclusively or predominantly null associations with fruit consumption across a variety of outcomes from birth to 11.5 years (**Table 33**).[6,27,29-31] The direction of these relatively small effect sizes tended to show that greater fruit intake is non-significantly associated with higher levels of growth.[27,30,31] However, the single study that detected a statistically significant association between fruit consumption and growth reported that greater frequency of fruit consumption at age 9 months was associated with lower BMIZ at age 2 years, but not at age 3 or 4 years.[6]

Few studies examined body composition[30,31] or the risk of obesity,[1,30,31] and the outcomes were inconsistent across studies. One study reported a statistically significant association between greater fruit consumption at age 18 months and higher waist circumference at age 8 years, but the utility of this measure in this age group is limited.[30] The remaining studies did not detect a relationship between fruit consumption and body composition[31] or risk of overweight.[1]

Conclusion statements and grades

The Committee developed a conclusion statement about the relationship between fruit consumption and growth based on their review of the body of evidence (**Table 32**). The grade reflects the strength of the evidence underlying the conclusion statement. However, the Committee did not draw a conclusion statement about the relationship between fruit consumption and body composition and risk of obesity because there is not enough available evidence (**Table 32**). The risk of bias assessments for the studies that addressed this question are documented in **Table 34**.

Table 32. Conclusion statement, grade for fruit consumption by infants and young children and growth, and consumption of fruit by infants and young children and body composition and risk of obesity

Conclusion Statement	**Fruit consumption by infants and young children, up to age 24 months, is not associated with unfavorable outcomes related to growth patterns during childhood. This conclusion is based on evidence graded as limited.**
Grade	Limited
Body of Evidence	5 articles (4 studies): 4 prospective cohort studies
Consistency	Minimal concerns with consistency.
Precision	Some concerns due to few included studies and relatively wide confidence intervals; power calculated were not reported.
Risk of bias	Substantial concerns with risk of bias, particularly due to confounding and missing data.
Directness	Minimal concerns with directness.
Generalizability	Some concerns with applicability to the U.S. population due to few studies were conducted in the United States.
Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between fruit consumption by infants and young children, up to age 24 months, and body composition and risk of obesity during childhood because there is not enough evidence available.**
Grade	Grade Not Assignable
Body of Evidence	3 articles: 3 prospective cohort studies
Rationale	There is not enough evidence available to answer this question.

Assessment of the evidence

The body of evidence underlying the graded conclusion statement above includes 5 articles from 4 PCS. The evidence was graded based on an assessment of 5 grading elements, as described below. Publication bias was also a consideration; however, this was not assessed as a serious concern because the body of evidence included studies that reported only nonsignificant findings as well as studies that reported a mix of both significant and nonsignificant results, across a range of analytic sample sizes. However, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias.

Consistency

Studies consistently reported null associations between fruit consumption by infants and young children and growth. The studies also examined relatively consistent exposures and outcomes assessed.

Precision

Only 4 studies were examined the relationship between fruit consumption by infants and young children and outcomes related to growth. The analytic sample sizes ranged from 302 to 1,872, but the confidence intervals, when reported, were relatively wide. No studies reported a power calculation.

Risk of bias

There were several risk of bias concerns across the body of evidence (**Table 34**). Most of the studies had high risk of bias due to confounding because studies did not account for most of the key confounders. One study had a very high risk of bias due to confounding because of a lack of any model adjustments. Most studies had some concerns or high risk of bias due to missing data because of high rates of missing data which was not accounted for. Finally, all studies had some concerns or high risk of bias due to selection of the reported result because none reported a pre-registered protocol or analysis plan.

Directness

The studies examined exposures and outcomes that aligned with the analytic framework.

Generalizability

There were some concerns with generalizability to the U.S. population due to few studies being conducted in the United States.

Table 33. Evidence examining the relationship between fruit consumption and growth, body composition, and risk of obesity[a]

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Amaro-Rivera, 2019[1] PCS, U.S. (Puerto Rico) Analytic N = 68 (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Hispanic: 100% Maternal education: ≤HS: 32.5%, >HS: 67.5% Other SEP measure(s): WIC participation: 100% Maternal age: Parent's age: <30 y: 55.8%, ≥30 y: 44.2% Milk feeding practices: EBF for ≥1 mo: 51%, Ever FF: 70.1%, Any BF at ~10 mo: 20.8% Child sex (female): 47% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Annual change in fruits Diet Quality Index Scores; amount, continuous **Dietary assessment methods:** Interviewer-administered questionnaire completed by caregivers. Diet Quality Index Score based on FFQ. **Age(s) at dietary assessment:** 0-5, 8-36 mo **Amounts consumed:** NR **Outcome(s):** WLZ (≥1 vs <1) **Outcome assessment methods:** Weight and length measured by trained research staff. Weight status assessed using WHO age- and sex-specific WLZ growth charts. Relative risk for WLZ (≥1 z-score vs <1 z-score), with underweight defined as WLZ ≤-2 SD, healthy weight status defined as WLZ >-2 and <1 SD, risk of overweight defined as WLZ between 1-<2, and overweight or obesity defined as WLZ ≥2 SD. **Age(s) at outcome assessment:** 11-36 mo (Median: 21 mo, 11-23 mo: 61.0%, 24-36 mo: 39.0%)	**WLZ (≥1 vs <1) @ 11-36 mo (RR (95% CI))** Fruits score: 0.92 (0.72, 1.17)	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry **Key confounders NOT accounted for:** gestational age **Model adjustments:** Weight-for-length z-score at baseline **Funding:** University of Puerto Rico Central Administration Grant; Capacity Advancement in Research Infrastructure; NIMHD

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Au, 2023[6] PCS, WIC ITFPS-2, U.S. Analytic N = 1,523 (24 mo), 1,680 (36 mo), 1,872 (48 mo) (Excluded participants with missing data on HEI-2015 or BMI at 2, 3, or 4 y, born prematurely, had very low birth weight, or had long-term medical problems that could affect eating.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Hispanic: 40.6%, Non-Hispanic White: 29.1%, Non-Hispanic African American: 24.8%, Non-Hispanic Other: 5.5% Maternal education: <HS: 24.4%, HS: 37.7%, >HS: 37.5% Other SEP measure(s): Participating in WIC: 100%; Maternal employment at 6 mo: Full-time: 21.5%, Part-time: 20.2%, Not working for pay: 58.2%; Poverty level at enrollment: ≤75% of poverty guideline: 64.0%, >75-<130%: 26.3%, >130% poverty: 9.7% Maternal age: 16-19 y: 11.7%, 20-25 y: 41.1%, ≥26 y: 47.3% Milk feeding practices: Any BF: 81.9%; Any formula use: 95.5% Child sex (female): 49% Birth weight: Low (<2.5 kg): 5.3%, Normal (2.5-≤4.5 kg): 93.4%, High (>4.5 kg): 1.3% Gestational age: Excluded infants born prematurely	**Exposure(s) and comparator(s):** Fruit (frequency, continuous, Infant Diet Quality Index component score from 0-1 based on degree of adherence to guidelines; max score: ≥2x/d at 9 mo) **Dietary assessment methods:** 24-h dietary recall via telephone interview with caregiver **Age(s) at dietary assessment:** 1, 3, 5, 7, 9 11, 13, 15, 18, 24, 30, 36, 42, and 48 mo **Amounts consumed:** ≥2x/d at 9 mo: 47.4%, None at 9 mo: 16.6% **Outcome(s):** BMIZ **Outcome assessment methods:** Weight and length/height collected at WIC sites or from child's health care provider. BMIZ based on CDC age- and sex-specific growth charts **Age(s) at outcome assessment:** 2, 3, 4 y	BMIZ @ 2, 3, 4 y **2 y: Greater adherence to guidelines associated with lower BMIZ, p<0.05** 3 y: Data NR, p>0.10 4 y: Data NR, p>0.10	**Key confounders accounted for:** SEP; sex; gestational age **Key confounders NOT accounted for:** milk feeding practices; baseline anthropometry **Model adjustments:** None **Funding:** NHLBI; USDA/NIFA

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Garden, 2011[30] PCS, CAPS, Australia Analytic N = 362 (Excluded participants with missing data on diet or anthropometrics) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Grandparents ethnicity/country of birth: Caucasian: 55%, European: 9%, Middle Eastern: 4%, Indian: 5%, Asian: 4%, Undefined: 24% Maternal education: NR Other SEP measure(s): Paternal education: ≤10 y: 33%, 11-12 y: 18%, Tertiary education: 48% Maternal age: NR Milk feeding practices: BF ≥6 mo: 42% Child sex (female): 49% Birth weight: 3,493 (492) g Gestational age: NR Other relevant characteristics: Secondary analysis of RCT (testing intervention of house dust mite avoidance and omega-3 supplementation); all children recruited at increased risk of developing asthma	**Exposure(s) and comparator(s):** Fruit (amount, continuous, as quintiles) **Dietary assessment methods:** 3-d weighed food records completed by parent/caregiver **Age(s) at dietary assessment:** 18 mo **Amounts consumed:** Quintiles of fruit intake g: 0, 17, 45, 80, 124 % total energy intake: 0, 1, 3, 5, 8 **Outcome(s):** BMI, waist circumference **Outcome assessment methods:** Weight, length, and waist circumference measured by study nurses **Age(s) at outcome assessment:** 8 y	**BMI @ 8 y (Coefficient (95% CI))** Per quintile g: 0.17 (-0.04, 0.38), p for trend=0.11 % of total energy: 0.18 (-0.03, 0.39), p for trend=0.09 **WC @ 8 y (Coefficient (95% CI))** Per quintile **g: 0.63 (0.05, 1.20), p for trend=0.03** % of total energy: 0.56 (0.00, 1.12), p for trend=0.05	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** sex, asthma study intervention group, birth weight, breastfeeding for at least 6 mo, parental obesity status, ethnicity, smoking in pregnancy and father's education, total energy intake (food intake in g only) **Funding:** The National Health and Medical Research Council of Australia; Cooperative Research Centre for Asthma; New South Wales Department of Health; Children's Hospital Westmead; University of Sydney, Faculty of Medicine; Commonwealth Department of Health and Aging

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Garden, 2012[29] PCS, CAPS, Australia Analytic N = 298 (Excluded participants who were not still participating in the study at 11.5 y or did not have dietary data.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR (Australian born mother: 74%, Australian born father: 69%; Child's grandparents ethnicity/country of birth: Caucasian: ~54%, European: ~9%, Middle Eastern/Indian/Asian: ~12%, Undefined: ~25%) Maternal education: 52% tertiary educated Other SEP measure(s): Full-time employment: Mother: 49%, Father: 87% Maternal age: 29.0 (5.1) y Milk feeding practices: BF duration: 0 to <3 mo: 40%, 3 to <6 mo: 16.8%, ≥6 mo: 43.2% Child sex (female): 49% Birth weight: 100% ≥2.5 kg Gestational age: 100% ≥36 wk Other relevant characteristics: Secondary analysis of RCT (testing intervention of house dust mite avoidance and omega-3 supplementation); all children recruited at increased risk of developing asthma	**Exposure(s) and comparator(s):** Fruit (amount, continuous) **Dietary assessment methods:** 3-d weighed food record (2 weekdays and 1 weekend day) completed by parent/caregiver **Age(s) at dietary assessment:** 18 mo **Amounts consumed:** See results for intake data **Outcome(s):** BMI trajectory **Outcome assessment methods:** Weight and height measured by study nurses. Three BMI trajectories defined using latent basis growth mixture model in relationship to CDC percentiles, stratified by sex. **Age(s) at outcome assessment:** 1, 3, 6, 9, 12, 18 mo, 2-5 y (every 6 mo), 8 y, 11.5 y	**BMI trajectory @ birth-11.5 y (median intake at 18 mo by trajectory group)** Boys: normal trajectory: 57.3 g, early and persistent trajectory: 78.0 g, late BMI increase: 79.7 g, p=0.20 Girls: normal trajectory: 60.7 g, early and persistent trajectory: 61.3 g, late BMI increase: 57.7 g, p=0.75 Results analyzed by % of total energy were similar.	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry (multinomial regression only) **Key confounders NOT accounted for:** gestational age **Model adjustments:** dietary intervention group, BF, parental obesity, ethnicity, smoking during pregnancy, father's education status (multinomial regression only) **Funding:** National Health and Medical Research Council of Australia

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Jin, 2022[31] PCS, LoTiS, China Analytic N = 302 (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: 30.47 (3.70) y Milk feeding practices: BF duration: 7.60 (3.99) mo; Milk feeding at 12 mo: EBF: 4.6%, Exclusive FF: 73.7%, Mixed BF and FF: 21.7% Child sex (female): 45% Birth weight: 2.49 (0.45) kg Birth length: 46.04 (2.40) cm SGA at birth: 12.4% Gestational age: 36.43 (1.48) wk; 53.2% born preterm Other relevant characteristics: 100% twins (both included in analyses)	**Exposure(s) and comparator(s):** Fruits (frequency, continuous) **Dietary assessment methods:** FFQ completed by mother/guardian **Age(s) at dietary assessment:** 12 mo **Amounts consumed:** NR **Outcome(s):** WAZ, HAZ, BMIZ, body fat mass, body fat mass percentage, weight increment (12-24 mo), length increment (12-24 mo), BMI increment (12-24 mo) **Outcome assessment methods:** Weight and height were measured by study personnel. Body fat was measured using bioimpedance. **Age(s) at outcome assessment:** 12, 24 mo	**WAZ @ 24 mo (spearman correlation)** 0.097, p=0.072 **HAZ @ 24 mo (spearman correlation)** 0.061, p=0.288 **BMIZ @ 24 mo (spearman correlation)** 0.089, p=0.053 **Weight increment from 12 to 24 mo (spearman correlation)** 0.012, p=0.833 **Length increment from 12 to 24 mo (spearman correlation)** –0.089, p=0.122 **BMI increment from 12 to 24 mo (spearman correlation)** 0.025, p=0.685 **Body fat mass @ 24 mo (statistical measure NR, general linear model)** 0.053, p=0.509 **Body fat percentage @ 24 mo (statistical measure NR, general linear model)** 0.023, p=0.769	**Key confounders accounted for:** sex (body fat mass and % body fat mass only); baseline anthropometry (growth increments only) **Key confounders NOT accounted for:** WAZ, HAZ, BMIZ: SEP; sex; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry. Body fat mass, % body fat mass: SEP; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry. Growth increments: SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Model adjustments:** sex (body fat mass, % body fat); None (all other outcomes) **Funding:** National Key Research and Development Program of China; National Natural Science Foundation of China; Chongqing Joint Program of Science and Health; Key Disciplines of Medical and Health Research of Yuhang District of Hangzhou City

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Mahoney, 2018[27] PCS, Born in Bradford 1000, U.K. Analytic N = 12 mo: 722; 18 mo: 779 (Excluded participants with multiple births, missing child dietary data or outcome data, and not of White British or Pakistani ethnicity) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Pakistani: ~56%, White British: ~44% Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: NR Child sex (female): NR Birth weight: 3,234.15 (521.97) g Gestational age: NR	**Exposure(s) and comparator(s):** Fruit (frequency, ≤ vs > Median) **Dietary assessment methods:** FFQ completed by parents **Age(s) at dietary assessment:** 12, 18 mo **Amounts consumed:** Frequency at 12, 18 mo, respectively (Median, IQR): 1.9 (1.1, 2.9) x/d, 5.0 (4.0, 6.0) x/d **Outcome(s):** BMIZ **Outcome assessment methods:** Height, weight measured by trained researchers. Age- and sex-adjusted BMI calculated based on WHO 2006 standards. **Age(s) at outcome assessment:** 36 mo	**BMIZ @ 36 mo (β (95% CI))** Intake @ 12 mo: > vs ≤ 1.9x/d: 0.09 (-0.07, 0.25), p=0.25 Intake @ 18 mo: > vs ≤ 5.0x/d: -0.04 (-0.19, 0.11), p=0.60	**Key confounders accounted for:** Sex; race and/or ethnicity **Key confounders NOT accounted for:** SEP; milk feeding practices; gestational age; baseline anthropometry **Model adjustments:** Ethnicity, sex, birth weight, other key indicator food groups (formula milk; commercial savoury baby foods; commercial sweet baby foods; chips, roast and potato shapes; processed meat products; vegetables; fruit; cakes, biscuits, chocolate and sweets; crisps and savoury snacks; sugar-sweetened drinks; pure fruit juice; low-sugar drinks; water) **Funding:** NIHR

[a] Abbreviations: @: at; β: beta; BF: breastfeeding; BMI: body mass index; BMIZ: BMI z-score; CAPS: Childhood Asthma Prevention Study; CDC: Centers for Disease Control and Prevention; CI: confidence interval; cm: centimeter; d: day; EBF: exclusive breastfeeding; FF: formula feeding; FFQ: food frequency questionnaire; g: gram; h: hour; HAZ: height-for-age z-score; HEI: Healthy Eating Index; HS: high school; IQR: interquartile range; LoTiS: Longitudinal Twin Study; mo: month; NR: not reported; NS: non-significant; PCS: prospective cohort study; RCT: randomized controlled trial; RR: risk ratio; SD: standard deviation; SEP: socioeconomic position; U.K.: United Kingdom; U.S.: United States; vs: versus; WAZ: weight-for-age z-score; WHO: World Health Organization; WIC: Special Supplemental Nutrition Program for Women, Infants, and Children; WIC-IFTPS-2: WIC Infant and Toddler Feeding Practices Study-2; wk: week; WLZ: weight-for-length z-score; x: times; y: year

Table 34. Risk of bias for observational studies examining fruit consumption and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Amaro-Rivera, 2019[1]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Au, 2023[6]	HIGH	LOW	LOW	LOW	SOME CONCERNS	LOW	SOME CONCERNS	HIGH
Garden, 2011[30]	SOME CONCERNS	LOW	LOW	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Garden, 2012[29]	SOME CONCERNS	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Jin, 2022[31] (body fat mass, % fat mass)	HIGH	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH	HIGH
Jin, 2021[31] (BMIZ, HAZ, WAZ, growth increments)	VERY HIGH	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH	VERY HIGH
Mahoney, 2018[27]	HIGH	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Vegetables

Description of the evidence

Five studies (from 6 articles) met inclusion criteria and examined the relationship between vegetable consumption among infants and young children, up to age 24 months, and growth, body composition, and risk of obesity (**Table 36**).[1,6,27,29-31] All studies were PCS, using data from the following cohorts: Born in Bradford 1000 study,[27] CAPS,[29,30] LoTiS,[31] WIC ITFPS-2,[6] and 1 unnamed cohort.[1] One study that was a secondary analysis of an RCT testing the effect of dust mite avoidance and omega-3 supplementation on asthma prevention.[29,30]

Population

Two studies were conducted in the United States,[1,6] including 1 study conducted in Puerto Rico,[1] and 1 study each was conducted in Australia,[29,30] China,[31] the United Kingdom.[27] The analytic sample sizes ranged from 68[1] to 1,872.[6] No studies reported having sufficient power related to consumption of vegetables and the relevant outcomes.

Race and/or ethnicity varied across studies, including 1 study with 100% Hispanic participants,[1] 2 studies with approximately half Caucasian[29,30] or White British[27] participants, and 1 study with approximately 41% Hispanic, 29% non-Hispanic White, and 25% non-Hispanic African American participants.[6] A variety of measures of SEP were reported across the studies. Maternal education varied with 37.5%[6] and 67.5%[1] completing high school in 2 studies, and 52% receiving tertiary education in a third, Australian study.[29] Two studies exclusively included mothers who were participating in WIC,[1,6] 1 of which also reporting that 64% of participants had an income less than or equal to 75% of the poverty guideline.[6] Another study reported that 87% of fathers and 49% of mothers had full-time employment,[29] while another study reported 22% of mothers were employed at 6 months.[6] Maternal age was, on average, approximately 30 years in 2 studies,[29,31] while 1 study reported that 44% of participants were age 30 years or older[1] and 47% of mothers were age 26 years or older in another.[6] Human milk and infant formula feeding practices varied across studies: 51% of infants were exclusively breastfed at 1 month in 1 study,[1] 82% received any breast milk in another,[6] 42% of children were breastfed at 6 months in a third study,[29,30] and the mean breastfeeding duration was 7.6 months in a fourth.[31]

The studies noted that approximately 50% were female.[1,6,29-31] Regarding birth weight, 1 study noted that the majority of infants were born weighing between 2.5 and 4.5 kilograms,[6] while the mean birth weight was 3.2[27] and 3.5 kilograms[30] in 2 additional studies. The average birth weight was 2.5 kilograms in a fourth study conducted exclusively among twins[31] Gestational age was reported in 3 studies, with 2 excluding infants born preterm while the third, conducted exclusively with twins, reported that 53.2% of the infants were born preterm.[31] Among the 2 studies that reported baseline anthropometry, 1 reported that 12.7% had overweight at age 12 months,[31] while the other reported that the average weight was 11.6 kilograms at age 18 months.[30]

Exposures and comparators

All studies assessed amount or frequency of vegetable consumption up to 24 months,[1,6,27,29-31] none of which specified the types of vegetables that were included. Most studies analyzed a continuous measure of the amount or frequency of vegetable consumption,[1,6,29-31] except for 1 study that compared vegetable consumption greater than, to less than or equal to, the median frequency.[27] The studies used a variety of assessment methods to measure vegetable consumption. Three studies used a FFQ,[1,27,31] 1 study used a 3-day weighed food record,[29,30] and 1 study used a 24-hour recall.[6] Three of the studies assessed vegetable consumption multiple times up to age 24 months,[1,6,27] with 3 studies assessing vegetable consumption up to 12 months,[1,6,27] and 3 studies assessing vegetable intake beyond 12 months up to 24 months.[1,27,29-31]

Outcomes

Four studies examined growth,[6,27,29-31] 2 studies examined body composition,[30,31] and 1 study examined risk of overweight.[1] The outcomes were measured by trained personnel in all studies. The most common outcome measure was BMIZ or BMI (including trajectories or measures of change), which were assessed in all 4 studies. Other outcomes examined included weight and length increment,[31] WAZ,[31] HAZ,[31] waist circumference,[30] body fat mass and percentage,[31] and the odds of having a WLZ greater than or equal to 1.[1] BMIZ were based on WHO growth standards[27] and the CDC growth charts.[6,29] The age at outcome assessment ranged from age 11 months[1] to 11.5 years.[29]

Synthesis of the evidence

All 4 studies that examined growth reported exclusively or predominantly null associations with vegetable consumption across a variety of outcomes from birth to 11.5 years (**Table 36**).[6,27,29-31] Among the null associations, the effect sizes were relatively small with mixed directionality. Only 1 study detected a statistically significant association between vegetable consumption and growth, reporting that greater frequency of vegetable consumption at age 18 months was associated with lower BMIZ at age 36 months.[27]

Few studies examined body composition[30,31] or the risk of obesity,[1,30,31] all of which reported null associations with vegetable consumption. These studies reported relatively small effect sizes with mixed directions of association.

Conclusion statements and grades

The Committee developed a conclusion statement about the relationship between vegetable consumption and growth based on their review of the body of evidence (**Table 35**). The grade reflects the strength of the evidence underlying the conclusion statement. However, the Committee did not draw a conclusion statement about the relationship between vegetable consumption and body composition and risk of obesity because there is not enough available evidence (**Table 35**). The risk of bias assessments for the studies that addressed this question are documented in **Table 37**.

Table 35. Conclusion statements, grades for vegetable consumption by infants and young children and growth, and vegetable consumption by infants and young children and body composition and risk of obesity

Conclusion Statement	**Vegetable consumption by infants and young children, up to age 24 months, is not associated with unfavorable outcomes related to growth patterns during childhood. This conclusion is based on evidence graded as limited.**
Grade	Limited
Body of Evidence	5 articles (4 studies): 4 prospective cohort studies
Consistency	Minimal concerns with consistency.
Precision	Some concerns due to few included studies; power calculations were not reported.
Risk of bias	Substantial concerns with risk of bias, particularly due to confounding and missing data.
Directness	Minimal concerns with directness.
Generalizability	Some concerns with applicability to the U.S. population due to few studies being conducted in the United States.
Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between vegetable consumption by infants and young children, up to age 24 months, and body composition and risk of obesity during childhood because there is not enough evidence available.**
Grade	Grade Not Assignable
Body of Evidence	3 articles: 3 prospective cohort studies
Rationale	There is not enough evidence available to answer this question.

Assessment of the evidence

The body of evidence underlying the graded conclusion statement above includes 5 articles from 4 PCS. The evidence was graded based on an assessment of 5 grading elements, as described below. Publication bias was also a consideration; however, this was not assessed as a serious concern because the body of evidence included studies that reported only nonsignificant findings as well as studies that reported a mix of both significant and nonsignificant results, across a range of analytic sample sizes. However, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias.

Consistency

Studies consistently reported null associations between vegetable consumption by infants and young children and growth. The studies also examined relatively consistent exposures and outcomes assessed.

Precision

Few studies (4) were included that examined consumption of vegetable by infants and young children and growth-related outcomes. The analytic sample sizes ranged from 302 to 1,872. No studies reported a power calculation.

Risk of bias

There were several risk of bias concerns across the body of evidence (**Table 37**). Most of the studies had high risk of bias due to confounding due to studies not accounting for most of the key confounders. One study had a very high risk of bias due to confounding due to a lack of any model adjustments. Most studies had some concerns or high risk of bias due to missing data because of high rates of missing data which was not accounted for. Finally, all studies had some concerns or high risk of bias due to selection of the reported result because none reported a pre-registered protocol or analysis plan.

Directness

The studies examined exposures and outcomes that aligned with the analytic framework.

Generalizability

There were some concerns with generalizability to the U.S. population due to few studies being conducted in the United States.

Table 36. Evidence examining the relationship between vegetable consumption and growth, body composition, and risk of obesity [a]

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Amaro-Rivera, 2019[1] PCS, U.S. (Puerto Rico) Analytic N = 68 (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Hispanic: 100% Maternal education: ≤HS: 32.5%, >HS: 67.5% Other SEP measure(s): WIC participation: 100% Maternal age: Parent's age: <30 y: 55.8%, ≥30 y: 44.2% Milk feeding practices: EBF for ≥1 mo: 51%, Ever FF: 70.1%, Any BF at ~10 mo: 20.8% Child sex (female): 47% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Annual change in vegetables Diet Quality Index Scores (amount; continuous) **Dietary assessment methods:** Interviewer-administered questionnaire completed by caregivers. Diet Quality Index Score based on FFQ. **Age(s) at dietary assessment:** 0-5, 8-36 mo **Amounts consumed:** NR **Outcome(s):** WLZ (≥1) **Outcome assessment methods:** Weight and length measured by trained research staff. Weight status assessed using WHO age- and sex-specific WLZ growth charts. Relative risk for WLZ (≥1 z-score vs <1 z-score), with underweight defined as WLZ ≤-2 SD, healthy weight status defined as WLZ >-2 and <1 SD, risk of overweight defined as WLZ between 1-<2, and overweight or obesity defined as WLZ ≥2 SD. **Age(s) at outcome assessment:** 11-36 mo (Median: 21 mo, 11-23 mo: 61.0%, 24-36 mo: 39.0%)	**WLZ (≥1 vs <1) @ 11-36 mo (RR (95% CI))** Vegetables score: 0.80 (0.63, 1.02)	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry **Key confounders NOT accounted for:** gestational age **Model adjustments:** WLZ at baseline **Funding:** University of Puerto Rico Central Administration Grant; Capacity Advancement in Research Infrastructure; NIMHD

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Au, 2023[6] PCS, WIC ITFPS-2, U.S. Analytic N = 1,523 (24 mo), 1,680 (36 mo), 1,872 (48 mo) (Excluded participants with missing data on HEI-2015 or BMI at 2, 3, or 4 y, born prematurely, had very low birth weight, or had long-term medical problems that could affect eating.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Hispanic: 40.6%, Non-Hispanic White: 29.1%, Non-Hispanic African American: 24.8%, Non-Hispanic Other: 5.5% Maternal education: <HS: 24.4%, HS: 37.7%, >HS: 37.5% Other SEP measure(s): Participating in WIC: 100%; Maternal employment at 6 mo: Full-time: 21.5%, Part-time: 20.2%, Not working for pay: 58.2%; Poverty level at enrollment: ≤75% of poverty guideline: 64.0%, >75-<130%: 26.3%, >130% poverty: 9.7% Maternal age: 16-19 y: 11.7%, 20-25 y: 41.1%, ≥26 y: 47.3% Milk feeding practices: Any BF: 81.9%; Any formula use: 95.5% Child sex (female): 49% Birth weight: Low (<2.5 kg): 5.3%, Normal (2.5-≤4.5 kg): 93.4%, High (>4.5 kg): 1.3% Gestational age: Excluded infants born prematurely	**Exposure(s) and comparator(s):** Vegetables (frequency, continuous, Infant Diet Quality Index component score from 0-1 based on degree of adherence to guidelines; max score: ≥2x/d at 9 mo) **Dietary assessment methods:** 24-h dietary recall via telephone interview with caregiver **Age(s) at dietary assessment:** 1, 3, 5, 7, 9 11, 13, 15, 18, 24, 30, 36, 42, and 48 mo **Amounts consumed:** ≥2x/d at 9 mo: 37.0%, None at 9 mo: 22.8% **Outcome(s):** BMIZ **Outcome assessment methods:** Weight and length/height collected at WIC sites or from child's health care provider. BMIZ based on CDC age- and sex-specific growth charts **Age(s) at outcome assessment:** 2, 3, 4 y	**BMIZ @ 2, 3, 4 y** 2 y: Data NR, p>0.10 3 y: Data NR, p>0.10 4 y: Data NR, p>0.10	**Key confounders accounted for:** SEP; sex; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; milk feeding practices; baseline anthropometry **Model adjustments:** None **Funding:** NHLBI; USDA/NIFA

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Garden, 2011[30] PCS, CAPS, Australia Analytic N = 362 (Excluded participants with missing data on diet or anthropometrics) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Grandparents ethnicity/country of birth: Caucasian: 55%, European: 9%, Middle Eastern: 4%, Indian: 5%, Asian: 4%, Undefined: 24% Maternal education: NR Other SEP measure(s): Paternal education: ≤10 y: 33%, 11-12 y: 18%, Tertiary education: 48% Maternal age: NR Milk feeding practices: BF ≥6 mo: 42% Child sex (female): 49% Birth weight: 3,493 (492) g Gestational age: NR Other relevant characteristics: Secondary analysis of RCT (testing intervention of house dust mite avoidance and omega-3 supplementation); all children recruited at increased risk of developing asthma	**Exposure(s) and comparator(s):** Vegetables (amount, continuous, as quintiles) **Dietary assessment methods:** 3-d weighed food records **Age(s) at dietary assessment:** 18 mo **Amounts consumed:** Quintiles of vegetable intake g: 0, 20, 35, 54, 82 % total energy: 0, 1, 3, 5, 7 **Outcome(s):** BMI, waist circumference **Outcome assessment methods:** Weight, length, and waist circumference measured by study nurses **Age(s) at outcome assessment:** 8 y	**BMI @ 8 y (Coefficient (95% CI))** Vegetables, per quintile g: 0.20 (0.00, 0.40), p for trend=0.05 % of total energy: 0.13 (-0.06, 0.33), p for trend=0.19 **WC @ 8 y (Coefficient (95% CI))** Vegetables, per quintile g: 0.50 (-0.04, 1.04), p for trend=0.07 % of total energy: 0.29 (-0.25, 0.83), p for trend=0.29	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** sex, asthma study intervention group, birth weight, breastfeeding for at least 6 mo, parental obesity status, ethnicity, smoking in pregnancy and father's education, total energy intake (food intake in g only) **Funding:** The National Health and Medical Research Council of Australia; Cooperative Research Centre for Asthma; New South Wales Department of Health; Children's Hospital Westmead; University of Sydney, Faculty of Medicine; Commonwealth Department of Health and Aging

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Garden, 2012[29] PCS, CAPS, Australia Analytic N = 298 (Excluded participants who were not still participating in the study at 11.5 y or did not have dietary data.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR (Australian born mother: 74%, Australian born father: 69%; Child's grandparents ethnicity/country of birth: Caucasian: ~54%, European: ~9%, Middle Eastern/Indian/Asian: ~12%, Undefined: ~25%) Maternal education: 52% tertiary educated Other SEP measure(s): Full-time employment: Mother: 49%, Father: 87% Maternal age: 29.0 (5.1) y Milk feeding practices: BF duration: 0 to <3 mo: 40%, 3 to <6 mo: 16.8%, ≥6 mo: 43.2% Child sex (female): 49% Birth weight: 100% ≥2.5 kg Gestational age: 100% ≥36 wk Other relevant characteristics: Secondary analysis of RCT (testing intervention of house dust mite avoidance and omega-3 supplementation); all children recruited at increased risk of developing asthma	**Exposure(s) and comparator(s):** Vegetables (amount, continuous) **Dietary assessment methods:** Parent/caregiver completed 3-d weighed food record (2 weekdays and 1 weekend day) **Age(s) at dietary assessment:** 18 mo **Amounts consumed:** See results for intake data **Outcome(s):** BMI trajectory **Outcome assessment methods:** Weight and height measured by study nurses. Three BMI trajectories defined using latent basis growth mixture model in relationship to CDC percentiles, stratified by sex. **Age(s) at outcome assessment:** 1, 3, 6, 9, 12, 18 mo, 2-5 y (every 6 mo), 8 y, 11.5 y	**BMI trajectory @ birth-11.5 y (median intake at 18 mo by trajectory group)** Vegetables Boys: normal trajectory: 43.2 g, early and persistent trajectory: 57.3 g, late BMI increase: 36.3 g, p=0.49 Girls: normal trajectory: 35.3 g, early and persistent trajectory: 43.3 g, late BMI increase: 43.0 g, p=0.48 Results analyzed by % of total energy were similar.	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry (multinomial regression only) **Key confounders NOT accounted for:** gestational age **Model adjustments:** dietary intervention group, BF, parental obesity, ethnicity, smoking during pregnancy, father's education status (multinomial regression only) **Funding:** National Health and Medical Research Council of Australia

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Jin, 2022[31] PCS, LoTiS, China Analytic N = 302 (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: 30.47 (3.70) y Milk feeding practices: BF duration: 7.60 (3.99) mo; Milk feeding at 12 mo: EBF: 4.6%, Exclusive FF: 73.7%, Mixed BF and FF: 21.7% Child sex (female): 45% Birth weight: 2.49 (0.45) kg Birth length: 46.04 (2.40) cm SGA at birth: 12.4% Gestational age: 36.43 (1.48) wk; 53.2% born preterm Other relevant characteristics: 100% twins (both included in analyses)	**Exposure(s) and comparator(s):** Tubers, Vegetables (frequency, continuous) **Dietary assessment methods:** FFQ completed by mother/guardian **Age(s) at dietary assessment:** 12 mo **Amounts consumed:** NR **Outcome(s):** WAZ, HAZ, LAZ, BMIZ, percent body fat mass, weight increment (12-24 mo), length increment (12-24 mo), BMI increment (12-24 mo) **Outcome assessment methods:** Weight and height were measured by study personnel. Body fat was measured using bioimpedance. **Age(s) at outcome assessment:** 12, 24 mo	**WAZ @ 24 mo (spearman correlation)** Tubers: 0.080, p=0.168 Vegetables: 0.036, p=0.534 **HAZ @ 24 mo (spearman correlation)** Tubers: 0.036, p=0.535 Vegetables: 0.036, p=0.534 **BMIZ @ 24 mo (spearman correlation)** Tubers: 0.083, p=0.152 Vegetables: –0.031, p=0.587 **Weight increment from 12 to 24 mo (spearman correlation)** Tubers: –0.094, p=0.103 Vegetables: –0.008, p=0.889 **Length increment from 12 to 24 mo (spearman correlation)** Tubers: 0.000, p=1.000 Vegetables: –0.078, p=0.175 **BMI increment from 12 to 24 mo (spearman correlation)** Tubers: –0.037, p=0.543 Vegetables: 0.041, p=0.505 **Body fat mass @ 24 mo (statistical measure NR, general linear model)** Tubers: –0.039, p=0.624 Vegetables: –0.078, p=0.327 **Body fat percentage @ 24 mo (statistical measure NR, general linear model)** Tubers: –0.069, p=0.388 Vegetables: –0.103, p=0.195	**Key confounders accounted for:** sex; baseline anthropometry (growth increments only) **Key confounders NOT accounted for:** SEP; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry (WAZ, HAZ, BMIZ, body fat mass, body fat percentage) **Model adjustments:** sex (body fat mass, % body fat mass); None (all other outcomes) **Funding:** National Key Research and Development Program of China; National Natural Science Foundation of China; Chongqing Joint Program of Science and Health; Key Disciplines of Medical and Health Research of Yuhang District of Hangzhou City

Study and Participant Characteristics	Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Mahoney, 2018[27] PCS, Born in Bradford 1000, U.K. Analytic N = 12 mo: 722; 18 mo: 779 (Excluded participants with multiple births, missing child dietary data or outcome data, and not of White British or Pakistani ethnicity) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Pakistani: ~56%, White British: ~44% Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: NR Child sex (female): NR Birth weight: 3,234.15 (521.97) g Gestational age: NR	**Exposure(s) and comparator(s):** Vegetables (frequency, ≤ vs > Median) **Dietary assessment methods:** FFQ completed by parents **Age(s) at dietary assessment:** 12, 18 mo **Amounts consumed:** Frequency at 12, 18 mo, respectively (Median, IQR): Vegetables per d: 1.7 (1.1, 2.6) x/wk, 6.0 (4.0, 6.0) x/wk **Outcome(s):** BMIZ **Outcome assessment methods:** Height, weight measured by trained researchers. Age- and sex-adjusted BMI calculated based on WHO 2006 standards. **Age(s) at outcome assessment:** 36 mo	**BMIZ @ 36 mo (β (95% CI))** Intake @ 12 mo: > vs ≤ 1.7x/d: -0.06 (-0.21, 0.10), p=0.48 **Intake @ 18 mo: > vs ≤ 6.0x/d: -0.20 (-0.36, -0.03), p=0.02**	**Key confounders accounted for:** Sex; race and/or ethnicity **Key confounders NOT accounted for:** SEP; milk feeding practices; gestational age; baseline anthropometry **Model adjustments:** Ethnicity, sex, birth weight, other key indicator food groups (formula milk; commercial savoury baby foods; commercial sweet baby foods; chips, roast and potato shapes; processed meat products; vegetables; fruit; cakes, biscuits, chocolate and sweets; crisps and savoury snacks; sugar-sweetened drinks; pure fruit juice; low-sugar drinks; water) **Funding:** NIHR

[a] Abbreviations: @: at; β: beta; BF: breastfeeding; BMI: body mass index; BMIZ: BMI z-score; CAPS: Childhood Asthma Prevention Study; CDC: Centers for Disease Control and Prevention; CI: confidence interval; cm: centimeter; d: day; EBF: exclusive breastfeeding; FF: formula feeding; FFQ: food frequency questionnaire; g: gram; HAZ: height for age z-score; HEI: Healthy Eating Index; HS: high school; IQR: interquartile range; LAZ: length for age z-score; LoTiS: Longitudinal Twin Study; mo: month; NR: not reported; OR: odds ratio; PCS: prospective cohort study; RCT: randomized controlled trial; ref: reference; RR: risk ratio; SD: standard deviation; SEP: socioeconomic position; U.K.: United Kingdom; U.S.: United States; vs: versus; WAZ: weight for age z-score; WHO: World Health Organization; WIC: Special Supplemental Nutrition Program for Women, Infants, and Children; WIC-IFTPS-2: WIC Infant and Toddler Feeding Practices Study-2; wk: week; WLZ: weight for length z-score; x: times; y: year

Table 37. Risk of bias for observational studies examining vegetable consumption and growth, body composition, and risk of obesity a

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Amaro-Rivera, 2019[1]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Au, 2023[6]	HIGH	LOW	LOW	LOW	SOME CONCERNS	LOW	SOME CONCERNS	HIGH
Garden, 2011[30]	SOME CONCERNS	LOW	LOW	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Garden, 2012[29]	SOME CONCERNS	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Jin, 2022[31] (body fat mass, % fat mass)	HIGH	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH	HIGH
Jin, 2022[31] (BMIZ, HAZ, WAZ, growth increments)	VERY HIGH	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH	VERY HIGH
Mahoney, 2018[27]	HIGH	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Grains

Description of the evidence

Nine studies (from 14 articles) met inclusion criteria and examined the relationship between consumption of grains among infants and young children, up to age 24 months, and growth, body composition, and risk of obesity (**Table 39**).[1,29,30,32-42] Two studies were randomized controlled trials (RCTs; 1 cluster RCT[39,41] and 1 parallel RCT[35]). Seven studies were PCS,[1,29,30,32-34,36-38,40,42] using data from the following cohorts: CAPS,[29,30] Halland Health and Growth Study (H2GS),[32,33,37] IFPS II,[34,42] NorthPop,[38] Nurture,[40] and 2 unnamed cohorts.[1,36] One study was a prospective analysis of an RCT that aimed to examine the effect of dust mite prevention and omega-3 supplementation on asthma prevention.[29,30]

Population

Four studies were conducted in the United States,[1,34,35,40,42] including 1 study from Puerto Rico,[1] 2 studies were conducted in Sweden,[32,33,37,38] and 1 study each was conducted in Australia,[29,30] China,[39,41] and Norway.[36] Two articles from the unnamed cohorts were from the same cohort.[39,41] The analytic sample sizes of the studies ranged from 68[1] to 2,404.[32] Most studies did not report power calculations related to grains consumption and the relevant outcomes.[1,29,30,32-34,36-42] The 1 study that did report power noted that it was not sufficiently powered.[35]

Five studies provided information on the racial and/or ethnic background of participants: 100% of the participants were Chinese in 1 study[41]; in another, 100% of participants were Hispanic[1]; in the third study, 91% of participants were White, while the remaining participants were Hispanic (5%) and Black (4%)[34]; the fourth study reported that 72% of participants were Black, 19% were White, and 7% were Latina[40]; finally, the fifth study reported that the child's grandparent's ethnicity or country of birth was Caucasian (54%), European (9%), Middle Eastern/Indian/Asian (12%), and undefined (25%).[29,30] Average maternal age tended to be in the mid-twenties to early-thirties[29,38,40,42] or a large proportion of participants were in this age range,[1,32,34,36,37] across the 7 studies that reported this information.,[1,29,32,34,36-38,40,42] Human milk and formula feeding practices were reported in 8 studies and were varied.[1,29,30,32-37,39-42] Among the RCTs, all infants were exclusively breastfed at enrollment (ranging from approximately age 4 to 6 months).[35,39,41] Among the 3 PCS that reported on exclusive breastfeeding, 51% were exclusively breastfeeding at 1 month in 1 study,[1] 46% were exclusively breastfeeding at 4 months in the second study,[36] while the third study reported that 2% of participants were exclusively breastfeeding at 6 months.[32] Duration of any breastfeeding also tended to vary across studies: 1 study reported that 79%,[32] 58%,[32] and 5-9%[33,37] of participants were breastfeeding at 4, 6, and 12 months, respectively, a second study reported that 42% of participants were breastfeeding at 6 months,[30] a third reported that 21% were breastfeeding at 10 months,[1] while a fourth study reported that the mean duration of breastfeeding was 14.7 weeks.[40] One study reported breastfeeding intensity, noting that ≥20% of milk feedings were breast milk at age 2 months for 67% of participants.[34]

Measures of SEP were reported in 8 studies.[1,29,32-34,36-38,40-42] Maternal education was reported across 8 studies, with most noting that 50% of the participants, or more, had at least 12 years or a high school level of education[1,29,32-34,36-38,40,42] although in 1 study approximately 55% had at least 9 years of education.[41] Among the 3 studies that reported household income,[34,38,40] 1 study reported that 61% had a household income less than or equal to 349% of federal poverty line,[34] 74% had a household income of $40,000 or less in a second study,[40] and the final study reported an average household disposable income of 526,058 Swedish Krona.[38] One study exclusively enrolled participants who were participating in WIC,[1] while a second study reported that 38% of participants participated in WIC.[42]

Regarding the characteristics of the infants and young children, approximately 50% of participants were female[1,29,30,33-40,42] and mean birth weight ranged from approximately 3.4[35] to 3.8[36] kilograms. Of the 8 studies that reported gestational age, 6 studies exclusively enrolled full-term infants,[35-41] while 1 study exclusively enrolled infants born at or after 36 weeks[29] and a second study reported a mean gestational age of approximately 39 weeks.[42] Baseline anthropometry was reported in 5 studies.[30,33,35,37,39-41] Across both RCTs, there were no significant differences between groups in baseline anthropometry.[35,39,41] The remaining 3 studies reported 24% had high infant weight gain during the first year in 1 study,[33] mean weight and length at age 18 months was 11.6 kilograms and 83.4 cm, respectively, in the second study[30] and WLZ at age 3 months was 0.14 in the third study.[40]

Exposures and comparators

The 2 RCTs compared the effect of consuming infant cereal, fortified[35,39,41] or unfortified,[39,41] to consuming meat.[35,39,41] The intervention period was from age 6 to 18 months in 1 study[39,41] and from approximately age 4-6 to 7 months in the other.[35] A variety of exposures were examined across the PCS. Two studies examined the frequency or amount of milk cereal drink consumption,[32,33,37,38] 2 studies examined porridge,[32,33,36] and 1 study each examined infant cereal added to bottles,[34,42] cereal foods (i.e., bread, pasta, rice, breakfast cereals),[29,30] cereal-based foods (i.e., cookies, crackers, doughnuts, cakes, pies, buns, muffins, pizza),[29,30] whole grains,[1] refined grains,[1] and baby snacks (teething biscuits, puffs, melts).[40] Four studies analyzed the exposures continuously,[1,29,30,36,42]while the remaining studies examined the exposures categorically. [32-34,37,38,40]

The PCS used a variety of assessment methods to measure dietary intake, including FFQs,[1,36,38,42] 3 studies other questionnaires,[32,34,37,40] and 3-day food records.[29,30,35] The assessments were conducted across a wide range of ages, spanning from age 1 months up to age 24 months, with 6 measuring consumption up to age 12 months[1,32-34,36-38,40,42] and 3 measuring consumption after age 12 months.[1,29,30,33] Four studies conducted multiple assessments of grains consumption between birth and age 24 months.[1,33,40,42]

Outcomes

Eight studies examined measures of growth,[29,30,34-37,39-42]while 1 study assessed body composition,[30] and 3 studies examined the risk of overweight or obesity.[1,32,33,38] A variety of outcome measures were reported across the studies including BMI,[30,36] BMIZ,[29,38] WLZ,[39-41] WAZ,[39,41] LAZ,[39,41] weight,[34,35] rapid infant weight gain,[37,42] length,[35,41] head circumference,[35,41] waist circumference,[30] and risk of overweight or obesity, based on a variety of cut-offs.[1,32,33,38] Five of the studies examined change or trajectories of the outcomes over time,[29,34,35,37,41,42] while 6 studies examined outcomes measured at single time points.[1,30,32,33,36,38-40] Research staff or nurses measured the outcomes in all but 1 study, which collected maternal report of infant weight at the last doctor's visit.[34,42] The ages at which the outcomes were measured ranged from age 6 months[40] up to age 11.5 years.[29]

Synthesis of the evidence

Across both RCTs and PCS, most studies reported predominantly or exclusively null effects or associations of grains with measures of growth and risk of overweight or obesity, although 5 studies did report some significant relationships with grains consumption (**Table 39**).[35,39,41]

Regarding the null findings, the 2 RCTs[35,39,41] reported null effects comparing consumption of meat to infant cereal on outcomes predominantly related to weight from age 7 to 18 months. However, 1 of these RCT is less generalizable to the U.S. population as it was conducted in an area of China with moderate stunting levels.[39,41] Across the PCS, 6 studies did not detect significant associations between a variety of grain products,[1,36-38,40] including infant porridge,[32,33,36] milk cereal drink,[37,38] baby snacks,[40] whole grains,[1] and refined grains,[1] and outcomes related to growth, such as BMIZ and WLZ, and risk of overweight or obesity from infancy through early childhood. Across the 7 studies that reported any null associations, studies tended to show a non-significant positive association between baby snacks,[40] cereal foods,[30] cereal added to bottle,[34] whole grains,[1] refined grains,[1] and milk cereal drink[33] and outcomes related to growth and risk of overweight or obesity.

Half of these studies also reported significant effects or associations of grains with measures of growth and risk of overweight or obesity. Both of the RCTs reported that infants fed cereal had significantly lower non-weight-related growth, including length[39,41] and head circumference,[35] compared to infants fed meat. Three of the 8 PCS also reported significant associations,[30,32-34,42] all of which varied in the type of grains examined, including milk cereal drink,[32,33] cereal-based foods,[30] and cereal added to baby bottle.[34,42] The directionality of these studies were mixed, with 2 studies reporting a tendency for rapid weight gain or risk of overweight with cereal added to bottle and milk cereal drink, respectively, and 1 study reporting lower BMI with greater cereal-based foods consumption.

The single study that assessed body composition reported mixed findings: consumption of cereal foods, which included bread, pasta, rice, and breakfast cereals, at age 18 months was not associated with waist circumference, while greater consumption of cereal-based foods, which included cookies, crackers, doughnuts, cakes, pies, buns, muffins, and pizza, was associated with lower waist circumference at age 8 years (**Table 39**).[30]

Conclusion statements and grades

The Committee developed a conclusion statement about the relationship between grains consumption and growth and risk of obesity based on their review of the body of evidence (**Table 38**). The grade reflects the strength of the evidence underlying the conclusion statement. However, the Committee did not draw a conclusion statement about the relationship between grains consumption and body composition because there is not enough available evidence (**Table 38**). The risk of bias assessments for the studies that addressed this question are documented in **Table 40**, **Table 41**, and **Table 42** for parallel RCTs, cluster-RCTs, and PCS, respectively.

Table 38. Conclusion statement, grade for grains consumption by infants and young children and growth and risk of obesity

Conclusion Statement	**Grains consumption by infants and young children, from age 6 months up to age 24 months, is not associated with unfavorable outcomes related to growth patterns and risk of obesity during childhood. This conclusion is based on evidence graded as limited.**
Grade	Limited
Body of Evidence	14 articles (9 studies): 2 randomized controlled trials (3 articles), 7 prospective cohort studies (11 articles)
Consistency	Some concerns due to some inconsistency in the results, as well as the exposures examined.
Precision	Substantial concerns due to insufficient power or lack of information on power.
Risk of bias	Substantial concerns, particularly due to randomization in randomized controlled trials, and confounding, exposure measurement, and missing data in observational studies.
Directness	Some concerns due to some studies that were less direct.
Generalizability	Some concerns due to most studies conducted outside the United States and some studies examining exposures less generalizable to the United States.
Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between grains consumption by infants and young children, from age 6 months up to age 24 months, and outcomes related to body composition during childhood because there is not enough evidence available.**
Grade	Grade Not Assignable
Body of Evidence	1 article: 1 prospective cohort study
Rationale	There is not enough evidence available to answer this question.

Assessment of the evidence

The body of evidence underlying the graded conclusion statement above includes 14 articles from 2 RCT and 7 PCS. The evidence was graded based on an assessment of 5 grading elements, as described below. Publication bias was also a consideration; however, this was not assessed as a serious concern because the body of evidence included studies that reported only nonsignificant findings as well as studies that reported a mix of both significant and nonsignificant results, across a range of analytic sample sizes. However, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias.

Consistency

The studies were somewhat inconsistent in regard to both the significance and direction of findings. Specifically, several studies reported null findings, some studies reported a mix of null and significant results for greater growth or risk of overweight or obesity, and some studies reported a mix of null and significant results for lower growth. The studies varied in the grain products that were examined, with some assessing specific products such as infant cereal or milk cereal drink, and others measuring broader categories of products such as whole and refined grains, cereal foods, and cereal-based products.

Precision

There were substantial concerns in precision across this body of evidence. One trial reported that they did not have sufficient power. The remaining studies provided no information on power.

Risk of bias

There were several risk of bias concerns across the body of evidence (**Table 40**, **Table 41**, and **Table 42**). First, both RCTs had some concerns for or were at high risk of bias due to randomization. Next, across the PCS, all had at least some risk of bias concerns due to confounding because none accounted for every key confounder. Two of these studies had a very high risk of bias due to confounding as no model adjustments were made. Most PCS also had some concerns with risk of bias due to exposure measurement because of the use of unvalidated measures. Most studies had high risk of bias due to missing data because high levels of missing data were present but not accounted for. With the exception of 1 RCT, all studies had some concerns or high risk of bias due to selection of the reported result because pre-registered protocols or analysis plans were not available. Risk of bias due to selection of participants, post-exposure interventions, and outcome measurement were predominantly assessed as low.

Directness

The populations, interventions/exposures, comparators, and outcomes examined in the studies were primarily directly related to the systematic review question. One study examined infant cereal provided in a bottle, but this less direct exposure was not weighed heavily in the synthesis.

Generalizability

There were some concerns with generalizability to the U.S. population due to less than half of the studies being conducted in the United States. Additionally, several studies examined exposures that are less generalizable to the United States, such as milk cereal drink. However, several studies had representation of individuals across different racial and/or ethnic groups and SEP levels, such as maternal education.

Table 39. Evidence examining the relationship between grains consumption and growth, body composition, and risk of obesity[a]

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
RCT-Parallel			
Krebs, 2006[35] RCT-Parallel, U.S. Analytic N by group: Meat: n=38, Cereal: n=34 Attrition: Meat: 18%, Cereal: 18% (Excluded participants who dropped out due to inability to continue EBF, return to work, relocation) Adequately powered: No **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: 100% EBF at 4 mo Child sex (female): 51% Birth weight: ~3.37 kg Gestational age: 100% born at term	**Intervention(s):** Meat group: Received pureed beef (Gerber Beef and Beef Gravy, Second Foods) as first complementary food from ~4-6 mo - 7mo; deferred introduction of infant cereal until after 7 mo; encouraged to wait until ~5 months to start complementary food **Comparator(s):** Cereal group: Received Fe-fortified cereal from ~4-6 mo - 7mo (Gerber Fe fortified infant rice cereal, without Zn, First Foods) as first complementary food, mixed with either expressed human milk or water on approximately a 1:2 ratio of cereal to fluid; deferred introduction of meats/other high protein foods until after 7 mo; encouraged to wait until ~5 months to start complementary food **Dietary assessment methods:** 3-d diet records **Compliance:** NR **Age at intervention:** ~4-6 mo - 7 mo **Intervention duration:** ~2 mo **Outcome(s):** Weight, length, HC, weight-for-length **Outcome assessment methods:** Weight, length, and head circumference were measured by trained study nurses. Percentiles for weight-for-length for age based on CDC data. **Age(s) at outcome assessment:** 4 mo, 5 mo, 6 mo, 7 mo, 9 mo, 12 mo	**Monthly weight change (g) from 4-7 mo and 7-12 mo (mean (SE))** Meat vs Cereal From 4-7 mo: 399 (20) vs 427 (21), p=NS From 7-12 mo: 267 (17) vs 252 (18), p=NS **Monthly length change (cm) from 4-7 mo and 7-12 mo (mean (SE))** Meat vs Cereal From 4-7 mo: 1.62 (0.062) vs 1.78 (0.065), p=NS From 7-12 mo: 1.25 (0.046) vs 1.27 (0.048), p=NS **Monthly HC change (cm) from 4-7 mo and 7-12 mo (mean (SE))** Meat vs Cereal From 4-7 mo: 0.79 (0.028) vs 0.81 (0.028), p=NS **From 7-12 mo: 0.48 (0.018) vs 0.41 (0.019), p=0.02** **Monthly weight-for-length percentile from 4-7 mo and 7-12 mo (mean)** Meat vs Cereal At 4-7 mo: Data NR, p=NS At 7-12 mo: Data NR, p=NS	**Model adjustments:** Birth weight, gestational age, sex **Funding:** National Cattleman's Beef Association, NIH, Gerber Products Company (food provision)

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
RCT-Cluster			
Ma, 2016[39] RCT-Cluster, China Analytic N by group: Meat: n=137 (20 clusters); Fortified cereal: n=140 (20 clusters); Local cereal: n=133 (20 clusters) Attrition: NA for sub-samples (attrition before sub-sample identified: Meat: 10%, Fortified cereal: 10%, Local cereal: 14%) (Excluded participants who were lost to follow-up or who were not randomly selected for the sub-sample for blood collection and analysis.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: 100% EBF at enrollment (5 mo) Child sex (female): 48% Birth weight: 100% >2,000 g Gestational age: 100% with term delivery (37-42 wk)	**Intervention(s):** Meat: Minced fresh, certified safe pork to be boiled and served daily (50 g) **Comparator(s):** Fortified cereal: Commercially available fortified cereal (Fe, Zn, vitamin B12); Local cereal: isocaloric local cereal (made of glutinous rice flour, white granulated sugar, and honey). **Dietary assessment methods:** Consumption checked and recorded by community doctors biweekly (meat) or weekly (cereal) **Compliance:** NR **Age at intervention:** 6 mo to 18 mo **Intervention duration:** 12 mo **Outcome(s):** LAZ, WAZ, WLZ **Outcome assessment methods:** Length and weight measured by trained study personnel. Z scores calculated using 2006 WHO Child Growth Standards **Age(s) at outcome assessment:** 6, 12, and 18 mo	**LAZ @ 18 mo (mean (SD))** Meat vs Fortified cereal vs Local cereal **-1.47 (0.99) vs -1.83 (0.95) vs -1.67 (0.97), p=0.024 (Meat vs Fortified cereal, p<0.05)** **Change in LAZ from 6 to 18 mo (mean (SD))** Meat vs Fortified cereal vs Local cereal **-0.41 (0.78) vs -0.71 (0.64) vs -0.62 (0.75), p=0.021 (Meat vs Local cereal and Meat vs Fortified cereal, p<0.05)** **WAZ @ 18 mo (mean (SD))** Meat vs Fortified cereal vs Local cereal -0.89 (0.93) vs -1.04 (0.89) vs -0.91 (0.88), p=0.496 **Change in WAZ @ 6-18 mo (mean (SD))** Meat vs Fortified cereal vs Local cereal -0.42 (0.61) vs -0.43 (0.58) vs -0.34 (0.73), p=0.872 **WLZ @ 18 mo (mean (SD))** Meat vs Fortified cereal vs Local cereal -0.27 (0.92) vs -0.24 (0.84) vs -0.15 (0.82), p=0.507 **Change in WLZ @ 6-18 mo (mean (SD))** Meat vs Fortified cereal vs Local cereal -0.61 (0.90) vs -0.44 (0.78) vs -0.36 (0.86), p=0.114	**Model adjustments:** sex, birth weight, mother's pre-pregnancy BMI **Funding:** National Natural Science Foundation of China, Thrasher Foundation

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Tang, 2014[41] RCT-Cluster, China Analytic N by group: Meat: n=462 (20 clusters), Cereal: n=856 (40 clusters) Attrition: Meat: 10%; Cereal: 11% (Reasons for attrition NR) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Chinese: 100% Maternal education: ≥9 y education: ~55% Other SEP measure(s): Paid work: ~7% Maternal age: NR Milk feeding practices: 100% EBF at 6 mo (enrollment) Child sex (female): NR Birth size: NR Gestational age: 100% with term delivery	**Intervention(s):** Meat: Minced fresh, certified safe pork to be boiled and served daily (60 g) **Comparator(s):** Cereal: Commercially available or isocaloric packaged pressed rice cereal product produced locally **Dietary assessment methods:** Weekly histories and observation of feeding **Compliance:** NR **Age at intervention:** 6 mo to 18 mo **Intervention duration:** 12 mo **Outcome(s):** Length, weight, HC, LAZ, WAZ, WLZ, HCZ **Outcome assessment methods:** Length, weight, and HC measured by trained study personnel. Z scores calculated using WHO standards. **Age(s) at outcome assessment:** 6, 7, 9, 12, 15, and 18 mo	**Change in length (cm) from 6 to 18 mo (mean (SD))** **Meat vs Cereal: 13.01 (1.9) vs 12.75 (1.8), p=0.01** **Change in LAZ from 6 to 18 mo (mean (SD))** **Meat vs Cereal:-0.43 (0.72) vs -0.54 (0.67), p<0.01** **Change in weight (kg) from 6 to 18 mo (mean (SD))** Meat vs Cereal: 2.45 (0.60) vs 2.38 (0.60), p=0.08 **Change in WAZ from 6 to 18 mo (mean (SD))** Meat vs Cereal: -0.35 (0.60) vs -0.43 (0.61), p=0.05 **Change in WLZ from 6 to 18 mo (mean (SD))** Meat vs Cereal: -0.47 (0.79) vs -0.50 (0.81), p=0.62 **Change in HC (cm) from 6 to 18 mo (mean (SD))** Meat vs Cereal: 3.80 (0.73) vs 3.82 (0.65), p=0.66 **Change in HCZ from 6 to 18 mo (mean (SD))** Meat vs Cereal: -0.19 (0.56) vs -0.18 (0.50), p=0.87	**Model adjustments:** Baseline length, baseline LAZ, maternal education, work status, maternal height and weight **Funding:** Thrasher Foundation; Science and Technology Commission of Shanghai Municipality; National Natural Science Foundation of China; Shanghai Key Laboratory of Pediatric Gastroenterology and Nutrition; NIH

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
PCS			
Almquist-Tangen, 2013[32] PCS, H2GS, Sweden Analytic N = 2,404 (12 mo), 2,241 (18 mo) (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: <12 y: 46%, >13 y: 54% Other SEP measure(s): Paternal education: <12 y: 62%, >13 y: 38% Maternal age: <25 y: 10%, 25-34 y: 67%, ≥35 y: 23% Milk feeding practices: BF at 4 mo: 78.7%, EBF at 4 mo: 74.4%, Mixed feeders at 4 mo: 4.3%, exclusively FF at 4 mo: 21.3%; BF at 6 mo: 58.3%, EBF at 6 mo: 1.6% Child sex (female): NR Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Milk cereal drink (gruel made from flour boiled in water, consumed from a bottle) at 6 mo (yes vs no (ref)); Porridge at 6 mo (yes vs no (ref)) **Dietary assessment methods:** Family questionnaire **Age(s) at dietary assessment:** 6 mo **Amounts consumed:** Milk cereal drink at 6 mo: 46.6% (Of these, 1-2 250 mL bottles/d: 59.8%, 3-4 bottles/d: 25%, 5-6 bottles/d: 14%); Porridge at 6 mo: 87.7% **Outcome(s):** High BMI (BMI >1 SD in study population) **Outcome assessment methods:** Height and weight measured by trained child health nurses **Age(s) at outcome assessment:** 12 mo, 18 mo	**High BMI (>1 SD) @ 12 mo, 18 mo (OR (95% CI))** Milk cereal drink at 6 mo: yes vs no (ref) **12 mo: 1.66 (1.07, 2.57), p=0.02** **18 mo: 1.58 (1.04, 2.39), p=0.03** Porridge at 6 mo: yes vs no (ref) 12 mo: 0.79 (0.40, 1.57), p=0.51 18 mo: 0.73 (0.39, 1.38), p=0.33	**Key confounders accounted for:** SEP; sex; milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** race and/or ethnicity **Model adjustments:** maternal and paternal obesity, maternal and paternal education, maternal smoking, age and sex of infant, birth weight, gestational age, BMI at 4 wk, BMI at 4 mo, BMI at 6 mo **Funding:** Research and Development Department, Halland

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Almquist-Tangen, 2019[32] PCS, H2GS, Sweden Analytic N = 1,745 (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: <9 y: 5%, 9-12 y: 42%, >12 y: 53% Other SEP measure(s): Paternal education: <9 y: 6%, 9-12 y: 58%, >12 y: 36% Maternal age: NR Milk feeding practices: Any BF at 12 mo: 9% Child sex (female): 51% LGA: 3% SGA: 3% Gestational age: NR	**Exposure(s) and comparator(s):** Milk cereal drink (Fe-fortified liquid foods made of cereal boiled in milk, commercially available, nutritionally similar to porridge) at 12 mo (3+ bottles/d, 1-2 bottles/d, vs no use (ref)); Milk cereal drink at 6, 12, 18, and 24 mo (yes vs no (ref)); Porridge at 12 mo (yes vs no (ref)) **Dietary assessment methods:** Parent questionnaires **Age(s) at dietary assessment:** 1, 4, 6, 12, 18, 24, 36, 48, and 60 mo **Amounts consumed:** Milk cereal drink at 12 mo: 3+ bottles/d: 19%, 1-2 bottles/d: 66%, No use: 15% Porridge at 12 mo: 89% **Outcome(s):** Overweight **Outcome assessment methods:** Weight and length measured at child health care centers by trained nurses. Overweight defined based on data from 6 nationally representative cross-sectional growth studies (Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, U.S.) using the centile curve that would pass through BMI = 25 at 18 y **Age(s) at outcome assessment:** 36, 48, 60 mo	**Overweight @ 5 y (Crude OR (95% CI))** Porridge at 12 mo, yes vs no (ref): 1.20 (0.76, 1.88), p=0.43 **Overweight @ 5 y (OR (95% CI))** Milk cereal drink at 12 mo **1-2 bottles/d vs no use (ref), 1.94 (1.08, 3.50), p=0.028** 3+ bottles/d vs no use (ref): 1.11 (0.54, 2.26), p=0.78 **Overweight @ 36, 48, 60 mo (Crude OR (95% CI))** Milk cereal drink at 6 mo, yes vs no (ref) **36 mo: 1.35 (1.03, 1.76), p<0.05** **48 mo: 1.42 (1.07, 1.89), p<0.05** 60 mo: 1.13 (0.84, 1.51), p=NS Milk cereal drink at 12 mo, yes vs no (ref) **36 mo: 1.59 (1.04, 2.44), p<0.05** 48 mo: 1.48 (0.94, 2.30), p=NS **60 mo: 1.75 (1.08, 2.82), p<0.05** Milk cereal drink at 18 mo, yes vs no (ref) 36 mo: 1.24 (0.87, 1.77), p=NS 48 mo: 1.07 (0.75, 1.54), p=NS 60 mo: 1.22 (0.83, 1.81), p=NS Milk cereal drink at 24 mo, yes vs no (ref) 36 mo: 1.00 (0.74, 1.35), p=NS 48 mo: 0.93 (0.68, 1.26), p=NS 60 mo: 0.84 (0.61, 1.16), p=NS	**Key confounders accounted for:** Milk cereal drink at 12 mo: SEP; sex; milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** Porridge at 12 mo, Milk cereal drink at 6, 18, and 24 mo: SEP; sex; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry Milk cereal drink at 12 mo: race and/or ethnicity **Model adjustments:** Porridge at 12 mo, Milk cereal drink at 6, 18, and 24 mo: None Milk cereal drink at 12 mo: Maternal obesity, paternal obesity, maternal education, paternal education, paternal smoking, large for gestational age, sex **Funding:** Research and Development Department at the Region of Halland and from Region Skane

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Amaro-Rivera, 2019[1] PCS, U.S. (Puerto Rico) Analytic N = 68 (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Hispanic: 100% Maternal education: ≤HS: 32.5%, >HS: 67.5% Other SEP measure(s): WIC participation: 100% Maternal age: Parent's age: <30 y: 55.8%, ≥30 y: 44.2% Milk feeding practices: EBF for ≥1 mo: 51%, Ever FF: 70.1%, Any BF at ~10 mo: 20.8% Child sex (female): 47% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Annual change (amounts) in whole grains, refined grains Diet Quality Index Scores (continuous) **Dietary assessment methods:** Interviewer-administered questionnaire completed by caregivers. Diet Quality Index Score based on semi-quantitative FFQ. **Age(s) at dietary assessment:** 0-5, 8-36 mo (types/amounts) **Amounts consumed:** NR **Outcome(s):** WLZ (≥1) **Outcome assessment methods:** Weight and length measured by trained research staff. Weight status assessed using WHO age- and sex-specific WLZ growth charts. Relative risk for WLZ (≥1 z-score vs <1 z-score), with underweight defined as WLZ ≤-2 SD, healthy weight status defined as WLZ >-2 and <1 SD, risk of overweight defined as WLZ between 1-<2, and overweight or obesity defined as WLZ ≥2 SD. **Age(s) at outcome assessment:** 11-36 mo (Median: 21 mo, 11-23 mo: 61.0%, 24-36 mo: 39.0%)	**WLZ (≥1 vs <1) @ 11-36 mo (RR (95% CI))** Whole grains score: 1.08 (0.80, 1.48) Refined grains score: 1.21 (0.86, 1.71)	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry **Key confounders NOT accounted for:** gestational age **Model adjustments:** WLZ at baseline **Funding:** University of Puerto Rico Central Administration Grant; Capacity Advancement in Research Infrastructure; NIMHD

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Gaffney, 2014[34] PCS, IFPS II, U.S. Analytic N = 1,447 (Excluded participants with missing data for the outcome or main exposures of interest) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: White: 90.8%, Hispanic: 5.3%, Black: 3.9% Maternal education: HS or less: 18.7%, Some college: 36.7%, 4-year college or more: 44.6% Other SEP measure(s): Household income (% of poverty line): <185%: 30.3%, 185 to ≤349%: 30.5%, >349%: 39.1% Maternal age: 18-24 y: 17.6%, 25-34 y: 64.5%, > 34 y: 17.8% Milk feeding practices: BF intensity at 2 mo: Low (<20% of milk feedings being BM): 33.1%, Medium/High (≥20% of milk feedings being BM): 66.9% Child sex (female): 50% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Cereal (added to baby bottle; Yes vs No (ref)) **Dietary assessment methods:** Questionnaire completed by mother **Age(s) at dietary assessment:** 2 mo **Amounts consumed:** Yes: 11.7%, No: 88.3% **Outcome(s):** Weight gain **Outcome assessment methods:** Weight at last doctor's visit reported by mother **Age(s) at outcome assessment:** 6 mo	**Weight gain (lb) from birth to 6 mo (β)** **Mothers with PPD: 0.15, p=0.03** Among mothers without PPD: 0.02, p=0.80	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices **Key confounders NOT accounted for:** gestational age; baseline anthropometry **Model adjustments:** Maternal race/ethnicity, age at childbirth, maternal education, household income, pre-pregnancy BMI, postpartum smoking status, infant sex, perceived infant fussiness to be a problem at 2 mo, BF intensity at 2 mo, added cereal to baby bottle at 2 mo, introduction to solid foods **Funding:** NR

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Garden, 2011[30] PCS, CAPS, Australia Analytic N = 362 (Excluded participants with missing data on diet or anthropometrics) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Grandparents ethnicity/country of birth: Caucasian: 55%, European: 9%, Middle Eastern: 4%, Indian: 5%, Asian: 4%, Undefined: 24% Maternal education: NR Other SEP measure(s): Paternal education: ≤10 y: 33%, 11-12 y: 18%, Tertiary education: 48% Maternal age: NR Milk feeding practices: BF ≥6 mo: 42% Child sex (female): 49% Birth weight: 3,493 (492) g Gestational age: NR Other relevant characteristics: Secondary analysis of RCT (testing intervention of house dust mite avoidance and omega-3 supplementation); all children recruited at increased risk of developing asthma	**Exposure(s) and comparator(s):** Continuous (amounts; as tertiles, quartiles, or quintiles) Cereal foods: bread, pasta, rice, breakfast cereals Cereal-based foods: cookies, crackers, doughnuts, cakes, pies, buns, muffins, pizza **Dietary assessment methods:** 3-d weighed food records **Age(s) at dietary assessment:** 18 mo **Amounts consumed:** Quintiles of grams (g); % total energy intake Cereal foods: 6, 37, 51, 68, 95; 1, 9, 12, 16, 21 Cereal-based foods: 0, 8, 17, 28, 51; 0, 3, 6, 10, 14 **Outcome(s):** BMI, waist circumference **Outcome assessment methods:** Weight, length, and waist circumference measured by study nurses **Age(s) at outcome assessment:** 8 y	**BMI @ 8 y (β (95% CI))** Cereal foods, per quintile g: 0.16 (-0.05, 0.37), p for trend=0.14 % of total energy: 0.12 (-0.08, 0.33), p for trend=0.23 Cereal-based foods, per quintile **g: -0.23 (-0.44, -0.22), p for trend=0.03** **% of total energy: -0.27 (-0.47, -0.07), p for trend=0.01** **WC (cm) @ 8 y (β (95% CI))** Cereal foods, per quintile g: 0.35 (-0.21, 0.91), p for trend=0.22 % of total energy: 0.28 (-0.27, 0.83), p for trend=0.32 Cereal-based foods, per quintile **g: -0.61 (-1.17, -0.05), p for trend=0.03** **% of total energy: -0.76 (-1.29, -0.23), p for trend=0.01**	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** sex, asthma study intervention group, birth weight, breastfeeding for at least 6 months, parental obesity status, ethnicity, smoking in pregnancy and father's education, total energy intake (food intake in grams only) **Funding:** The National Health and Medical Research Council of Australia; Cooperative Research Centre for Asthma; New South Wales Department of Health; Children's Hospital Westmead; University of Sydney, Faculty of Medicine; Commonwealth Department of Health and Aging

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Garden, 2012[29] PCS, CAPS, Australia Analytic N = 298 (Excluded participants who were not still participating in the study at 11.5 y or did not have dietary data.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR (Australian born mother: 74%, Australian born father: 69%; Child's grandparents ethnicity/country of birth: Caucasian: ~54%, European: ~9%, Middle Eastern/Indian/Asian: ~12%, Undefined: ~25%) Maternal education: 52% tertiary educated Other SEP measure(s): Full-time employment: Mother: 49%, Father: 87% Maternal age: 29.0 (5.1) y Milk feeding practices: BF duration: 0 to <3 mo: 40%, 3 to <6 mo: 16.8%, ≥6 mo: 43.2% Child sex (female): 49% Birth weight: 100% ≥2.5 kg Gestational age: 100% ≥36 wk Other relevant characteristics: Secondary analysis of RCT (testing intervention of house dust mite avoidance and omega-3 supplementation); all children recruited at increased risk of developing asthma	**Exposure(s) and comparator(s):** Intake (amount) at 18 mo (all continuous): Cereal foods (bread, pasta, rice, breakfast cereals, etc) Cereal-based products (cookies, crackers, doughnuts, cakes, pies, buns, muffins, pizza, etc), **Dietary assessment methods:** Maternal interview/questionnaire (timing of any) and parent/caregiver completed 3-d weighed food record (2 weekdays and 1 weekend day) (types and amounts) **Age(s) at dietary assessment:** 18 mo (types and amounts) **Amounts consumed:** See results for intake data **Outcome(s):** BMI trajectory **Outcome assessment methods:** Weight and height measured by study nurses. Three BMI trajectories defined using latent basis growth mixture model in relationship to CDC percentiles, stratified by sex. **Age(s) at outcome assessment:** 1, 3, 6, 9, 12, 18 mo, 2-5 y (every 6 mo), 8 y, 11.5 y	**BMI trajectory @ birth-11.5 y (median intake at 18 mo by trajectory group)** Cereals, including bread, pasta, rice, etc. Boys: normal trajectory: 60.7 g, early and persistent trajectory: 52.1 g, late BMI increase: 63.4 g, p=0.79 Girls: normal trajectory: 54.2 g, early and persistent trajectory: 59.9 g, late BMI increase: 58.3 g, p=0.87 Cereal based extra foods Boys: normal trajectory: 18.0 g, early and persistent trajectory: 11.0 g, late BMI increase: 26.7 g, p=0.15 Girls: normal trajectory: 22.5 g, early and persistent trajectory: 28.5 g, late BMI increase: 18.5 g, p=0.56 Results analyzed by % of total energy were similar.	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry (multinomial regression only). **Key confounders NOT accounted for:** gestational age **Model adjustments:** dietary intervention group, BF, parental obesity, ethnicity, smoking during pregnancy, father's education status (multinomial regression only) **Funding:** National Health and Medical Research Council of Australia

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Lande, 2005[36] PCS, Norway Analytic N = 1,441 (Excluded participants who did not complete semiquantitative FFQs at both 6 mo and 12 mo, were not born full term, and had a ponderal index at birth <10th percentile.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: ≤10 y: 10%, 11-12 y: 41%, ≥13 y: 50% Other SEP measure(s): NR Maternal age: <25 y: 12%, 25-34 y: 71%, ≥35 y: 17% Milk feeding practices: EBF ≥4 mo: ~46%, BF duration: <6 mo: ~16%, 6-11 mo: ~47%, ≥12 mo: ~37% Child sex (female): 47% Birth weight: 3,795 (477) g Birth length: 50.8 (2.0) cm Gestational age: 100% born after 37 completed wk gestation	**Exposure(s) and comparator(s):** Commercial infant porridge at 6 mo (continuous) **Dietary assessment methods:** Semiquantitative FFQ completed by mothers/parents **Age(s) at dietary assessment:** 6 mo and 12 mo (timing of any only) **Amounts consumed:** ~169 g/d **Outcome(s):** BMI **Outcome assessment methods:** Weight and height measured by health-care personnel at child health clinics. **Age(s) at outcome assessment:** 6 mo, 12 mo	**BMI @ 12 mo** Data NR, p=NS	**Key confounders accounted for:** SEP; milk feeding practices; gestational age **Key confounders NOT accounted for:** sex; race and/or ethnicity; baseline anthropometry **Model adjustments:** NA (exposures of interest not retained in model) **Funding:** Research Council of Norway

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Lindholm, 2020[37] PCS, H2GS, Sweden Analytic N = 1,780 (Excluded participants with missing outcome data, with outcome data measured outside age limits, or born preterm) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: Upper secondary school: 39%, Elementary school: 5%, University: 51%, Other: 4% Other SEP measure(s): NR Maternal age: <25 y: 14%, 25-35 y: 69%, ≥35: 17% Milk feeding practices: Predominantly BF: 87% at birth, 67% at 3-4 mo, 29% at 6 mo, 4.5% at 12 mo; Exclusively FF: 6% at birth, 20% at 3-4 mo Child sex (female): 49% Birth weight: ~3,600 g; AGA: 92% Gestational age: 100% full-term	**Exposure(s) and comparator(s):** Milk cereal drink ("gruel", liquid complement to BM that is commercially available and made from grains and dehydrated skimmed milk mixed with hot water; yes vs no (ref)) **Dietary assessment methods:** Parent questionnaires **Age(s) at dietary assessment:** 6 mo **Amounts consumed:** Milk cereal drink at 6 mo: 44% **Outcome(s):** RWG **Outcome assessment methods:** Weight measured by study personnel. Weight transformed to sex- and age-specific SDS using Swedish reference data. RWG defined as change >0.67 weight SDS. **Age(s) at outcome assessment:** 6 mo, 12 mo	**RWG from 6-12 mo (OR (95% CI))** 1.00 (0.64, 1.57), p=0.985	**Key confounders accounted for:** SEP; sex; milk feeding practices; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; baseline anthropometry **Model adjustments:** Birth weight, sex, maternal and paternal education, maternal and paternal smoking, maternal weight before pregnancy, maternal gestational weight gain, paternal weight at the first measurement point, maternal and paternal diabetes and cardiovascular disease, BF, bottle-feeding, nighttime meals **Funding:** SEP; sex; milk feeding practices; gestational age

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Lundkvist, 2021[38] PCS, NorthPop, Sweden Analytic N = 1,499 (Excluded participants without anthropometric data at 18 (±1) mo and those born <37 wk.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: Primary: 0.7%, Lower secondary: 2.7%, Upper secondary: 24%, Post secondary: 69%, Post-graduate (including doctoral degree): 3.1% Other SEP measure(s): Household disposable income: 526,058 SEK; Co-parent education: Primary: 0.4%, Lower secondary: 3.0%, Upper secondary: 38%, Post-secondary: 46%, Post-graduate (including doctoral degree): 2.7% Maternal age: 30.9 (4.5) y Milk feeding practices: NR Child sex (female): 49% Birth weight: 3,594 (478) g; LBW: 0.7%, Normal weight: 95.9%, Macrosomia: 3.5% Gestational age: 40 (1.3) wk; 100% term	**Exposure(s) and comparator(s):** Milk cereal drink: frequent consumers (daily), consumers (monthly and weekly), nonconsumers **Dietary assessment methods:** FFQ (1 mo recall) **Age(s) at dietary assessment:** 9 mo **Amounts consumed:** Frequent consumers: 52.3%, Consumers: 16.8%, Nonconsumers: 30.9% **Outcome(s):** BMIZ, overweight **Outcome assessment methods:** Weight and length derived from child health care records. Sex- and age- specific BMIZ calculated using WHO standards. Overweight defined as BMIZ > 2. **Age(s) at outcome assessment:** 18 mo	**BMIZ @ 18 mo** Frequent consumers vs Consumers vs Nonconsumers: Data NR, NS **Overweight @ 18 mo** Frequent consumers vs Consumers vs Nonconsumers: Data NR, NS	**Key confounders accounted for:** sex; milk feeding practices; gestational age **Key confounders NOT accounted for:** SEP; race and/or ethnicity; baseline anthropometry **Model adjustments:** BMIZ: fruit juice at 18 mo, breastfeeding at 9 mo, maternal BMI; Overweight: None **Funding:** Swedish Research Council; Region Vasterbotten; Umea University

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Moore, 2019[40] PCS, Nurture, U.S. Analytic N = 466 (Reasons for attrition NR) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Black: 71.5%, White: 19.2%, Other: 8.9%; Latina: 6.5%; (Child race and/or ethnicity: Black: 68.6%, White: 15.0%, White: 14.9%, Latina: 8.9%) Maternal education: ≤ HS diploma: 47.8%; Some college: 30.3%; College graduate: 15.5%; Graduate degree: 6.3% Other SEP measure(s): Household income: ≤$20k: 55.4%, $20-40k: 19.1%, >$40k: 16.7% Maternal age: 27.1 (5.8) y Milk feeding practices: BF duration: 14.7 (18.2) wk Child sex (female): 49% Birth weight-for-gestational age z-score: -0.31 (0.9) Gestational age: 100% ≥37 wk	**Exposure(s) and comparator(s):** Baby snacks (teething biscuits, puffs, melts): never, sometimes, often **Dietary assessment methods:** Infant feeding questionnaire from IFPS II and FITS completed by mother: home visit (3, 6, 9, 12 mo); interactive voice response telephone calls (1, 2, 4, 5, 7, 8, 10, 11 mo) **Age(s) at dietary assessment:** 1-12 mo (monthly) **Amounts consumed:** Baby snacks, frequency median (IQR): 0-3 mo: 0.0 x/d (0.0, 0.0), 4-6 mo: 0.0 x/d (0.0, 1.0), 7-9 mo: 2.7 x/d (1.3, 3.7), 10-12 mo: 3.0 x/d (2.0, 4.0) Sweets, frequency median (IQR): 0-3 mo: 0.0 x/d (0.0, 0.0), 4-6 mo: 0.0 x/d (0.0, 0.0), 7-9 mo: 0.0 x/d (0.0, 1.0), 10-12 mo: 0.7 x/d (0.0, 1.7) **Outcome(s):** WLZ **Outcome assessment methods:** Weight and length were measured by study personnel. Age- and sex-specific WLZ calculated using WHO reference standards. **Age(s) at outcome assessment:** 3 mo, 6 mo, 9 mo, 12 mo	**WLZ @ 6 mo (β (SE))** Baby snacks at 4-6 mo Sometimes vs Never (ref): 0.11 (0.07), p=NS Often vs Never (ref): -0.08 (0.10), p=NS **WLZ @ 9 mo (β (SE))** Baby snacks at 7-9 mo Sometimes vs Never (ref): -0.12 (0.11), p=NS Often vs Never (ref): 0.07 (0.12), p=NS **WLZ @ 12 mo (β (SE))** Baby snacks at 10-12 mo Sometimes vs Never (ref): -0.14 (0.11), p=NS Often vs Never (ref): 0.02 (0.13), p=NS	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** birth weight-for-gestational age z-scores, total weeks of any breastfeeding **Funding:** NIH

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Ventura, 2019[42] PCS, IFPS II, U.S. Analytic N = 695 (Excluded participants with implausible WAZ scores (> 5 or <-5), with missing data on birth weight and fewer than 2 weight measurements, where the mother was away from infant more than 70 h/wk at any assessment, where mother reported infant had a serious health problem at any age, with missing data on any predictor or outcome variables, and infants who did not have high risk bottle-feeding (high-stable use and rapid increase).) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Minority race/ethnicity (minority not defined in paper): 13% Maternal education: HS degree or less: 23% Other SEP measure(s): WIC participation: 38%; Poverty-to-income ratio level, percent of poverty level: ~292% Maternal age: ~30 y Milk feeding practices: BM-feeding intensity (% of daily milk feedings that were BM), 0-6 mo: ~11% Child sex (female): 50% Birth weight: ~8 lb Gestational age: ~39 wk Other relevant characteristics: Analysis limited to infants with "high risk bottle use" (high-stable bottle use and rapid increase in bottle use)	**Exposure(s) and comparator(s):** Cereal (added to bottle of formula or BM; continuous) **Dietary assessment methods:** FFQ of infant's diet in past 7 days completed by mothers **Age(s) at dietary assessment:** 1, 2, 3, 4, 5, 6 mo **Amounts consumed:** NR **Outcome(s):** RWG **Outcome assessment methods:** Maternal report of infant's measured weight and length at last pediatrician visit. Weight standardized to age- and sex-specific WAZs based on WHO child growth standards. RWG defined as difference between WAZ from birth to last weight assessed between 6 and 12 mo ≥0.67. **Age(s) at outcome assessment:** 3, 5, 7, 12 mo	**No RWG from birth to 6-12 mo (OR (95% CI))** **0.82 (0.69, 0.97), p<0.05**	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** Child sex, gestational age, birth weight, maternal age, pre-pregnancy obesity, smoking during pregnancy, parity, poverty-income ratio level, WIC participation, education level, race/ethnicity, BM-feeding intensity, frequency of bottle-to-bed, frequency of cereal in bottle, frequency of infant-led bottle-emptying, frequency of maternal encouragement of bottle-emptying, frequency of feedings, early introduction to CFB **Funding:** NR

[a] Abbreviations: @: at; AGA: appropriate for gestational age; β: beta; BF: breastfeeding; BM: breastmilk; BMI: body mass index; BMIZ: BMI z-score; CAPS: Childhood Asthma Prevention Study; CDC: Centers for Disease Control and Prevention; CI: confidence interval; cm: centimeter; d: day; EBF: exclusive breastfeeding; etc: *et cetera*; Fe: iron; FF: formula feeding; FFQ: food-frequency questionnaire; FITS: Feeding Infants and Toddlers Study; g: gram; h: hour; H2GS: Halland Health and Growth Study; HC: head circumference; HCZ: head circumference z-score; HS: high school; IFPS II: Infant Feeding Practices Study II; IQR: interquartile range; kg: kilogram; LAZ: length-for-age z-score; LBW: low birthweight; lb: pound; mo: month; NA: not applicable; NCHS: National Center for Health Statistics; NR: not reported; NS: non-significant; OR: odds ratio; PCS: prospective cohort study; RCT: randomized controlled trial; RR: risk ratio; RWG: rapid weight gain; SD: standard deviation; SDS: standard deviation score; SE: standard error; SEK: Swedish Krona; SEP: socioeconomic position; SGA: small for gestational age; svg: serving; U.S.: United States; vs: versus; WAZ: weight-for-age z-score; WC: waist circumference; WHO: World Health Organization; WIC: Special Supplemental Nutrition Program for Women, Infants, and Children; wk: week; WLZ: weight-for-length z-score; x: times; y: year; Zn: zinc

Table 40. Risk of bias for randomized controlled trials (parallel) examining grains consumption and growth, body composition, and risk of obesity[a]

Article	Randomization	Deviations from intended interventions (effect of assignment or per-protocol)	Missing outcome data	Outcome measurement	Selection of the reported result	Overall risk of bias
Krebs, 2006[35]	SOME CONCERNS	LOW	SOME CONCERNS	LOW	SOME CONCERNS	SOME CONCERNS

Table 41. Risk of bias for randomized controlled trials (cluster) examining grains consumption and growth, body composition, and risk of obesity[b]

Article	Randomization	Timing of identification and recruitment of individual participants in relation to timing of randomization	Deviations from the intended interventions (effect of assignment/ adhering to intervention)	Missing outcome data	Outcome measurement	Selection of the reported result	Overall risk of bias
Ma, 2016[39]	HIGH	SOME CONCERNS	LOW	LOW	LOW	SOME CONCERNS	HIGH
Tang, 2014[41]	HIGH	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH

[a] Possible ratings of low, some concerns, or high determined using the "Cochrane Risk-of-bias 2.0" (RoB 2.0) (August 2019 version)" (Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng H-Y, Corbett MS, Eldridge SM, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, McAleenan A, Reeves BC, Shepperd S, Shrier I, Stewart LA, Tilling K, White IR, Whiting PF, Higgins JPT. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019; **366**: l4898.

[b] Possible ratings of low, some concerns, or high determined using the "Cochrane Risk-of-bias 2.0" (RoB 2.0) (August 2019 version)" (Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng H-Y, Corbett MS, Eldridge SM, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, McAleenan A, Reeves BC, Shepperd S, Shrier I, Stewart LA, Tilling K, White IR, Whiting PF, Higgins JPT. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019; **366**: l4898.

Table 42. Risk of bias for observational studies examining grains consumption and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Almquist-Tangen, 2013[32]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Almquist-Tangen, 2019[33] (milk cereal drink at 12 mo)	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	HIGH	HIGH
Almquist-Tangen, 2019[33] (all other exposures)	VERY HIGH	SOME CONCERNS	LOW	LOW	HIGH	LOW	HIGH	VERY HIGH
Amaro-Rivera, 2019[1]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Gaffney, 2014[34]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	SOME CONCERNS	SOME CONCERNS	HIGH
Garden, 2011[30]	SOME CONCERNS	LOW	LOW	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Garden, 2012[29]	SOME CONCERNS	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Lande, 2005[36]	HIGH	LOW	LOW	LOW	HIGH	LOW	HIGH	HIGH
Lindholm, 2020[37]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Lundkvist, 2021[38] (overweight)	VERY HIGH	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	VERY HIGH
Lundkvist, 2021[38] (BMIZ)	HIGH	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Moore, 2019[40]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Ventura, 2019[42]	SOME CONCERNS	LOW	LOW	LOW	HIGH	SOME CONCERNS	SOME CONCERNS	HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Protein foods

Description of the evidence

Ten studies (13 articles) met inclusion criteria and examined the relationship between the consumption of foods from the protein foods group by infants and young children, up to age 24 months, and growth, body composition, and risk of obesity (**Table 44**).[1,27,29-31,35,39,41,43-47] Two studies (3 articles) were parallel RCTs[35,46,47] and 1 study (2 articles) was a cluster-RCT.[39,41] Seven studies (8 articles) were PCS,[1,27,29-31,43-45] using data from the following cohorts: the All Children in South-East Sweden,[43] CAPS,[29,30] LoTiS,[31] Born in Bradford 1000,[27] the Feeding Queensland Babies Study Cohort,[45] and 2 unnamed studies[1,44] One PCS was a secondary analysis of a RCT testing the impact of dust mite avoidance and omega-3 fatty acid supplementation on asthma prevention.[29,30]

Population

The studies were conducted in several countries including Australia,[29,30,45] China,[31,39,41] Sweden,[43] the United Kingdom,[27,44] and the United States,[1,35,46,47] including 1 study from Puerto Rico.[1] The analytic sample sizes of the RCTs ranged from 53[46] to 1,318.[41] For the PCS, the analytic sample sizes ranged from 25[45] to 6,749.[43] Regarding power, 1 article reported that the study was powered for outcomes related to growth,[47] 1 article reported that the study did not meet the sample size goal based on a power calculation for outcomes related to growth, body composition, or risk of obesity,[35] while the remaining studies did not provide any information on power.

Race and/or ethnicity varied across the 7 studies that reported this information. Specifically, 75% or more of the participants were White in 2 studies,[44,46,47] approximately 90% of children had 2 Swedish parents in 1 study,[43] 100% of participants were Hispanic in 1 study,[1] 100% of participants were Chinese in 1 study,[39,41] approximately 55% and 45% of participants were Pakistani and White British, respectively, in 1 study,[27] and the ethnicity/country of birth of the children's grandparents in 1 study were varied including Caucasian (55%), European (9%), Middle Eastern (4%), Indian (5%), Asian (4%), and undefined (24%).[29,30] Of the 6 studies that reported maternal age, most reported that the average age was approximately 30 years,[29,31,43,46,47] with 1 study reporting that 64% were age 31 to 40 years[44] and 1 study reporting that approximately 56% were younger than age 30 years.[1] Among the RCTs, 2 studies enrolled infants age 4-6 months who were exclusively breast feeding,[35,39,41] while 1 study enrolled infants age 5 months who were exclusively formula feeding.[46,47] Of the 5 PCS that reported information on human milk feeding,[1,29-31,43,44] a range of practices were reported. Specifically 2 studies reported an average duration of breast feeding of approximately 7 to 8 months,[31,43] 2% of infants breast fed at age 6 months in 1 study,[44], approximately 43% of infants were breast fed for 6 months or longer in 1 study,[29,30] and approximately 21% of infants were breast fed at age 10 months.[1] Five studies provided information on measures of SEP.[1,29,30,41,43,44] The most common SEP measure was maternal education, with reported education levels including approximately 55% with at least 9 years of education in 1 study,[41] approximately 68% with greater than a high school education in a second study,[1] approximately 35% with a college or university education in a third study,[43] and approximately 52% with tertiary education in the last study.[29] Employment was reported across 3 studies and varied widely, with 1 study reporting that only 7% of women were participating in paid work,[41] a second study reporting that 49% were employed full-time,[29] and the third noting that over 75% of participants had either "higher" or "intermediate" occupations.[44] One study noted that household disposable income was either "high" or "medium" in over 80% of participants,[43] while another study exclusively enrolled individuals participating in WIC.[1]

The children enrolled in these studies were approximately 50% female.[1,29-31,35,39,43-47] Among studies reporting birth size, the average birth weight predominantly ranged from approximately 3.2 kilograms to 3.6 kilograms,[2,27,29,30,35,39,43,44,46,47] although 1 study of twins reported an average birth weight of 2.5 kilograms.[31] Additionally, 3 studies reported that 100% of participants had a birth weight greater than or equal to 2.0 kilograms[39] or 2.5 kilograms.[29,44] With the exception of the study of twins, which reported that 53% of the children were born preterm,[31] the studies predominantly focused on infants born term with 4 reporting that 100% of the included children were born term or at 36 weeks gestation and later[29,35,39,41,44] and 2 studies reporting that the average gestational age at birth was 39 to 40 weeks.[43,46,47] Across the RCTs, 1 reported small, but statistically significant, differences in infant length between the intervention and comparator groups at baseline, but analyses were adjusted for baseline length and LAZ,[41] while the other 2 RCTs reported that baseline anthropometry did not vary by intervention group.[35,47] The PCS did not report baseline anthropometry by level of exposure[30,31] or did not report baseline anthropometry.[1,27,29,43,45,46]

Interventions/exposures and comparators

The studies examined a variety of foods from the protein foods group, although nearly all focused on animal sources. Among the RCT, all 3 compared consumption of meat (beef,[35] pork,[39,41] or beef and ham[46,47]) to consumption of infant cereal (fortified[35,39,41] or unfortified[39,41]) or dairy-based complementary foods.[46,47] While 1 study aimed to compare different food sources of the macronutrient protein,[46,47] the 2 studies that compared meat to infant cereal noted interest in the contribution of meat to intake of protein, iron, and zinc.[35,39,41] The interventions began at age 4 to 6 months and ranged in duration from approximately 2[35] to 12[39,41] months. Compliance to the assigned group was high in the 1 RCT that reported this information.[46,47] Among the PCS, a broader range of exposures were examined including: red meat and poultry[29,30,44]; red meat, poultry, and seafood[31]; red meat, poultry, seafood, and eggs[45]; seafood[43]; processed meat products (undefined)[27]; and meat (undefined) and beans.[1] Five studies used FFQs to assess consumption of protein foods,[1,27,31,43,45] while the remaining 2 studies used a weighed food record or diary.[29,30,44] All of the PCS assessed protein foods consumption at or after age 12 months, but 2 studies additionally examined protein foods consumption prior to age 12 months.[1,44]

Outcomes

Growth, body composition, and risk of obesity were assessed using a variety of measures. Outcomes related to growth were the most frequently reported[27,29-31,35,39,41,44-47] and most commonly included weight, WAZ, length, LAZ, BMIZ, head circumference, and head circumference z-score. Body composition,[30,31,45] and risk of overweight and/or obesity[1,43] were less frequently assessed. Measures of body composition included waist circumference,[30] body fat mass and percentage,[31] and fat mass index, fat-free mass index, and waist-to-height ratio z-scores.[45] Among studies that utilized z-scores, most reported using CDC[29,35,46,47] or WHO[1,27,31,39,41,45-47] growth standards to calculate z-scores. The outcomes were measured by study personnel in all studies except for 1, in which weight and height were reported by the parents and then subsequently validated between health clinic charts.[43] The age at which the outcomes were measured varied greatly, ranging from age 4 months[35,44] to age 11.5 years,[29] although most outcomes were measured up to age 24 months.[1,31,35,39,41,44,46,47]

Synthesis of the evidence

Of the 10 studies that analyzed the relationship between protein foods consumption and growth, body composition, and risk of obesity, 5 studies reported a mix of statistically significant and non-significant findings,[29,30,35,39,41,45-47] while 5 studies reported exclusively null results[1,27,31,43,44] (**Table 44**). Two of these 10 studies only reported correlations.[31,45]

All 3 RCTs reported mixed results.[35,39,41,46,47] Two of the RCTs found that infants consuming meat-based complementary foods tended to have greater or greater increases in length or LAZ compared to infants consuming infant cereal[39,41] or dairy based complementary foods,[46,47] while differences between intervention groups for other outcomes such as weight, WAZ, WLZ, and head circumference were not detected. The generalizability of 1 of these RCTs to the United States is limited, due to the study location's moderately high stunting rate.[39,41] Finally, while monthly change in head circumference from age 7 to 12 months, but not from age 4 to 7 months, was greater among infants consuming meat, compared to iron-fortified infant cereal, at the beginning of complementary feeding, group differences were not detected for monthly change in weight, length, and weight-for-length percentile.[35] Two PCS also detected that protein foods consumption was significantly associated with several outcomes.[29,30,45] Specifically, greater consumption of meat and poultry combined at age 18 months was associated with higher BMI and waist circumference at age 8 years, and less favorable BMI trajectories (among boys) from birth to age 11.5 years in 1 study,[29,30] while more frequent consumption of meat, fish, and eggs combined at age 12 months was correlated with greater fat-free mass index and waist-to-height ratio z-scores, but not BMIZ or fat mass index z-score, at age 2-3 years in the other.[45]

The remaining 5 studies, all from PCS, did not detect associations between protein foods consumption and growth, body composition, or risk of obesity.[1,27,31,43,44] These studies tended to report non-significant differences of small magnitude in outcomes by protein foods consumption[1,27,31] or simply reported statistical significance.[43,44] There was considerable variability in the exposures, outcomes, and the ages in which these variables were assessed across these studies. Exposures examined in these studies were assessed at ages 4 months up to 24 months and included amounts of red and white meat,[44] frequency of meats (including poultry and seafood),[31] amounts of meat (undefined) and beans,[1] frequency of fatty-fish,[43] and frequency of processed meat products (undefined).[27] The outcomes were assessed at time points between age 12 months and 8 years,[43] and included a wide range of measures including BMIZ,[27,31] WAZ,[31] weight,[31,44] HAZ,[31] length,[31,44] head circumference,[44] body fat mass and percentage,[31] weight status,[43] and WLZ ≥1.[1]

There were several important limitations across the body of evidence. First, few studies examined protein foods as a food group comprehensively and directly. Instead, most studies focused on smaller subsets of foods from the protein foods group, most commonly meats alone or in combination with poultry and/or seafood. Only 1 study reported including both animal and plant sources of protein foods and few studies reported including seafood or eggs. Second, there was considerable heterogeneity across the studies on a variety of factors. The studies examined a wide range of interventions and exposures, some assessing single foods or small groups of foods (e.g., beef, pork, fatty fish, processed meat) while other examined broader combinations of protein foods. Few studies analyzed the same combinations of foods from the protein foods group in their assessment, adding to the heterogeneity of the exposures. Additionally, the comparators varied, with trials comparing consumption of meat to consumption of infant cereal and dairy, and the PCS comparing differing amounts in some and differing frequency in others.

Conclusion statement and grade

The Committee did not draw a conclusion statement about the relationship between consumption of protein foods as a food group by infants and young children, up to 24 months, and growth, body composition, and risk of obesity (**Table 43**). This was due to substantial concerns with consistency and directness in the body of evidence. Across the studies, there was marked heterogeneity in the interventions, exposures, and comparators examined. Additionally, few studies examined protein foods as a food group collectively. Instead, most studies examined subsets of this food group, such as meats alone; few studies examined eggs or beans. Publication bias was also a consideration; however, this was not assessed as a serious concern because the body of evidence included studies that reported only nonsignificant findings as well as studies that reported a mix of both significant and nonsignificant results, across a range of analytic sample sizes. However, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias. The risk of bias assessments for the studies that addressed this question are documented in **Table 45**, **Table 46**, and **Table 47**, for parallel-RCT, cluster-RCT, and PCS, respectively.

Table 43. Conclusion statement, grade for consumption of protein foods by infants and young children and growth, body composition, and risk of obesity

Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between consumption of protein foods as a food group by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency and directness in the body of evidence.**
Grade	Grade Not Assignable
Body of Evidence	13 articles (10 studies): 3 parallel randomized controlled trials (5 articles), 7 prospective cohort studies (8 articles)
Rationale	The studies varied substantially in the types of protein foods examined and the comparators. Few studies directly examined protein foods as a food group.

Table 44. Evidence examining the relationship between consumption of protein foods and growth, body composition, and risk of obesity[a]

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Parallel-RCT			
Krebs, 2006[35] RCT-Parallel, U.S. Analytic N by group: Meat: n=38, Cereal: n=34 Attrition: Meat: 18%, Cereal: 18% (Excluded participants who dropped out due to inability to continue EBF, return to work, relocation) Adequately powered: No **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: 100% EBF at 4 mo Child sex (female): 51% Birth weight: ~3.37 kg Gestational age: 100% born at term	**Intervention(s):** Meat group: Received pureed beef (Gerber Beef and Beef Gravy, Second Foods) as first complementary food from ~4-6 mo - 7mo; deferred introduction of infant cereal until after 7 mo; encouraged to wait until ~5 months to start complementary food **Comparator(s):** Cereal group: Received Fe-fortified cereal from ~4-6 mo - 7mo (Gerber Fe fortified infant rice cereal, without Zn, First Foods) as first complementary food, mixed with either expressed human milk or water on approximately a 1:2 ratio of cereal to fluid; deferred introduction of meats/other high protein foods until after 7 mo; encouraged to wait until ~5 months to start complementary food **Dietary assessment methods:** 3-d diet records **Compliance:** NR **Age at intervention:** ~4-6 mo - 7 mo **Intervention duration:** ~2 mo **Outcome(s):** Weight, length, HC, weight-for-length **Outcome assessment methods:** Weight, length, and head circumference were measured by trained study nurses. Percentiles for weight-for-length for age based on CDC data. **Age(s) at outcome assessment:** 4 mo, 5 mo, 6 mo, 7 mo, 9 mo, 12 mo	**Monthly weight change (g) from 4-7 mo and 7-12 mo (mean (SE))** Meat vs Cereal From 4-7 mo: 399 (20) vs 427 (21), p=NS From 7-12 mo: 267 (17) vs 252 (18), p=NS **Monthly length change (cm) from 4-7 mo and 7-12 mo (mean (SE))** Meat vs Cereal From 4-7 mo: 1.62 (0.062) vs 1.78 (0.065), p=NS From 7-12 mo: 1.25 (0.046) vs 1.27 (0.048), p=NS **Monthly HC change (cm) from 4-7 mo and 7-12 mo (mean (SE))** Meat vs Cereal From 4-7 mo: 0.79 (0.028) vs 0.81 (0.028), p=NS **From 7-12 mo: 0.48 (0.018) vs 0.41 (0.019), p=0.02** **Monthly weight-for-length percentile from 4-7 mo and 7-12 mo (mean)** Meat vs Cereal At 4-7 mo: Data NR, p=NS At 7-12 mo: Data NR, p=NS	**Model adjustments:** Birth weight, gestational age, sex **Funding:** National Cattleman's Beef Association, NIH, Gerber Products Company (food provision)

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Tang, 2018[47] RCT-Parallel, U.S. Analytic N by group: Meat: n=32, Dairy: n=32 Attrition: Meat: 8.6%, Dairy: 11.1% (Excluded participants who moved, were not compliant, switched formula, or lost contact) Adequately powered: Yes **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: White: ~75%, Hispanic: ~17.5%, Black: ~4.5%, Asian: ~3% Maternal education: NR Other SEP measure(s): NR Maternal age: ~30 y Milk feeding practices: 100% exclusively formula-fed infants Child sex (female): ~53.5% Birth weight: ~3.3 kg Gestational age: ~39 wk	**Intervention(s):** Meat-based complementary foods (pureed meats) from 5 mo to 12 mo of age in addition to infant formula (same formula given to both groups). (Total protein intake, including formula, ~3g/kg/d.) Fruit and vegetable intake not restricted. **Comparator(s):** Dairy-based complementary foods (infant yogurt, cheese, powdered concentrate of 80% whey protein) from 5 mo to 12 mo of age in addition to infant formula (same formula given to both groups). (Total protein intake, including formula, ~3g/kg/d.) Fruit and vegetable intake not restricted. **Dietary assessment methods:** Parental report via calendars to record daily consumption, 3-d diet records completed monthly. Return of unused foods, if any. **Compliance:** Intervention: Protein from meat-based CF at 10 mo - 2.1 g/kg/d, Protein from dairy-based CF at 10 mo - 0.03 g/kg/d; Comparator: Protein from meat-based CF at 10 mo - 0.01 g/kg/d, Protein from dairy-based CF at 10 mo - 2.0 g/kg/d **Age at intervention:** 5-12 mo **Intervention duration:** 7 mo **Outcome(s):** Weight, WAZ, Length, LAZ, WLZ, Head circumference, Head circumference Z-score **Outcome assessment methods:** Length, weight, and head circumference measured by blinded, trained research personnel. Z-scores calculated using WHO/CDC growth standards. **Age(s) at outcome assessment:** 5, 7, 8, 9, 10, 11, and 12 mo	**Weight (kg) @ 5 mo - 12 mo (Mean (SD))** Meat vs Dairy Group x time interaction: p=0.81 5 mo: 7.37 (0.67) vs 7.35 (0.74), p=NS 7 mo: 8.17 (0.70) vs 8.10 (0.77), p=NR 8 mo: 8.63 (0.78) vs 8.49 (0.74), p=NR 9 mo: 8.90 (0.75) vs 8.91 (0.75), p=NR 10 mo: 9.28 (0.78) vs 9.23 (0.78), p=NR 11 mo: 9.61 (0.81) vs 9.51 (0.79), p=NR 12 mo: 9.92 (0.91) vs 9.92 (0.97), p=NR **Length (cm) @ 5 mo - 12 mo (Mean (SD))** Meat vs Dairy **Group x time interaction: p=0.0002** 5 mo: 65.3 (2.2) vs 65.3 (2.5), p=NS 7 mo: 68.1 (2.7) vs 67.3 (2.2), p=NR 8 mo: 69.5 (2.4) vs 68.5 (2.3), p=NR 9 mo: 71.0 (2.3) vs 69.9 (2.5), p=NR 10 mo: 72.5 (2.6) vs 71.2 (2.4), p=NR 11 mo: 73.8 (2.6) vs 72.3 (2.3), p=NR 12 mo: 75.7 (2.6) vs 73.9 (2.2), p=NR **HC (cm) @ 5 mo - 12 mo (Mean (SD))** Meat vs Dairy Group x time interaction: p=0.55 5 mo: 43.0 (1.2) vs 43.1 (1.1), p=NS 12 mo: 46.4 (1.3) vs 46.3 (1.1), p=NR **HCZ @ 5 mo - 12 mo (Mean (SD))** Meat vs Dairy Group x time interaction: p=0.41 5 mo: 0.51 (0.82) vs 0.54 (0.77), p=NS 7 mo: 0.36 (1.02) vs 0.43 (0.80), p=NR 8 mo: 0.45 (0.76) vs 0.47 (0.95), p=NR 9 mo: 0.36 (0.93) vs 0.40 (0.90), p=NR 10 mo: 0.48 (0.86) vs 0.50 (0.90), p=NR 11 mo: 0.38 (0.91) vs 0.34 (0.76), p=NR 12 mo: 0.55 (0.81) vs 0.49 (0.79), p=NR	**Model adjustments:** None (participants matched by sex and race/ethnicity) **Funding:** NIH (NIDDK); NIH/National Center for Advancing Translational Sciences Colorado Clinical and Translational Science Awards; Abbott Nutrition; American Heart Association; the Beef Checkoff (National Cattlemen's Beef Association); Leprino Foods; National Pork Board.

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Tang, 2018[47] (Continued) RCT-Parallel, U.S. Analytic N by group: Meat: n=32, Dairy: n=32 Attrition: Meat: 8.6%, Dairy: 11.1% (Excluded participants who moved, were not compliant, switched formula, or lost contact) Adequately powered: Yes **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: White: ~75%, Hispanic: ~17.5%, Black: ~4.5%, Asian: ~3% Maternal education: NR Other SEP measure(s): NR Maternal age: ~30 y Milk feeding practices: 100% exclusively formula-fed infants Child sex (female): ~53.5% Birth weight: ~3.3 kg Gestational age: ~39 wk	**Intervention(s):** Meat-based complementary foods (pureed meats) from 5 mo to 12 mo of age in addition to infant formula (same formula given to both groups). (Total protein intake, including formula, ~3g/kg/d.) Fruit and vegetable intake not restricted. **Comparator(s):** Dairy-based complementary foods (infant yogurt, cheese, powdered concentrate of 80% whey protein) from 5 mo to 12 mo of age in addition to infant formula (same formula given to both groups). (Total protein intake, including formula, ~3g/kg/d.) Fruit and vegetable intake not restricted. **Dietary assessment methods:** Parental report via calendars to record daily consumption, 3-d diet records completed monthly. Return of unused foods, if any. **Compliance:** Intervention: Protein from meat-based CF at 10 mo - 2.1 g/kg/d, Protein from dairy-based CF at 10 mo - 0.03 g/kg/d; Comparator: Protein from meat-based CF at 10 mo - 0.01 g/kg/d, Protein from dairy-based CF at 10 mo - 2.0 g/kg/d **Age at intervention:** 5-12 mo **Intervention duration:** 7 mo **Outcome(s):** Weight, WAZ, Length, LAZ, WLZ, Head circumference, Head circumference Z-score **Outcome assessment methods:** Length, weight, and head circumference measured by blinded, trained research personnel. Z-scores calculated using WHO/CDC growth standards. **Age(s) at outcome assessment:** 5, 7, 8, 9, 10, 11, and 12 mo	**WAZ @ 5 mo - 12 mo (Mean (SD))** Meat vs Dairy Group x time interaction: p=0.49 5 mo: -0.03 (0.69) vs -0.14 (0.82), p=NS 7 mo: 0.13 (0.64) vs 0.10 (0.72), p=NS 8 mo: 0.26 (0.71) vs 0.13 (0.72), p=NS 9 mo: 0.28 (0.69) vs 0.26 (0.70), p=NS 10 mo: 0.35 (0.66) vs 0.30 (0.71), p=NS 11 mo: 0.43 (0.66) vs 0.33 (0.69), p=NS 12 mo: 0.40 (0.74) vs 0.39 (0.78), p=NS **LAZ @ 5 mo - 12 mo (Mean (SD))** Meat vs Dairy **Group x time interaction: p=0.00001** 5 mo: -0.19 (0.86) vs -0.30 (1.02), p=NS 7 mo: -0.14 (1.02) vs -0.44 (0.98), p=NS 8 mo: -0.19 (0.88) vs -0.58 (1.00), p=NS **9 mo: -0.12 (0.86) vs -0.62 (1.10), p<0.05** **10 mo: -0.07 (0.91) vs -0.62 (1.02), p<0.05** **11 mo: -0.05 (0.91) vs -0.69 (1.01), p<0.05** **12 mo: 0.14 (0.90) vs -0.60 (0.91), p=0.001** **WLZ @ 5 mo - 12 mo (Mean (SD))** Meat vs Dairy **Group x time interaction: p=0.015** 5 mo: 0.18 (0.73) vs 0.16 (0.88), p=NS 7 mo: 0.40 (0.79) vs 0.55 (0.95), p=NS 8 mo: 0.57 (0.84) vs 0.68 (0.94), p=NS 9 mo: 0.51 (0.78) vs 0.82 (0.96), p=NS 10 mo: 0.53 (0.80) vs 0.84 (0.98), p=NS **11 mo: 0.63 (0.68) vs 0.88 (0.88), p=0.03** **12 mo: 0.48 (0.75) vs 0.92 (0.88), p=0.03**	**Model adjustments:** None (participants matched by sex and race/ethnicity) **Funding:** NIH (NIDDK); NIH/National Center for Advancing Translational Sciences Colorado Clinical and Translational Science Awards; Abbott Nutrition; American Heart Association; the Beef Checkoff (National Cattlemen's Beef Association); Leprino Foods; National Pork Board.

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Tang, 2019[46] RCT-Parallel, U.S. Analytic N by group: Meat: n=27, Dairy: n=26 Attrition: Meat: 23%; Dairy: 28% (Excluded participants who moved, were not compliant, switched formula, or lost contact) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: ~30 y Milk feeding practices: 100% exclusively formula-fed infants Child sex (female): ~53% Birth weight: ~3.3 kg Gestational age: ~39 wk	**Intervention(s):** Meat-based complementary foods (pureed meats) from 5 mo to 12 mo of age in addition to infant formula (same formula given to both groups). (Total protein intake, including formula, ~3g/kg/d.) Fruit and vegetable intake not restricted. **Comparator(s):** Dairy-based complementary foods (infant yogurt, cheese, powdered concentrate of 80% whey protein) from 5 mo to 12 mo of age in addition to infant formula (same formula given to both groups). (Total protein intake, including formula, ~3g/kg/d.) Fruit and vegetable intake not restricted. **Dietary assessment methods:** Parental report via calendars to record daily consumption, 3-d diet records completed monthly. Return of unused foods, if any. **Compliance:** >90% of protein from solid foods was from the assigned protein group (meat or dairy); <5% was from the alternative **Age at intervention:** 5-12 mo **Intervention duration:** 7 mo **Outcome(s):** Weight, Length, WAZ, LAZ, WLZ **Outcome assessment methods:** Length and weight measured by blinded, trained research personnel. **Age(s) at outcome assessment:** 24 mo	**Weight (kg) @ 24 mo (Mean (SD))** Meat vs Dairy 12.6 (1.0) vs 12.4 (1.5), p=0.38 **Length (cm) @ 24 mo (Mean (SD))** Meat vs Dairy **89.0 (2.3) vs 87.1 (3.3), p=0.02** **WAZ @ 24 mo (Mean (SD))** Data NR, p=0.65 **LAZ @ 24 mo (Mean (SD))** Meat vs Dairy 12 mo: 75.7 (2.6) vs 73.9 (2.2), p=NR **WLZ @ 24 mo (Mean (SD))** Data NR, p=0.40	**Model adjustments:** NA (participants matched by sex and race/ethnicity) **Funding:** NIH (NIDDK); NIH/National Center for Advancing Translational Sciences Colorado Clinical and Translational Science Awards; Abbott Nutrition; American Heart Association; the Beef Checkoff (National Cattlemen's Beef Association); Leprino Foods; National Pork Board

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Cluster-RCT			
Ma, 2016[39] RCT-Cluster, China Analytic N by group: Meat: n=137 (20 clusters); Fortified cereal: n=140 (20 clusters); Local cereal: n=133 (20 clusters) Attrition: NA for sub-samples (attrition before sub-sample identified: Meat: 10%, Fortified cereal: 10%, Local cereal: 14%) (Excluded participants who were lost to follow-up or who were not randomly selected for the sub-sample for blood collection and analysis.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: 100% EBF at enrollment (5 mo) Child sex (female): 48% Birth weight: 100% >2,000 g Gestational age: 100% with term delivery (37-42 wk)	**Intervention(s):** Meat: Minced fresh, certified safe pork to be boiled and served daily (50 g) **Comparator(s):** Fortified cereal: Commercially available fortified cereal (Fe, Zn, vitamin B12); Local cereal: isocaloric local cereal (made of glutinous rice flour, white granulated sugar, and honey). **Dietary assessment methods:** Consumption checked and recorded by community doctors biweekly (meat) or weekly (cereal) **Compliance:** NR **Age at intervention:** 6 mo to 18 mo **Intervention duration:** 12 mo **Outcome(s):** LAZ, WAZ, WLZ **Outcome assessment methods:** Length and weight measured by trained study personnel. Z scores calculated using 2006 WHO Child Growth Standards **Age(s) at outcome assessment:** 6, 12, and 18 mo	**LAZ @ 18 mo (mean (SD))** Meat vs Fortified cereal vs Local cereal **-1.47 (0.99) vs -1.83 (0.95) vs -1.67 (0.97), p=0.024 (Meat vs Fortified cereal, p<0.05)** **Change in LAZ from 6 to 18 mo (mean (SD))** Meat vs Fortified cereal vs Local cereal **-0.41 (0.78) vs -0.71 (0.64) vs -0.62 (0.75), p=0.021 (Meat vs Local cereal and Meat vs Fortified cereal, p<0.05)** **WAZ @ 18 mo (mean (SD))** Meat vs Fortified cereal vs Local cereal -0.89 (0.93) vs -1.04 (0.89) vs -0.91 (0.88), p=0.496 **Change in WAZ @ 6-18 mo (mean (SD))** Meat vs Fortified cereal vs Local cereal -0.42 (0.61) vs -0.43 (0.58) vs -0.34 (0.73), p=0.872 **WLZ @ 18 mo (mean (SD))** Meat vs Fortified cereal vs Local cereal -0.27 (0.92) vs -0.24 (0.84) vs -0.15 (0.82), p=0.507 **Change in WLZ @ 6-18 mo (mean (SD))** Meat vs Fortified cereal vs Local cereal -0.61 (0.90) vs -0.44 (0.78) vs -0.36 (0.86), p=0.114	**Model adjustments:** sex, birth weight, mother's pre-pregnancy BMI **Funding:** National Natural Science Foundation of China, Thrasher Foundation

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Tang, 2014[41] RCT-Cluster, China Analytic N by group: Meat: n=462 (20 clusters), Cereal: n=856 (40 clusters) Attrition: Meat: 10%; Cereal: 11% (Reasons for attrition NR) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Chinese: 100% Maternal education: ≥9 y education: ~55% Other SEP measure(s): Paid work: ~7% Maternal age: NR Milk feeding practices: 100% EBF at 6 mo (enrollment) Child sex (female): NR Birth size: NR Gestational age: 100% with term delivery	**Intervention(s):** Meat: Minced fresh, certified safe pork to be boiled and served daily (60 g) **Comparator(s):** Cereal: Commercially available or isocaloric packaged pressed rice cereal product produced locally **Dietary assessment methods:** Weekly histories and observation of feeding **Compliance:** NR **Age at intervention:** 6 mo to 18 mo **Intervention duration:** 12 mo **Outcome(s):** Length, weight, HC, LAZ, WAZ, WLZ, HCZ **Outcome assessment methods:** Length, weight, and HC measured by trained study personnel. Z scores calculated using WHO standards. **Age(s) at outcome assessment:** 6, 7, 9, 12, 15, and 18 mo	**Change in length (cm) from 6 to 18 mo (mean (SD))** **Meat vs Cereal: 13.01 (1.9) vs 12.75 (1.8), p=0.01** **Change in LAZ from 6 to 18 mo (mean (SD))** **Meat vs Cereal:-0.43 (0.72) vs -0.54 (0.67), p<0.01** **Change in weight (kg) from 6 to 18 mo (mean (SD))** Meat vs Cereal: 2.45 (0.60) vs 2.38 (0.60), p=0.08 **Change in WAZ from 6 to 18 mo (mean (SD))** Meat vs Cereal: -0.35 (0.60) vs -0.43 (0.61), p=0.05 **Change in WLZ from 6 to 18 mo (mean (SD))** Meat vs Cereal: -0.47 (0.79) vs -0.50 (0.81), p=0.62 **Change in HC (cm) from 6 to 18 mo (mean (SD))** Meat vs Cereal: 3.80 (0.73) vs 3.82 (0.65), p=0.66 **Change in HCZ from 6 to 18 mo (mean (SD))** Meat vs Cereal: -0.19 (0.56) vs -0.18 (0.50), p=0.87	**Model adjustments:** Baseline length, baseline LAZ, maternal education, work status, maternal height and weight **Funding:** Thrasher Foundation; Science and Technology Commission of Shanghai Municipality; National Natural Science Foundation of China; Shanghai Key Laboratory of Pediatric Gastroenterology and Nutrition; NIH

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
PCS			
Amaro-Rivera, 2019[1] PCS, U.S. (Puerto Rico) Analytic N = 68 (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Hispanic: 100% Maternal education: ≤HS: 32.5%, >HS: 67.5% Other SEP measure(s): WIC participation: 100% Maternal age: Parent's age: <30 y: 55.8%, ≥30 y: 44.2% Milk feeding practices: EBF for ≥1 mo: 51%, Ever FF: 70.1%, Any BF at ~10 mo: 20.8% Child sex (female): 47% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Annual change (amounts) in proteins Diet Quality Index Scores (continuous) **Dietary assessment methods:** Interviewer-administered questionnaire completed by caregivers. Diet Quality Index Score based on FFQ. **Age(s) at dietary assessment:** 0-5, 8-36 mo (types/amounts) **Amounts consumed:** NR **Outcome(s):** WLZ (≥1) **Outcome assessment methods:** Weight and length measured by trained research staff. Weight status assessed using WHO age- and sex-specific WLZ growth charts. Relative risk for WLZ (≥1 z-score vs <1 z-score), with underweight defined as WLZ ≤-2 SD, healthy weight status defined as WLZ >-2 and <1 SD, risk of overweight defined as WLZ between 1-<2, and overweight or obesity defined as WLZ ≥2 SD. **Age(s) at outcome assessment:** 11-36 mo (Median: 21 mo, 11-23 mo: 61.0%, 24-36 mo: 39.0%)	**WLZ (≥1 vs <1) @ 11-36 mo (RR (95% CI))** Proteins score: 1.05 (0.92, 1.20)	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry **Key confounders NOT accounted for:** gestational age **Model adjustments:** WLZ at baseline **Funding:** University of Puerto Rico Central Administration Grant; Capacity Advancement in Research Infrastructure; NIMHD

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Duchen, 2020[43] PCS, ABIS, Sweden Analytic N = 6,749 (5 y), 3,017 (8 y) (Excluded participants lost to follow-up, twin siblings, children with body height outside the normal distribution (+/- 2 SD), and children with body weight <-2 SD or >6 SD) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Both parents Swedish: ~91%, One parent not Swedish: ~7%, Both parents born abroad: ~2% Maternal education: Primary school: ~6%, Secondary school: ~59%, College/university: ~35% Other SEP measure(s): Paternal education: Primary school: ~12%, Secondary school: ~62%, College/university: ~26%; Disposable household income: Low (20%): ~16%, Medium (60%): ~41%, High (20%): ~43% Maternal age: ~30 y Milk feeding practices: Partial BF: ~7 mo, EBF: ~4.5 mo Child sex (female): 48% Birth weight: ~3,600 g Birth length: ~51 cm, Appropriate for gestational age: ~93% Gestational age: ~40 wk	**Exposure(s) and comparator(s):** Fatty-fish index: <1 x/wk, 1-2 x/wk, 3-5 x/wk, daily or almost daily **Dietary assessment methods:** FFQ **Age(s) at dietary assessment:** 1 y **Amounts consumed:** Fatty fish intake at 1 y: Seldom: ~89%, 1-2 x/wk: ~10%, 3-5 x/wk / almost daily: ~1% **Outcome(s):** Weight status **Outcome assessment methods:** Weight and height reported by parents and validated between health clinic charts at 5 y. Age and sex specific BMI calculated using international standards; used to divide participants into 4 categories (underweight, normal weight, overweight, obesity) **Age(s) at outcome assessment:** 5 y, 8 y	**Weight status @ 5 y, 8 y (t value)** @ 5 y: 1.18, p=0.24 @ 8 y: 1.07, p=0.29	**Key confounders accounted for:** SEP; sex; milk feeding practices **Key confounders NOT accounted for:** race and/or ethnicity; gestational age; baseline anthropometry **Model adjustments:** Sex, maternal BMI, birth weight, maternal nutritional quality during pregnancy, mother smoking during pregnancy, mother's education, serious life events before the child is 5 y/8 y, physical activity at 5 y/8 y, TV watching at 5 y/8 y; 5 y only: size for gestational age, BF duration, fatty fish consumption at 2.5 y, psychosocial vulnerability in the family, household income **Funding:** The Ekhaga Foundation, The Swedish Research Council Formas, The Research Council for the South-East of Sweden, The Östergötland County Council, and The Swedish Asthma and Allergy Research Foundation, The Swedish Research Council, and Trygg Hansa Research Foundation

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Garden, 2011[30] PCS, CAPS, Australia Analytic N = 362 (Excluded participants with missing data on diet or anthropometrics) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Grandparents ethnicity/country of birth: Caucasian: 55%, European: 9%, Middle Eastern: 4%, Indian: 5%, Asian: 4%, Undefined: 24% Maternal education: NR Other SEP measure(s): Paternal education: ≤10 y: 33%, 11-12 y: 18%, Tertiary education: 48% Maternal age: NR Milk feeding practices: BF ≥6 mo: 42% Child sex (female): 49% Birth weight: 3,493 (492) g Gestational age: NR Other relevant characteristics: Secondary analysis of RCT (testing intervention of house dust mite avoidance and omega-3 supplementation); all children recruited at increased risk of developing asthma	**Exposure(s) and comparator(s):** Continuous (amounts; as tertiles, quartiles, or quintiles): Meats **Dietary assessment methods:** 3-d weighed food records **Age(s) at dietary assessment:** 18 mo **Amounts consumed:** Quintiles of grams (g); % total energy intake Meats: 0, 9, 21, 34, 53; 0, 2, 4, 7, 11 **Outcome(s):** BMI, waist circumference **Outcome assessment methods:** Weight, length, and waist circumference measured by study nurses **Age(s) at outcome assessment:** 8 y	**BMI @ 8 y (β (95% CI))** Meats, per quintile **g: 0.25 (0.04, 0.45), p for trend=0.02** **% of total energy: 0.27 (0.07, 0.47), p for trend=0.01** **WC (cm) @ 8 y (β (95% CI))** Meats, per quintile **g: 0.59 (0.03, 1.15), p for trend=0.04** **% of total energy: 0.63 (0.10, 1.17), p for trend=0.02**	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** sex, asthma study intervention group, birth weight, breastfeeding for at least 6 months, parental obesity status, ethnicity, smoking in pregnancy and father's education, total energy intake (food intake in grams only) **Funding:** The National Health and Medical Research Council of Australia; Cooperative Research Centre for Asthma; New South Wales Department of Health; Children's Hospital Westmead; University of Sydney, Faculty of Medicine; Commonwealth Department of Health and Aging

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Garden, 2012[29] PCS, CAPS, Australia Analytic N = 298 (Excluded participants who were not still participating in the study at 11.5 y or did not have dietary data.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR (Australian born mother: 74%, Australian born father: 69%; Child's grandparents ethnicity/country of birth: Caucasian: ~54%, European: ~9%, Middle Eastern/Indian/Asian: ~12%, Undefined: ~25%) Maternal education: 52% tertiary educated Other SEP measure(s): Full-time employment: Mother: 49%, Father: 87% Maternal age: 29.0 (5.1) y Milk feeding practices: BF duration: 0 to <3 mo: 40%, 3 to <6 mo: 16.8%, ≥6 mo: 43.2% Child sex (female): 49% Birth weight: 100% ≥2.5 kg Gestational age: 100% ≥36 wk Other relevant characteristics: Secondary analysis of RCT (testing intervention of house dust mite avoidance and omega-3 supplementation); all children recruited at increased risk of developing asthma	**Exposure(s) and comparator(s):** Intake (amount) at 18 mo (all continuous): Meats **Dietary assessment methods:** Parent/caregiver completed 3-d weighed food record (2 weekdays and 1 weekend day) **Age(s) at dietary assessment:** 18 mo (types and amounts) **Amounts consumed:** See results for intake data **Outcome(s):** BMI trajectory **Outcome assessment methods:** Weight and height measured by study nurses. Three BMI trajectories defined using latent basis growth mixture model in relationship to CDC percentiles, stratified by sex. **Age(s) at outcome assessment:** 1, 3, 6, 9, 12, 18 mo, 2-5 y (every 6 mo), 8 y, 11.5 y	**BMI trajectory @ birth-11.5 y (OR (95% CI))** **Boys: Early and persistent BMI class vs normal BMI class (ref): 2.0 (1.2, 3.4)** **BMI trajectory @ birth-11.5 y (median intake at 18 mo by trajectory group)** **Boys: normal trajectory: 18.6 g, early and persistent trajectory: 38.8 g, late BMI increase: 24.1 g, p=0.01** Girls: normal trajectory: 26.4 g, early and persistent trajectory: 25.4 g, late BMI increase: 35.0 g, p=0.57 Results analyzed by % of total energy were similar.	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry (multinomial regression only). **Key confounders NOT accounted for:** gestational age **Model adjustments:** dietary intervention group, BF, parental obesity, ethnicity, smoking during pregnancy, father's education status (multinomial regression only) **Funding:** National Health and Medical Research Council of Australia

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Jin, 2022[31] PCS, LoTiS, China Analytic N = 302 (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: 30.47 (3.70) y Milk feeding practices: BF duration: 7.60 (3.99) mo; Milk feeding at 12 mo: EBF: 4.6%, Exclusive formula feeding: 73.7%, Mixed breast and formula feeding: 21.7% Child sex (female): 45% Birth weight: 2.49 (0.45) kg; Birth length: 46.04 (2.40) cm; SGA at birth: 12.4% Gestational age: 36.43 (1.48) wk; 53.2% born preterm Other relevant characteristics: 100% twins (both included in analyses)	**Exposure(s) and comparator(s):** Meats: Continuous (frequency) **Dietary assessment methods:** FFQ completed by mother/guardian **Age(s) at dietary assessment:** 12 mo **Amounts consumed:** NR **Outcome(s):** WAZ, HAZ, BMIZ, percent body fat mass, weight increment (12-24 mo), length increment (12-24 mo), BMI increment (12-24 mo) **Outcome assessment methods:** Weight and height were measured by study personnel. Z-scores calculated using WHO growth standards. Body fat was measured using bioimpedance. **Age(s) at outcome assessment:** 12, 24 mo	**WAZ @ 24 mo (spearman correlation)** Meats: 0.018, p=0.758 **HAZ @ 24 mo (spearman correlation)** Meats: –0.026, p=0.653 **BMIZ @ 24 mo (spearman correlation)** Meats: 0.058, p=0.312 **Weight increment from 12 to 24 mo (spearman correlation)** Meats: 0.112, p=0.052 **Length increment from 12 to 24 mo (spearman correlation)** Meats: 0.047, p=0.413 **BMI increment from 12 to 24 mo (spearman correlation)** Meats: –0.057, p=0.357 **Body fat mass @ 24 mo (statistical measure NR, general linear model)** Meats: 0.070, p=0.384 **Body fat percentage @ 24 mo (statistical measure NR, general linear model)** Meats: 0.034, p=0.669	**Key confounders accounted for:** sex; baseline anthropometry (growth increments only) **Key confounders NOT accounted for:** SEP; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry (WAZ, HAZ, BMIZ, body fat mass, body fat percentage) **Model adjustments:** sex (body fat mass, % body fat mass); None (all other outcomes) **Funding:** National Key Research and Development Program of China; National Natural Science Foundation of China; Chongqing Joint Program of Science and Health; Key Disciplines of Medical and Health Research of Yuhang District of Hangzhou City

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Mahoney, 2018[27] PCS, Born in Bradford 1000, U.K. Analytic N = 12 mo: 722; 18 mo: 779 (Excluded participants with multiple births, missing child dietary data or outcome data, and not of White British or Pakistani ethnicity) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: Pakistani: 56%, White British: 44% Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: NR Child sex (female): NR Birth weight: 3,234.15 (521.97) g Gestational age: NR	**Exposure(s) and comparator(s):** Processed meat products (≤ vs > Median frequency) **Dietary assessment methods:** FFQ completed by parents **Age(s) at dietary assessment:** 12, 18 mo **Amounts consumed:** Frequency at 12, 18 mo, respectively (Median, IQR): Processed meat products: 0.5 (0.0, 2.0) x/wk, 7.0 (0.0, 21.0) x/wk **Outcome(s):** BMIZ **Outcome assessment methods:** Height, weight measured by trained researchers. Age- and sex-adjusted BMI calculated based on WHO 2006 standards. **Age(s) at outcome assessment:** 36 mo	**BMIZ @ 36 mo (β (95% CI))** Intake @ 12 mo: > vs ≤ 0.5/wk: 0.01 (-0.16, 0.19), p=0.88 Intake @ 18 mo: > vs ≤ 7.0/wk: 0.00 (-0.19, 0.18), p=0.97	**Key confounders accounted for:** Sex; race and/or ethnicity; baseline anthropometry **Key confounders NOT accounted for:** SEP; milk feeding practices; gestational age **Model adjustments:** Ethnicity, sex, birth weight, other key indicator food groups (formula milk; commercial savoury baby foods; commercial sweet baby foods; chips, roast and potato shapes; processed meat products; vegetables; fruit; cakes, biscuits, chocolate and sweets; crisps and savoury snacks; sugar-sweetened drinks; pure fruit juice; low-sugar drinks; water) **Funding:** NIHR

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Morgan, 2004[44] PCS, U.K. Analytic N = 134 (Reasons for exclusion NR) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: White: 97%, Caribbean, Indian, Chinese: 3% Maternal education: NR Other SEP measure(s): Social classification: Higher occupations: 39.9%, Intermediate: 36.4%, Lower: 11.1%, Never worked/long-term unemployed: 6.1% Maternal age: 31-40 y: 64% Milk feeding practices: BF at birth: 83%, BF at 4 mo: 37%, BF at 6 mo: 2% Child sex (female): 47% Birth weight: 100% >2500 g Gestational age: 100% full-term	**Exposure(s) and comparator(s):** Total red and white meat intake (g) (sum of each 7-d food diary; continuous): 4-12 mo, 4-16 mo, 4-24 mo **Dietary assessment methods:** 7-d weighed food diaries **Age(s) at dietary assessment:** 4, 8, 12, 16, 20, and 24 mo **Amounts consumed:** 4-12 mo (median (25th percentile, 75th percentile)): BF<6 wk or FF: 283 (183, 453) g/21 d period, BF≥6 wk: 265 (174, 370) g/21 d period; 4-16 mo: NR; 4-24 mo (median (25th percentile, 75th percentile)): 278 (178–425) g/42 d (~7 g/d) **Outcome(s):** Weight, length, HC **Outcome assessment methods:** Weight, length, and head circumference measured by study personnel **Age(s) at outcome assessment:** 4, 8, 12, 16, 20 and 24 mo	**Weight @ 12, 16, 24 mo** @12 mo: Meat intake 4-12 mo: Data NR, p=NS @ 16 mo: Meat intake 4-16 mo: Data NR, p=NS @ 24 mo: Meat intake 4-24 mo: Data NR, p=NS **Length @ 12, 16, 24 mo** @ 12 mo: Meat intake 4-12 mo: Data NR, p=NS @ 16 mo: Meat intake 4-16 mo: Data NR, p=NS @ 24 mo: Meat intake 4-24 mo: Data NR, p=NS **HC @ 12, 16, 24 mo** @ 12 mo: Meat intake 4-12 mo: Data NR, p=NS @ 16 mo: Meat intake 4-16 mo: Data NR, p=NS @ 24 mo: Meat intake 4-24 mo: Data NR, p=NS	**Key confounders accounted for:** milk feeding practices **Key confounders NOT accounted for:** SEP; sex; race and/or ethnicity; gestational age; baseline anthropometry **Model adjustments:** BF, energy intake, protein intake, birth weight **Funding:** University of Surrey, Royal Surrey County Hospital NHS Trust, the Medical Research Council, the Meat and Livestock Commission

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Smith-Brown, 2018[45] PCS, Feeding Queensland Babies Study Cohort, Australia Analytic N = 25 (Reasons for exclusion NR) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: NR Child sex (female): 44% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Meat, fish, and egg (continuous; daily feedings); Animal protein foods (meat, fish, egg, and dairy; continuous; daily feedings) **Dietary assessment methods:** 18-item FFQ **Age(s) at dietary assessment:** 12 mo **Amounts consumed:** Meat, fish, and egg at 12 mo: 1.36 (0.64) daily feedings (Range: 0.00-2.43)*; Animal protein foods at 12 mo: 1.36 (0.64) daily feedings (Range: 0.00-2.43)* *Possible reporting error **Outcome(s):** FMI, FFMI, WHR, BMIZ **Outcome assessment methods:** Weight, height, and WC were measured by study personnel. Fat mass and fat free mass were measured using total body water (deuterium oxide dilution technique) converted to age- and sex-specific hydration constants. FMI and FFMI calculated by dividing fat-free/fat mass by square of height. BMIZ calculated using WHO reference data. WHR, FFMI, and FMI z-scores calculated using values calculated from NHANES. **Age(s) at outcome assessment:** 2-3 y (Mean: 2.65 y)	**BMIZ @ 2-3 y (Pearson's correlation)** Animal protein food (dairy and meat, fish, and egg): r=0.35, p=0.061 Meat, fish, and egg: r=0.39, p=0.086 **FMI Z-score @ 2-3 y (Pearson's correlation)** Animal protein food (dairy and meat, fish, and egg): r=-0.221, p=0.061 Meat, fish, and egg: r=-0.084, p=0.689 **FFMI Z-score @ 2-3 y (Pearson's correlation)** **Animal protein food (dairy and meat, fish, and egg): r=0.58, p=0.008** **Meat, fish, and egg: r=0.53, p=0.021** **WHR Z-score @ 2-3 y (Pearson's correlation)** Animal protein food (dairy and meat, fish, and egg): r=0.37, p=0.061 **Meat, fish, and egg: r=0.55, p=0.021**	**Key confounders accounted for:** None **Key confounders NOT accounted for**: SEP; sex; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry **Model adjustments:** None **Funding:** Australian government, Danone Nutricia

[a] Abbreviations: @: at; ABIS: All Children in South-East Sweden; AGA: appropriate for gestational age; ALA: alpha-linolenic acid; β: beta; BF: breastfeeding; BMI: body mass index; BMIZ: BMI z-score; CAPS: Childhood Asthma Prevention Study; CDC: Centers for Disease Control and Prevention; CI: confidence interval; cm: centimeter; d: day; EBF: exclusive breastfeeding; Fe: iron; FF: formula feeding; FFMI: fat-free mass index; FFQ: food-frequency questionnaire; FMI: fat mass index; g: gram; HAZ: height-for-age z-score; HC: head circumference; HCZ: head circumference z-score; kg: kilogram; LAZ: length-for-age z-score; LoTiS: Longitudinal Twin Study; mm: millimeter; mo: month; NHANES: National Health and Nutrition Examination Survey; NR: not reported; NS: non-significant; OR: odds ratio; PCS: prospective cohort study; PR: prevalence ratio; RCT: randomized controlled trial; RR: risk ratio; SD: standard deviation; SEP: socioeconomic position; SGA: small for gestational age; U.K: United Kingdom; U.S.: United States; vs: versus; WAZ: weight-for-age z-score; WC: waist circumference; WHO: World Health Organization; WHR: waist to height ratio; wk: week; WLZ: weight-for-length z-score; x: times; y: year; Zn: zinc

Table 45. Risk of bias for randomized controlled trials (parallel) examining consumption of protein foods and growth, body composition, and risk of obesity[a]

Article	Randomization	Deviations from intended interventions (effect of assignment or per-protocol)	Missing outcome data	Outcome measurement	Selection of the reported result	Overall risk of bias
Krebs, 2006[35]	SOME CONCERNS	LOW	SOME CONCERNS	LOW	SOME CONCERNS	SOME CONCERNS
Tang, 2018[47]	SOME CONCERNS	LOW	LOW	LOW	LOW	SOME CONCERNS
Tang, 2019[46]	SOME CONCERNS	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS

Table 46. Risk of bias for randomized controlled trials (cluster) examining consumption of protein foods and growth, body composition, and risk of obesity[b]

Article	Randomization	Timing of identification and recruitment of individual participants in relation to timing of randomization	Deviations from the intended interventions (effect of assignment/ adhering to intervention)	Missing outcome data	Outcome measurement	Selection of the reported result	Overall risk of bias
Ma, 2016[39]	HIGH	SOME CONCERNS	LOW	LOW	LOW	SOME CONCERNS	HIGH
Tang, 2014[41]	HIGH	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH

[a] Possible ratings of low, some concerns, or high determined using the "Cochrane Risk-of-bias 2.0" (RoB 2.0) (August 2019 version)" (Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng H-Y, Corbett MS, Eldridge SM, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, McAleenan A, Reeves BC, Shepperd S, Shrier I, Stewart LA, Tilling K, White IR, Whiting PF, Higgins JPT. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019; **366**: l4898.

[b] Possible ratings of low, some concerns, or high determined using the "Cochrane Risk-of-bias 2.0" (RoB 2.0) (August 2019 version)" (Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng H-Y, Corbett MS, Eldridge SM, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, McAleenan A, Reeves BC, Shepperd S, Shrier I, Stewart LA, Tilling K, White IR, Whiting PF, Higgins JPT. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019; **366**: l4898.

Table 47. Risk of bias for observational studies examining consumption of protein foods and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Amaro-Rivera, 2019	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Duchen, 2019	HIGH	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Garden, 2011	SOME CONCERNS	LOW	LOW	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Garden, 2012	SOME CONCERNS	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Jin, 2021 (BMIZ, HAZ, WAZ, growth increments)	VERY HIGH	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH	VERY HIGH
Jin, 2021 (body fat mass, % fat mass)	HIGH	SOME CONCERNS	LOW	LOW	LOW	LOW	HIGH	HIGH
Mahoney, 2018	HIGH	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Morgan, 2004	HIGH	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Smith-Brown, 2018	VERY HIGH	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	VERY HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Dairy and fortified soy alternatives

Description of the evidence

Eleven studies (14 articles) met inclusion criteria and examined the relationship between the consumption of dairy by infants and young children, up to age 24 months, and growth, body composition, and risk of obesity (**Table 49**).[14,29,30,45-55]Three studies (4 articles) were parallel RCTs[46,47,52,54] and 1 study (2 articles) was a non-randomized controlled trial (NRCT).[48,49] Seven studies (8 articles) were PCS,[14,29,30,45,50,51,53,55] using data from the following cohorts: the Bogalusa Heart Study,[14] CAPS,[29,30] the National Health Information Database,[50] the Feeding Queensland Babies Study,[45] the Child in Focus substudy of the Avon Longitudinal Study of Parents and Children,[51] and 2 unnamed studies[53,55] Two studies were secondary analyses of RCTs, 1 that tested the impact of dust mite avoidance and omega-3 fatty acid supplementation on asthma prevention[29,30] and 1 that assessed the effect of different ages of introduction to solid food on growth and body composition.[55]

Population

The studies were conducted in a variety of countries including Australia,[29,30,45,54] Canada,[48,49] Denmark,[52] Iceland,[53] Korea,[50] New Zealand,[54] the United Kingdom,[51] and the United States.[14,46,47,55] The analytic sample sizes primarily ranged from 25[45] to 948 participants;[51] however, 1 study based on data from a national health insurance service included 142,668 participants.[50] All 3 RCTs reported being sufficiently powered to address an outcome related to growth, body composition, or risk of obesity,[46,47,52,54] while the NRCT and PCS did not provide information related to statistical power.

Race and/or ethnicity was reported by approximately half of the studies. Across the 5 studies that did report this information, all reported that between 55% and 94% of participants were White, Caucasian, and/or were of European ancestry.[14,29,30,46,47,54,55] Individuals of other races and/or ethnicities, such as individuals who were Black,[14,46,47] Middle Eastern,[29,30] Indian,[29,30] Asian and/or Pacific Islander,[29,30,46,47,54] and Hispanic,[46,47] were represented across the studies but at much lower proportions. Average maternal age ranged from approximately age 27 to 31 years in the 4 studies that reported this information.[29,46,47,49,53] One RCT was conducted with infants who were exclusively formula-fed at age 5 months,[46,47] while the remaining studies with information on human milk and infant formula feeding reported a range of practices[14,29,30,48-53] Regarding any breastfeeding, 1 study reported that the average duration was 8 months,[53] while a second study noted that 42% of infants were breastfed for at least 6 months.[30] Regarding exclusive breastfeeding, 1 study reported an average duration of 4 months,[53] while a second study noted that 46% of participants were exclusively breastfed at age 4 to 6 months.[50] Additionally, among some studies that examined cow's milk as an exposure during infancy, those consuming cow's milk were not consuming human milk.[14,48,49,51] The most commonly reported measure of SEP was maternal education; the level of education attained varied across these studies,[29,49,51,53-55] ranging from an average of approximately 5 years postprimary school[49] to approximately 74% of participants with a tertiary education.[54]

Regarding the infants and young children, approximately 50% of the participants were female in individual studies and the average birth weight ranged from approximately 3.2 kilograms to 3.7 kilograms.[30,46,47,50-54] Some studies did not report average birth weight, but indicated that all participants weighed at least 2.5 kilograms at birth[29,48,49] or were not born small for gestational age (SGA).[55] Most or all infants included in individual studies were born at term.[29,46-55] One study found that baseline weight varied slightly between exposure groups,[14] however, the remaining studies did not detect differences in baseline anthropometry between study groups,[47-49,52,55] did not report testing for differences by intervention or exposure group,[30,51] or did not report this information.[45,50,54]

Interventions/exposures and comparators

The studies that examined dairy primarily focused on cow's milk,[14,29,30,48-55] although some studies examined dairy products more broadly[29,30,45-47] or examined alternatives to cow's milk (i.e., soy and goat milk).[50] The most common comparators were differing amounts or frequencies of dairy consumption,[14,29,30,48-54] with infants and young children in the control or comparison groups often continuing to consume human milk or infant formula due to the age that the interventions occurred or the exposures that were assessed. Two RCTs compared dairy consumption to different foods or products: 1 compared dairy-based complementary foods to meat-based complementary foods,[46,47] while 1 compared cow's milk to "toddler milk".[54] Finally, 1 PCS compared consumption of 2% milk to whole milk.[55] Among the PCS, most studies examined the exposures and comparators categorically, however 3 studies modeled dairy consumption continuously.[29,30,45,53] Most of the studies examined consumption of dairy up to age 12 months,[14,46-53], while 4 studies examined consumption of dairy from age 12 months up to age 24 months.[29,30,45,54,55]

Outcomes

Growth, body composition, and risk of obesity were assessed using a variety of outcomes. Outcomes related to growth were examined in all studies, with the most common measures including weight, length, WAZ, LAZ, WLZ, and BMIZ. Five studies examined body composition.[14,30,45,54,55] Studies that reported z-scores, standard deviation scores (SDS), or percentiles primarily calculated these based on growth standards from the WHO[45-50,54] or CDC,[29,46-49,55] although 1 used reference data from the National Health and Nutrition Examination Survey (NHANES)[45] and another used reference data from the United Kingdom.[51] The outcomes were all measured by study personnel or medical staff. The age of the participants at outcome assessment ranged from age 3 months[49] to age 11.5 years,[29] with 7 studies measuring outcomes up to age 24 months,[14,46-49,51,52,54,55] 4 studies measuring outcomes from age 2 to 10 years,[30,45,51,53] and 2 studies examining growth trajectory or timing of adiposity rebound based on multiple measurements conducted up to age 6[50] or 11.5 years.[29]

Synthesis of the evidence

Of the 11 studies that examined dairy consumption and outcomes related to growth, body composition, and risk of obesity, 8 reported mixed results,[29,30,45-51,53,54] while 3 did not detect any statistically significant differences in outcomes by dairy consumption[14,52] (**Table 49**).

One RCT,[52] 1 NRCT,[48,49] and 6 PCS[14,29,30,45,50,51,53] examined differing amounts or frequencies of dairy consumption. First, the RCT did not detect an effect of whole cow's milk consumption at age 9 months on either weight, length, or change in weight or length.[52] Next, the NRCT, which examined infants consuming evaporated cow's milk from early in infancy, found that weight gain velocity, change in WAZ, and head circumference growth velocity were greater from age 3 to 6 months, in addition to higher WAZ at age 18 months, compared to infants who continued to consume either human milk or infant formula; differences across other outcomes including WLZ/WHZ and LAZ were not detected.[48,49] The PCS examined a wide range of exposures, comparators, and outcomes, and both the direction and statistical significance of findings varied.[14,29,30,45,50,51,53] First, 3 studies detected direct associations between cow's milk consumption between ages 8 to 12 months and measures including weight SDS,[51] height SDS,[51] BMI SDS,[51] BMI,[53] and odds of early adiposity rebound.[50] Three additional studies examined cow's milk consumption but did not detect any associations with a variety of outcomes including weight,[14] length,[14] BMI,[30] BMI trajectory,[29] waist circumference,[30] and skinfold thickness.[14] The differences in these outcomes by cow's milk consumption were minimal and of variable direction.[14,29,30] Despite all 6 studies having examined cow's milk, there was still variability across comparators, with 2 comparing any to no consumption[14,50] and 3 examining different amounts consumed.[29,30,51,53] Further variability was observed in regard to the ages at which the exposures were measured, spanning from age 6 months through age 18 months. Few studies examined exposures other than cow's milk, and the results were varied. Specifically, 1 study reported that dairy foods consumption at age 18 months was associated with lower BMI, but not waist circumference or BMI trajectory, during childhood,[29,30] a second study reported that more frequent dairy consumption at age 12 months was positively correlated with fat-free mass index z-score at age 2 to 3 years, while correlations with other measures of body composition or growth were in a consistent direction, but weaker, and did not reach statistical significance,[45] and a third study found that soy milk, but not goat's milk, consumption at age 12 months was associated with greater odds of early adiposity rebound than infants continuing to consume human milk.[50]

Fewer studies compared consumption of dairy to another food or another type of dairy. Two RCTs found that infants randomized to consume dairy versus another product tended to show smaller increases or lower achieved length and LAZ during the intervention, but predominantly did not vary across a range of other measures related to growth such as BMIZ,[54] WLZ,[54] weight,[46,47,54] WAZ,[46,47,54] or head circumference.[47] However, these studies varied considerably across a range of factors including the exposure (cow's milk[54] versus dairy-based complementary foods more broadly),[46,47] the comparator ("toddler milk"[54] versus meat),[46,47] age at intervention (age 12 months[54] versus age 5 months),[46,47] and the time-point at which group differences were detected (mid-intervention[54] versus end of intervention),[46,47] limiting the comparability of these 2 trials. The RCT which compared consumption of cow's milk to toddler milk also assessed body composition, reporting that infants consuming cow's milk had higher body fat percentage, fat mass, and fat mass index by the end of the intervention, but did not differ in regard to fat-free mass, waist circumference or waist-to-height ratio.[54] A final PCS compared consumption of cow's milk with differing fat levels (2% versus whole), reporting no association between the fat level of cow's milk consumed from age 12 months up to age 24 months and a variety of outcomes including length, LAZ, weight, WAZ, percent body fat, and fat mass during this time period.[55]

Although 11 studies assessed the relationship between dairy consumption and outcomes related to growth, body composition, and risk of obesity, the ability to draw conclusions from this body of evidence were limited by marked heterogeneity across the interventions and exposures, comparators, and outcomes as highlighted above. First, the age at which interventions were conducted or the exposures were measured varied greatly from birth up to age 24 months. For instance, while some studies examined dairy consumption, particularly cow's milk, early in infancy, others examined dairy consumption at the upper range of this age group. Next, as previously noted, the comparators also varied widely across the studies: some compared dairy or cow's milk consumption to consumption of different products such as meat or "toddler milk", 1 study compared cow's milks with different fat contents, and the remaining studies compared differing amounts of cow's milk or dairy, including some with no consumption. For several of these studies, particularly those in which cow's milk was examined during infancy, the comparison groups that had lower or no consumption of cow's milk were continuing to consume either human milk or infant formula, further adding to the heterogeneity across studies Finally, the studies varied in the outcomes examined and the ages at which they were measured, ranging from age 6 months to age 11.5 years.

Conclusion statement and grade

The Committee did not draw a conclusion statement about the relationship between consumption of dairy by infants and young children, up to 24 months, and growth, body composition, and risk of obesity (**Table 48**). This was due to substantial concerns with consistency in the body of evidence. First, the age at which the interventions were conducted, or the exposures were measured, varied greatly from birth up to age 24 months. Next, the comparators also varied widely across the studies, inclusive of different foods, different fat contents, and different frequencies or amounts. Finally, the studies varied widely in the outcomes examined and the ages at which they were measured. Publication bias was also a consideration; however, this was not assessed as a serious concern because the body of evidence included studies that reported only nonsignificant findings as well as studies that reported a mix of both significant and nonsignificant results, across a range of analytic sample sizes. However, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias. The risk of bias of the parallel RCTs, NRCT, and PCS are presented in **Table 50**, **Table 51**, and **Table 52**, respectively.

Table 48. Conclusion statement, grade for dairy consumption by infants and young children and growth, body composition, and risk of obesity

Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between dairy consumption by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency in the body of evidence.**
Grade	Grade Not Assignable
Body of Evidence	14 articles (11 studies): 3 randomized controlled trials (4 articles), 1 non-randomized controlled trial (2 articles), 7 prospective cohort studies (8 articles)
Rationale	The studies varied in the ages at intervention/exposure assessment, comparator, and the outcomes examined.

Table 49. Evidence examining the relationship between dairy consumption and growth, body composition, and risk of obesity[a]

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
RCT-Parallel			
Larnkjaer, 2009[52] RCT-Parallel, Denmark Analytic N by group: Whole milk: n=38, Infant formula: n=45 Attrition: Whole milk: 17%, Infant formula: 6% (Excluded participants who did not complete the study) Adequately powered: Yes **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: Duration of full BF: ~4.2 mo; Any BF at 9-12 mo: whole milk: 57%, infant formula: 29%, p≤0.005 Child sex (female): 51% Birth weight: ~3,664 g Gestational age: 100% ≥37 wk Other relevant characteristics: RCT used 2x2 factorial design (also examined fish oil supplementation)	**Intervention(s):** Whole milk: whole milk as primary milk source; those still breastfed continued to do so **Comparator(s):** Infant formula: formula as the primary milk source; those still breastfed continued to do so **Dietary assessment methods:** 7-d dietary record completed by parents **Compliance:** Whole milk and whole milk products (g/d) at 12 mo: Whole milk group: 444 (200), Infant formula group: 97 (79), p<0.001; Infant formula (g/d) at 12 mo: Whole milk group: 17 (75), Infant formula group: 293 (151), p<0.001 **Age at intervention:** 9 mo **Intervention duration:** 3 mo **Outcome(s):** Weight, weight change, length, length change **Outcome assessment methods:** Measured by research staff. **Age(s) at outcome assessment:** 9, 12 mo	Whole milk vs Infant formula: **Weight (g) @ 12 mo (Mean (SD))** 9,823 (900) vs 10,021 (821), p=NS **Weight change (g/mo) from 9 to 12 mo (Mean (SD))** 257 (103) vs 242 (111), p=NS **Length (cm) @ 12 mo (Mean (SD))** 75.8 (2.2) vs 76.4 (2.2), p=NS **Length change (cm/mo) from 9 to 12 mo (Mean (SD))** 1.24 (0.28) vs 1.25 (0.34), p=NS	**Model adjustments:** Fish oil supplementation group, sex, baseline anthropometric value at 9 mo **Funding:** Danish Research and Development Programme for Food and Technology

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Tang, 2018[47] RCT-Parallel, U.S. Analytic N by group: Meat: n=32, Dairy: n=32 Attrition: Meat: 8.6%, Dairy: 11.1% (Excluded participants who moved, were not compliant, switched formula, or lost contact) Adequately powered: Yes **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: White: ~75%, Hispanic: ~17.5%, Black: ~4.5%, Asian: ~3% Maternal education: NR Other SEP measure(s): NR Maternal age: ~30 y Milk feeding practices: 100% exclusively formula-fed infants Child sex (female): ~53.5% Birth weight: ~3.3 kg Gestational age: ~39 wk	**Intervention(s):** Meat-based complementary foods (pureed beef, ham) from 5 mo to 12 mo of age in addition to infant formula (same formula given to both groups). (Total protein intake, including formula, ~3g/kg/d.) Fruit and vegetable intake not restricted. **Comparator(s):** Dairy-based complementary foods (infant yogurt, cheese, powdered concentrate of 80% whey protein) from 5 mo to 12 mo of age in addition to infant formula (same formula given to both groups). (Total protein intake, including formula, ~3g/kg/d.) Fruit and vegetable intake not restricted. **Dietary assessment methods:** Parental report via calendars to record daily consumption, 3-d diet records completed monthly. Return of unused foods, if any. **Compliance:** Intervention: Protein from meat-based complementary foods at 10 mo - 2.1 g/kg/d, Protein from dairy-based complementary foods at 10 mo - 0.03 g/kg/d; Comparator: Protein from meat-based complementary foods at 10 mo - 0.01 g/kg/d, Protein from dairy-based complementary foods at 10 mo - 2.0 g/kg/d **Age at intervention:** 5-12 mo **Intervention duration:** 7 mo **Outcome(s):** Weight, WAZ, Length, LAZ, WLZ, HC, HC Z-score **Outcome assessment methods:** Length, weight, and head circumference measured by blinded, trained research personnel. Z-scores calculated using WHO/CDC growth standards. **Age(s) at outcome assessment:** 5, 7, 8, 9, 10, 11, and 12 mo	**Weight (kg) @ 5 mo - 12 mo (Mean (SD))** Group x time interaction: p=0.81 5 mo: 7.37 (0.67) vs 7.35 (0.74), p=NS 7 mo: 8.17 (0.70) vs 8.10 (0.77), p=NR 8 mo: 8.63 (0.78) vs 8.49 (0.74), p=NR 9 mo: 8.90 (0.75) vs 8.91 (0.75), p=NR 10 mo: 9.28 (0.78) vs 9.23 (0.78), p=NR 11 mo: 9.61 (0.81) vs 9.51 (0.79), p=NR 12 mo: 9.92 (0.91) vs 9.92 (0.97), p=NR **Length (cm) @ 5 mo - 12 mo (Mean (SD))** **Group x time interaction: p=0.0002** 5 mo: 65.3 (2.2) vs 65.3 (2.5), p=NS 7 mo: 68.1 (2.7) vs 67.3 (2.2), p=NR 8 mo: 69.5 (2.4) vs 68.5 (2.3), p=NR 9 mo: 71.0 (2.3) vs 69.9 (2.5), p=NR 10 mo: 72.5 (2.6) vs 71.2 (2.4), p=NR 11 mo: 73.8 (2.6) vs 72.3 (2.3), p=NR 12 mo: 75.7 (2.6) vs 73.9 (2.2), p=NR **Head circumference (cm) @ 5 mo - 12 mo (Mean (SD))** Group x time interaction: p=0.55 5 mo: 43.0 (1.2) vs 43.1 (1.1), p=NS 12 mo: 46.4 (1.3) vs 46.3 (1.1), p=NR **Head circumference (z-score) @ 5 mo - 12 mo (Mean (SD))** Group x time interaction: p=0.41 5 mo: 0.51 (0.82) vs 0.54 (0.77), p=NS 7 mo: 0.36 (1.02) vs 0.43 (0.80), p=NR 8 mo: 0.45 (0.76) vs 0.47 (0.95), p=NR 9 mo: 0.36 (0.93) vs 0.40 (0.90), p=NR 10 mo: 0.48 (0.86) vs 0.50 (0.90), p=NR 11 mo: 0.38 (0.91) vs 0.34 (0.76), p=NR 12 mo: 0.55 (0.81) vs 0.49 (0.79), p=NR	**Model adjustments:** NA (participants matched by sex and race/ethnicity) **Funding:** NIH (NIDDK); NIH/National Center for Advancing Translational Sciences Colorado Clinical and Translational Science Awards; Abbott Nutrition; American Heart Association; the Beef Checkoff (National Cattlemen's Beef Association); Leprino Foods; National Pork Board.

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Tang, 2018[47] (Continued) RCT-Parallel, U.S. Analytic N by group: Meat: n=32, Dairy: n=32 Attrition: Meat: 8.6%, Dairy: 11.1% (Excluded participants who moved, were not compliant, switched formula, or lost contact) Adequately powered: Yes **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: White: ~75%, Hispanic: ~17.5%, Black: ~4.5%, Asian: ~3% Maternal education: NR Other SEP measure(s): NR Maternal age: ~30 y Milk feeding practices: 100% exclusively formula-fed infants Child sex (female): ~53.5% Birth weight: ~3.3 kg Gestational age: ~39 wk	**Intervention(s):** Meat-based complementary foods (pureed beef, ham) from 5 mo to 12 mo of age in addition to infant formula (same formula given to both groups). (Total protein intake, including formula, ~3g/kg/d.) Fruit and vegetable intake not restricted. **Comparator(s):** Dairy-based complementary foods (infant yogurt, cheese, powdered concentrate of 80% whey protein) from 5 mo to 12 mo of age in addition to infant formula (same formula given to both groups). (Total protein intake, including formula, ~3g/kg/d.) Fruit and vegetable intake not restricted. **Dietary assessment methods:** Parental report via calendars to record daily consumption, 3-d diet records completed monthly. Return of unused foods, if any. **Compliance:** Intervention: Protein from meat-based complementary foods at 10 mo - 2.1 g/kg/d, Protein from dairy-based complementary foods at 10 mo - 0.03 g/kg/d; Comparator: Protein from meat-based complementary foods at 10 mo - 0.01 g/kg/d, Protein from dairy-based complementary foods at 10 mo - 2.0 g/kg/d **Age at intervention:** 5-12 mo **Intervention duration:** 7 mo **Outcome(s):** Weight, WAZ, Length, LAZ, WLZ, HC, HC Z-score **Outcome assessment methods:** Length, weight, and head circumference measured by blinded, trained research personnel. Z-scores calculated using WHO/CDC growth standards. **Age(s) at outcome assessment:** 5, 7, 8, 9, 10, 11, and 12 mo	**WAZ @ 5 mo - 12 mo (Mean (SD))** Group x time interaction: p=0.49 5 mo: -0.03 (0.69) vs -0.14 (0.82), p=NS 7 mo: 0.13 (0.64) vs 0.10 (0.72), p=NS 8 mo: 0.26 (0.71) vs 0.13 (0.72), p=NS 9 mo: 0.28 (0.69) vs 0.26 (0.70), p=NS 10 mo: 0.35 (0.66) vs 0.30 (0.71), p=NS 11 mo: 0.43 (0.66) vs 0.33 (0.69), p=NS 12 mo: 0.40 (0.74) vs 0.39 (0.78), p=NS **LAZ @ 5 mo - 12 mo (Mean (SD))** **Group x time interaction: p=0.00001** 5 mo: -0.19 (0.86) vs -0.30 (1.02), p=NS 7 mo: -0.14 (1.02) vs -0.44 (0.98), p=NS 8 mo: -0.19 (0.88) vs -0.58 (1.00), p=NS **9 mo: -0.12 (0.86) vs -0.62 (1.10), p<0.05** **10 mo: -0.07 (0.91) vs -0.62 (1.02), p<0.05** **11 mo: -0.05 (0.91) vs -0.69 (1.01), p<0.05** **12 mo: 0.14 (0.90) vs -0.60 (0.91), p=0.001** **WLZ @ 5 mo - 12 mo (Mean (SD))** **Group x time interaction: p=0.015** 5 mo: 0.18 (0.73) vs 0.16 (0.88), p=NS 7 mo: 0.40 (0.79) vs 0.55 (0.95), p=NS 8 mo: 0.57 (0.84) vs 0.68 (0.94), p=NS 9 mo: 0.51 (0.78) vs 0.82 (0.96), p=NS 10 mo: 0.53 (0.80) vs 0.84 (0.98), p=NS **11 mo: 0.63 (0.68) vs 0.88 (0.88), p=0.03** **12 mo: 0.48 (0.75) vs 0.92 (0.88), p=0.03**	**Model adjustments:** NA (participants matched by sex and race/ethnicity) **Funding:** NIH (NIDDK); NIH/National Center for Advancing Translational Sciences Colorado Clinical and Translational Science Awards; Abbott Nutrition; American Heart Association; the Beef Checkoff (National Cattlemen's Beef Association); Leprino Foods; National Pork Board.

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Tang, 2019[46] RCT-Parallel, U.S. Analytic N by group: Meat: n=27, Dairy: n=26 Attrition: Meat: 23%; Dairy: 28% (Excluded participants who moved, were not compliant, switched formula, or lost contact) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: ~30 y Milk feeding practices: 100% exclusively formula-fed infants Child sex (female): ~53% Birth weight: ~3.3 kg Gestational age: ~39 wk	**Intervention(s):** Meat-based complementary foods (pureed meats) from 5 mo to 12 mo of age in addition to infant formula (same formula given to both groups). (Total protein intake, including formula, ~3g/kg/d.) Fruit and vegetable intake not restricted. **Comparator(s):** Dairy-based complementary foods (infant yogurt, cheese, powdered concentrate of 80% whey protein) from 5 mo to 12 mo of age in addition to infant formula (same formula given to both groups). (Total protein intake, including formula, ~3g/kg/d.) Fruit and vegetable intake not restricted. **Dietary assessment methods:** Parental report via calendars to record daily consumption, 3-d diet records completed monthly. Return of unused foods, if any. **Compliance:** >90% of protein from solid foods was from the assigned protein group (meat or dairy); <5% was from the alternative **Age at intervention:** 5-12 mo **Intervention duration:** 7 mo **Outcome(s):** Weight, Length, WAZ, LAZ, WLZ **Outcome assessment methods:** Length and weight measured by blinded, trained research personnel. **Age(s) at outcome assessment:** 24 mo	**Weight (kg) @ 24 mo (Mean (SD))** Meat vs Dairy: 12.6 (1.0) vs 12.4 (1.5), p=0.38 **Length (cm) @ 24 mo (Mean (SD))** **Meat vs Dairy: 89.0 (2.3) vs 87.1 (3.3), p=0.02** **WAZ @ 24 mo (Mean (SD))** Data NR, p=0.65 **LAZ @ 24 mo (Mean (SD))** **Meat vs Dairy: 0.19 (0.62) vs -0.37 (0.88), p=0.01** **WLZ @ 24 mo (Mean (SD))** Data NR, p=0.40	**Model adjustments:** NA (participants matched by sex and race/ethnicity) **Funding:** NIH (NIDDK); NIH/National Center for Advancing Translational Sciences Colorado Clinical and Translational Science Awards; Abbott Nutrition; American Heart Association; the Beef Checkoff (National Cattlemen's Beef Association); Leprino Foods; National Pork Board

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Wall, 2019[54] RCT-Parallel, GUMLi Study, Australia, New Zealand Analytic N by group: GUMLi: n=67, Cow's Milk: n=67 Attrition: GUMLi: 16%, Cow's Milk: 16% (Excluded participants who were unable to be contacted, discontinued treatment, or had missing outcome data) Adequately powered: Yes **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: European: 67%, Other: 17%, Maori: 9%, Asian: 5%, Pacific: 2% Maternal education: Mother's highest level of education - tertiary: 74% Other SEP measure(s): Mother worked before birth: 97%; Current employment status of mother: Full-time caregiver: 28%, Full-time paid employment: 25%, Part-time paid employment: 36%; Father's highest level of education - tertiary: 58%; Father currently employed full-time: 90%; Household income: <\$50k: 11%, \$50k-70k: 13%, \$70k-100k: 25%, \$100k-150k: 32%, >\$150k: 11% Maternal age: NR Milk feeding practices: NR Child sex (female): 47% Birth weight: ~3.5 kg Birth length: ~51 cm Birth BMIZ: ~-0.03 Gestational age: <37 wk: 6%, 37-39 wk: 41%, Full term: 54%	**Intervention(s):** Growing Up Milk - Lite (GUMLi): 300 ml/d, a toddler milk energy matched with cow's milk, but lower in protein (1.7 g) and total fat (1.9 g); fortified with iron, vitamin D, prebiotics, and probiotics **Comparator(s):** Cow's milk: 300 ml/d, energy matched with GUMLi but higher in protein (3.1 g) and total fat (3.1 g); unfortified **Dietary assessment methods:** Monthly questionnaire (telephone or face-to-face interview) completed by parents or guardians **Compliance:** Consumed 300 ml of study milk on 80% of days within monitored interval: GUMLi: 96%, Cow's milk: 97% **Age at intervention:** 12 mo **Intervention duration:** 12 mo **Outcome(s):** Weight, WAZ, length, LAZ, BMI, BMIZ, WLZ, WC, WHR, body fat %, fat free mass, fat mass, fat mass index **Outcome assessment methods:** Weight and length measured by study personnel. Body composition measured by bioelectrical impedance. Z-scores based on WHO growth standards **Age(s) at outcome assessment:** 18, 24 mo	GUMLi vs Cow's milk (ref) **Weight (kg) @ 18, 24 mo (mean difference (95% CI))** 18 mo: -0.15 (-0.37, 0.06), p=0.157 24 mo: -0.19 (-0.4, 0.03), p=0.089 **WAZ @ 18, 24 mo (mean difference (95% CI))** 18 mo: -0.13 (-0.27, 0.01), p=0.075 24 mo: -0.11 (-0.25, 0.03), p=0.124 **Length (cm) @ 18, 24 mo (mean difference (95% CI))** **18 mo: -0.69 (-1.25, -0.14), p=0.015** 24 mo: -0.4 (-0.96, 0.17), p=0.165 **LAZ @ 18, 24 mo (mean difference (95% CI))** **18 mo: -0.27 (-0.45, -0.08), p=0.005** 24 mo: -0.12 (-0.31, 0.06), p=0.191 **WLZ @ 18, 24 mo (mean difference (95% CI))** 18 mo: -0.04 (-0.23, 0.15), p=0.655 24 mo: -0.12 (-0.31, 0.08), p=0.233 **BMI @ 18, 24 mo (mean difference (95% CI))** 18 mo: -0.03 (-0.32, 0.27), p=0.861 24 mo: -0.14 (-0.44, 0.16), p=0.372 **BMIZ @ 18, 24 mo (mean difference (95% CI))** 18 mo: -0.01 (-0.22, 0.2), p=0.932 24 mo: -0.11 (-0.32, 0.1), p=0.304 **Body fat (%) @ 18, 24 mo (mean difference (95% CI))** 18 mo: -0.46 (-2.54, 1.61), p=0.660 **24 mo: -2.19 (-4.24, -0.15), p=0.036** 18 mo (Per-Protocol): -0.61 (-2.7, 1.47), p=0.562 **24 mo (Per-Protocol): -2.09 (-4.16, -0.03), p=0.047**	**Model adjustments:** Baseline outcome, study location, interaction between treatment and time period. **Funding:** Danone Pty. Ltd. (Danone Nutricia Research)

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Wall, 2019[54] (Continued) RCT-Parallel, GUMLi Study, Australia, New Zealand Analytic N by group: GUMLi: n=67, Cow's Milk: n=67 Attrition: GUMLi: 16%, Cow's Milk: 16% (Excluded participants who were unable to be contacted, discontinued treatment, or had missing outcome data) Adequately powered: Yes **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: European: 67%, Other: 17%, Maori: 9%, Asian: 5%, Pacific: 2% Maternal education: Mother's highest level of education - tertiary: 74% Other SEP measure(s): Mother worked before birth: 97%; Current employment status of mother: Full-time caregiver: 28%, Full-time paid employment: 25%, Part-time paid employment: 36%; Father's highest level of education - tertiary: 58%; Father currently employed full-time: 90%; Household income: <$50k: 11%, $50k-70k: 13%, $70k-100k: 25%, $100k-150k: 32%, >$150k: 11% Maternal age: NR Milk feeding practices: NR Child sex (female): 47% Birth weight: ~3.5 kg Birth length: ~51 cm Birth BMIZ: ~-0.03 Gestational age: <37 wk: 6%, 37-39 wk: 41%, Full term: 54%	**Intervention(s):** Growing Up Milk - Lite (GUMLi): 300 ml/d, a toddler milk energy matched with cow's milk, but lower in protein (1.7 g) and total fat (1.9 g); fortified with iron, vitamin D, prebiotics, and probiotics **Comparator(s):** Cow's milk: 300 ml/d, energy matched with GUMLi but higher in protein (3.1 g) and total fat (3.1 g); unfortified **Dietary assessment methods:** Monthly questionnaire (telephone or face-to-face interview) completed by parents or guardians **Compliance:** Consumed 300 ml of study milk on 80% of days within monitored interval: GUMLi: 96%, Cow's milk: 97% **Age at intervention:** 12 mo **Intervention duration:** 12 mo **Outcome(s):** Weight, WAZ, length, LAZ, BMI, BMIZ, WLZ, WC, WHR, body fat %, fat free mass, fat mass, fat mass index **Outcome assessment methods:** Weight and length measured by study personnel. Body composition measured by bioelectrical impedance. Z-scores based on WHO growth standards **Age(s) at outcome assessment:** 18, 24 mo	GUMLi vs Cow's milk (ref) **Fat-free mass (kg) @ 18, 24 mo (mean difference (95% CI))** 18 mo: -0.14 (-0.45, 0.17), p=0.364 24 mo: 0.05 (-0.26, 0.36), p=0.749 18 mo (Per-Protocol): -0.12 (-0.43, 0.19), p=0.448 24 mo (Per-Protocol): 0.04 (-0.27, 0.35), p=0.799 **Fat mass (kg) @ 18, 24 mo (mean difference (95% CI))** 18 mo: -0.13 (-0.41, 0.16), p=0.389 **24 mo: -0.39 (-0.67, -0.1), p=0.008** 18 mo (Per-Protocol): -0.14 (-0.43, 0.15), p=0.357 **24 mo (Per-Protocol): -0.38 (-0.67, -0.09), p=0.010** **Fat mass index @ 18, 24 mo (mean difference (95% CI))** 18 mo: -0.15 (-0.55, 0.25), p=0.454 **24 mo: -0.47 (-0.86, -0.08), p=0.020** 18 mo (Per-Protocol): -0.16 (-0.56, 0.24), p=0.422 **24 mo (Per-Protocol): -0.45 (-0.85, -0.06), p=0.026** **WC (cm) @ 18, 24 mo (mean difference (95% CI))** 18 mo: -0.24 (-1.09, 0.61), p=0.579 24 mo: -0.04 (-0.9, 0.82), p=0.935 **WHR @ 18, 24 mo (mean difference (95% CI))** 18 mo: -0.0006 (-0.01, 0.01), p=0.918 24 mo: 0.000 (-0.01, 0.01), p=0.991	**Model adjustments:** Baseline outcome, study location, interaction between treatment and time period. **Funding:** Danone Pty. Ltd. (Danone Nutricia Research)

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
NRCT			
Friel, 1997[49] NRCT, Canada Analytic N by group: EM: n=30, BF: n=29, FF: n=30 Attrition: EM: 14%, BF: 17%, FF: 14% (Excluded participants who switched feeding type during the first 3 mo or were lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: ~5 y postprimary school (EM with significantly lower education) Other SEP measure(s): Blishen score (socioeconomic scale): ~32 (EM with significantly lower social class) Maternal age: ~27 y (EM significantly younger) Milk feeding practices: NA Child sex (female): 42% Birth weight: 100% between 2,500-4,500 g Gestational age: 100% 38-42 wk	**Intervention(s):** Evaporated milk (EM): cow's milk (fat content not prescribed) evaporated to approximately half its original volume, and parents were instructed to prepare it as 1 part EM and 2 parts water, with sucrose or dextrose (2 tsp per 6 oz) added to achieve 68 kcal/100 ml **Comparator(s):** Human milk consumption; Infant formula consumption **Dietary assessment methods:** 3-d diet record; phone calls every 2 weeks **Compliance:** Those who switched feeding type were dropped from the study **Age at intervention:** 0-6 mo **Intervention duration:** 6 mo **Outcome(s):** Weight, length, HC, WAZ, LAZ, WLZ **Outcome assessment methods:** Weight, height, and HC measured by study personnel. Z-scores based on WHO/CDC data **Age(s) at outcome assessment:** 3 mo, 6 mo	EM vs BF vs FF **WLZ @ 3, 6 mo** EM vs BF vs FF: Data NR, p=NS **Weight (g) @ 3, 6 mo (Mean (SD))** 3 mo: 6,090 (736) vs 6,097 (686) vs 6,061 (642), p=NS 6 mo: 7,941 (1,166) vs 7,505 (870) vs 7,870 (921), p=NS **Weight gain velocity (g/d) from 0-3 and 3-6 mo (Mean (SD))** 0-3 mo: 28.1 (7.5) vs 28.3 (7.2) vs 27.6 (6.1), p=NS **3-6 mo: 20.2 (6.8) vs 15.5 (4.0) vs 20.4 (5.8), p<0.05 for EM vs BF** **WAZ @ 3, 6 mo** EM vs BF vs FF: Data NR, p=NS **Change in WAZ from 3 to 6 mo** **EM vs BF vs FF: 0.01 (0.56) vs -0.49 (0.37) vs 0.01 (0.53), p<0.05 for EM vs BF** **Length (cm) @ 3, 6 mo (Mean (SD))** 3 mo: 61.3 (2.1) vs 61.4 (1.7) vs 61.4 (2.3), p=NS 6 mo: 67.6 (2.1) vs 67.4 (2.1) vs 67.9 (2.5), p=NS **Length gain velocity (cm/d) from 0-3, 3-6 mo (Mean (SD))** 0-3 mo: 0.12 (0.02) vs 0.12 (0.01) vs 0.12 (0.01), p=NS 3-6 mo: 0.07 (0.01) vs 0.07 (0.01) vs 0.07 (0.01), p=NS **LAZ @ 3, 6 mo** EM vs BF vs FF: Data NR, p=NS	**Key confounders accounted for:** sex (z-scores only); milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** SEP; sex (all outcomes except z-scores); race and/or ethnicity **Model adjustments:** None **Funding:** Health Canada

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Friel, 1997[49] (Continued) NRCT, Canada Analytic N by group: EM: n=30, BF: n=29, FF: n=30 Attrition: EM: 14%, BF: 17%, FF: 14% (Excluded participants who switched feeding type during the first 3 mo or were lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: ~5 y postprimary school (EM with significantly lower education) Other SEP measure(s): Blishen score (socioeconomic scale): ~32 (EM with significantly lower social class) Maternal age: ~27 y (EM significantly younger) Milk feeding practices: NA Child sex (female): 42% Birth weight: 100% between 2,500-4,500 g Gestational age: 100% 38-42 wk	**Intervention(s):** Evaporated milk (EM): cow's milk (fat content not prescribed) evaporated to approximately half its original volume, and parents were instructed to prepare it as 1 part EM and 2 parts water, with sucrose or dextrose (2 tsp per 6 oz) added to achieve 68 kcal/100 ml **Comparator(s):** Human milk consumption; Infant formula consumption **Dietary assessment methods:** 3-d diet record; phone calls every 2 weeks **Compliance:** Those who switched feeding type were dropped from the study **Age at intervention:** 0-6 mo **Intervention duration:** 6 mo **Outcome(s):** Weight, length, HC, WAZ, LAZ, WLZ **Outcome assessment methods:** Weight, height, and HC measured by study personnel. Z-scores based on WHO/CDC data **Age(s) at outcome assessment:** 3 mo, 6 mo	EM vs BF vs FF **LAZ @ 3, 6 mo** EM vs BF vs FF: Data NR, p=NS **HC (cm) @ baseline, 3, 6 mo (Mean (SD))** 3 mo: 40.7 (1.3) vs 40.9 (1.2) vs 41.1 (1.3), p=NS 6 mo: 43.42 (1.5) vs 43.19 (1.2) vs 43.97 (1.4), p=NS **HC growth velocity (cm/d) from 0-3, 3-6 mo (Mean (SD))** 0-3 mo: 0.06 (0.01) vs 0.07 (0.01) vs 0.06 (0.01), p=NS **3-6 mo: 0.032 (0.01) vs 0.027 (0.00), 0.031 (0.01), p<0.05 for EM vs BF**	**Key confounders accounted for:** sex (z-scores only); milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** SEP; sex (all outcomes except z-scores); race and/or ethnicity **Model adjustments:** None **Funding:** Health Canada

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Friel, 1999[48] NRCT, Canada Analytic N by group: EM: n=30, BF: n=28 Attrition: EM: 14%, BF: 20% (Excluded participants who switched feeding type during the first 3 mo or were lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: NA Child sex (female): NR Birth weight: 100% between 2,500-4,500 g Gestational age: 100% 38-42 wk	**Intervention(s):** Evaporated milk (EM): cow's milk (fat content not prescribed) evaporated to approximately half its original volume, and parents were instructed to prepare it as 1 part EM and 2 parts water, with sucrose or dextrose (2 tsp per 6 oz) added to achieve 68 kcal/100 ml **Comparator(s):** Human milk consumption **Dietary assessment methods:** 3-d diet record; phone calls every 2 weeks **Compliance:** Those who switched feeding type were dropped from the study **Age at intervention:** 0-6 mo **Intervention duration:** 6 mo **Outcome(s):** WAZ, LAZ, WLZ, HC **Outcome assessment methods:** Weight, height, and HC measured by study personnel. Z-scores based on WHO/CDC data **Age(s) at outcome assessment:** 18 mo	EM vs Human milk **WAZ @ 18 mo** **0.53 (1.4) vs -0.16 (0.9), p<0.05** **LAZ @ 18 mo** 0.46 (0.72) vs 0.38 (1.06), p=NS **WHZ @ 18 mo** 0.56 (1.41) vs -0.33 (0.98) **HC (cm) @ 18 mo** 48 (1.7) vs 49 (6.4), p=NS	**Key confounders accounted for:** sex (z-scores only); milk feeding practices; gestational age; baseline anthropometry **Key confounders NOT accounted for:** sex (HC only); SEP; race and/or ethnicity **Model adjustments:** None **Funding:** Health Canada

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
PCS			
Farris, 1982[14] PCS, Bogalusa Heart Study, U.S. Analytic N = 285 (Excluded participants without outcome measurements at 6 mo or 1 y and consuming multiple milk sources) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: White: ~59%, Black: ~41% Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: BM at 6 mo: 1%, Soy-based formula at 6 mo: 7%, Milk-based formula at 6 mo: 42% Child sex (female): NR Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Cow's milk vs Milk formula vs Soy formula **Dietary assessment methods:** Infant Feeding Practices Questionnaires and dietary questionnaires completed by mothers **Age(s) at dietary assessment:** 1, 2, and 4 mo (infant feeding practices questionnaires); 6 mo and 1 y (dietary questionnaires) **Amounts consumed:** Cow's milk: 49%, Milk formula: 44%, Soy formula: 7% **Outcome(s):** Length, weight, skinfold (subscapular) **Outcome assessment methods:** Weight, length and skinfolds measured by trained personnel **Age(s) at outcome assessment:** 6 mo, 1 y	**Weight (kg) @ 1 y (mean (2 SE))** Cow's milk vs Milk formula vs Soy formula 9.8 (0.19) vs 9.8 (0.21) vs 9.4 (0.58), p=NS **Length (cm) @ 1 y (mean (2 SE))** Cow's milk vs Milk formula vs Soy formula 75.2 (0.53) vs 75.2 (0.45) vs 74.9 (1.29), p=NS **Subscapular skinfold (mm) @ 1 y (mean (2 SE))** Cow's milk vs Milk formula vs Soy formula 7.8 (3.85) vs 7.4 (0.34) vs 7.0 (0.88), p=NS	**Key confounders accounted for:** sex; race and/or ethnicity **Key confounders NOT accounted for:** SEP; milk feeding practices; gestational age; baseline anthropometry **Model adjustments:** None **Funding:** National Heart and Lung Institute of the U.S. Public Health Service; Specialized Center of Research-Arteriosclerosis at Louisana State University Medical Center

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Garden, 2011[30] PCS, CAPS, Australia Analytic N = 362 (Excluded participants with missing data on diet or anthropometrics) Adequately powered: NR Participant Characteristics (Mean (SD) unless otherwise noted) Race/ethnicity: Grandparents ethnicity/country of birth: Caucasian: 55%, European: 9%, Middle Eastern: 4%, Indian: 5%, Asian: 4%, Undefined: 24% Maternal education: NR Other SEP measure(s): Paternal education: ≤10 y: 33%, 11-12 y: 18%, Tertiary education: 48% Maternal age: NR Milk feeding practices: BF ≥6 mo: 42% Child sex (female): 49% Birth weight: 3,493 (492) g Gestational age: NR Other relevant characteristics: Secondary analysis of RCT (testing intervention of house dust mite avoidance and omega-3 supplementation); all children recruited at increased risk of developing asthma	**Exposure(s) and comparator(s):** Milk (skim, whole and evaporated), Dairy foods (combined milk and milk products: yogurt, cheese, ice cream, custard) (continuous as quintiles; amounts) **Dietary assessment methods:** 3-d weighed food records **Age(s) at dietary assessment:** 18 mo **Amounts consumed:** Quintiles of g or % total energy intake Milk g: 0, 157, 356, 491, 643, % energy: 0, 11, 23, 30, 38 Dairy foods g: 0, 278, 437, 561, 693, % energy: 0, 23, 33, 39, 47 **Outcome(s):** BMI, waist circumference **Outcome assessment methods:** Weight, length, and waist circumference measured by study nurses **Age(s) at outcome assessment:** 8 y	**BMI @ 8 y (Coefficient (95% CI))** Milk, per quintile g: -0.11 (-0.32, 0.11), p for trend=0.33 % of total energy: -0.17 (-0.38, 0.03), p for trend=0.10 Dairy foods, per quintile g: -0.20 (-0.41, 0.02), p for trend=0.07 **% of total energy: -0.21 (-0.41, 0.01), p for trend=0.04** **WC (cm) @ 8 y (Coefficient (95% CI))** Milk, per quintile g: -0.30 (-0.87, 0.28), p for trend=0.31 % of total energy: -0.21 (-0.76, 0.34), p for trend=0.45 Dairy foods, per quintile g: -0.51 (-1.09, 0.07), p for trend=0.08 % of total energy: -0.45 (-0.99, 0.08), p for trend=0.10	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** sex, asthma study intervention group, birth weight, breastfeeding for at least 6 months, parental obesity status, ethnicity, smoking in pregnancy and father's education, total energy intake (food intake in grams only) **Funding:** The National Health and Medical Research Council of Australia; Cooperative Research Centre for Asthma; New South Wales Department of Health; Children's Hospital Westmead; University of Sydney, Faculty of Medicine; Commonwealth Department of Health and Aging

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Garden, 2012[29] PCS, CAPS, Australia Analytic N = 298 (Excluded participants who were not still participating in the study at 11.5 y or did not have dietary data.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR (Australian born mother: 74%, Australian born father: 69%; Child's grandparents ethnicity/country of birth: Caucasian: ~54%, European: ~9%, Middle Eastern/Indian/Asian: ~12%, Undefined: ~25%) Maternal education: 52% tertiary educated Other SEP measure(s): Full-time employment: Mother: 49%, Father: 87% Maternal age: 29.0 (5.1) y Milk feeding practices: BF duration: 0 to <3 mo: 40%, 3 to <6 mo: 16.8%, ≥6 mo: 43.2% Child sex (female): 49% Birth weight: 100% ≥2.5 kg Gestational age: 100% ≥36 wk Other relevant characteristics: Secondary analysis of RCT (testing intervention of house dust mite avoidance and omega-3 supplementation); all children recruited at increased risk of developing asthma	**Exposure(s) and comparator(s):** Milk (skim, whole, and evaporated milk), Dairy foods (combined milk and milk products: yogurt, cheese, ice cream, custard) (continuous; amount) **Dietary assessment methods:** Parent/caregiver completed 3-d weighed food record (2 weekdays and 1 weekend day) **Age(s) at dietary assessment:** 18 mo **Amounts consumed:** See results for intake data **Outcome(s):** BMI trajectory **Outcome assessment methods:** Weight and height measured by study nurses. Three BMI trajectories defined using latent basis growth mixture model in relationship to CDC percentiles, stratified by sex. **Age(s) at outcome assessment:** 1, 3, 6, 9, 12, 18 mo, 2-5 y (every 6 mo), 8 y, 11.5 y	**BMI trajectory @ birth-11.5 y (median intake at 18 mo by trajectory group)** Milk Boys: normal trajectory: 478.8 g, early and persistent trajectory: 401.1 g, late BMI increase: 407.0 g, p=0.46 Girls: normal trajectory: 398.7 g, early and persistent trajectory: 510.0 g, late BMI increase: 380.8 g, p=0.74 Dairy foods Boys: normal trajectory: 554.3 g, early and persistent trajectory: 433.1 g, late BMI increase: 527.2 g, p=0.24 Girls: normal trajectory: 473.1 g, early and persistent trajectory: 576.5 g, late BMI increase: 480.9 g, p=0.45 group) Results analyzed by % of total energy were similar.	**Key confounders accounted for:** sex; race and/or ethnicity; milk feeding practices; baseline anthropometry (timing of any). SEP; sex; race/ethnicity; milk feeding practices; baseline anthropometry (types and amounts, multinomial regression only). **Key confounders NOT accounted for:** SEP; gestational age (timing of any). gestational age (types and amounts). **Model adjustments:** None (timing of any); dietary intervention group, BF, parental obesity, ethnicity, smoking during pregnancy, father's education status (types and amounts, multinomial regression only) **Funding:** National Health and Medical Research Council of Australia

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Goh, 2022[50] PCS, NHID, Korea Analytic N = 142,668 (Excluded participants with missing data on body weight or height, errors on age of measurement, and extreme outliers (BMI ≤4 or ≥50)) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): Household income (units NR): 11.81 (4.44) Maternal age: NR Milk feeding practices: Type of milk feeding at 4-6 mo: BM: 46.32%, Formula: 32.94%, Mixed milk: 20.35%, Special formula milk: 0.40% Child sex (female): 49% Birth weight: 3.20 (0.46) kg Gestational age: Preterm birth: 3.67%	**Exposure(s) and comparator(s):** Goat's milk, soy milk, cow's milk, BM (ref) **Dietary assessment methods:** Parental questionnaire **Age(s) at dietary assessment:** 12 mo **Amounts consumed:** BM: Boys: 38.81%, Girls: 40.77%; Goat's milk: Boys: 2.99%, Girls: 2.83%; Soy milk: Boys: 4.05%, Girls: 3..86%; Cow's milk: Boys: 4.25%, Girls: 4.43%; Formula milk: Boys: 49.88%, Girls: 48.10% **Outcome(s):** Early adiposity rebound **Outcome assessment methods:** Height and weight measured by trained medical staff. Early adiposity rebound defined as rebound of BMI percentile before 4 y. BMI percentile by age and sex was based on WHO Child Growth Standards. **Age(s) at outcome assessment:** 4-6 mo, 9-12 mo, 18-24 mo, 30-36 mo, 42-48 mo, 54-60 mo, 66-71 mo	**Early adiposity rebound (<4 y) (OR)** **Cow's milk vs BM (ref)** **Boys: 1.51, p=0.009** **Girls: 1.51, p=0.009** Goat's Milk vs BM (ref) Boys: Data NR, p=NS Girls: Data NR, p=NS **Soy Milk vs BM (ref)** **Boys: 1.47, p=0.021** **Girls: 1.46, p=0.016**	**Key confounders accounted for:** SEP; sex; milk feeding practices; baseline anthropometry **Key confounders NOT accounted for:** race and/or ethnicity; gestational age **Model adjustments:** Birth weight, preterm birth, household income; type of feeding milk (4-6 mo); number of weaning food per day, type of feeding milk (9-12 mo); use of salt in food, vitamin supplements (18-24 mo); appetite, number of meals per day, number of snacks per day, daily intake of cow's milk, daily intake of SSB, parents' concern about child's eating habits (30-36 mo); number of meals per day, daily intake of cow's milk, daily intake of SSB (42-48 mo) **Funding:** Dong-A University

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Hopkins, 2015[51] PCS, Child in Focus substudy of ALSPAC, U.K. Analytic N = 1,112 (n by analysis varied from 641-948) (Excluded participants born <37 wk gestation and with missing dietary information at 8 mo) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: Low: 22.5%, Medium: 35.2%, High: 42.3% Other SEP measure(s): NR Maternal age: NR Milk feeding practices: BM at 8 mo: BM group: 396 ml/d, Cow's milk groups (high and low): 0 ml/d Child sex (female): 46% Birth weight: 3.5 (0.47) kg Birth length: 50.9 (1.97) cm Birth BMI: 13.5 (1.20) Gestational age: 100% ≥37 wk	**Exposure(s) and comparator(s):** Cow's milk (high or low) vs BM (ref) at 8 mo **Dietary assessment methods:** 3-d unweighed food records completed by child's main carer **Age(s) at dietary assessment:** 8 mo **Amounts consumed:** Cow's milk intake (mean (95% CI)) at 8 mo: High cow's milk group (≥600 ml/d): 765 (733, 798) ml/d, Low cow's milk group (<600 ml/d): 441 (413, 469) ml/d, BM group: 70 (55, 84) ml/d **Outcome(s):** Weight, height, BMI **Outcome assessment methods:** Weight and height measured by trained staff. Sex and age specific SDS calculated based on UK 1990 growth reference. **Age(s) at outcome assessment:** 12, 18, 25, 31, 37, 43, 49, 61 mo; 7, 9, 10 y	**Weight (SDS) @ 12, 18, 25, 31, 37, 43, 49, 61 mo; 7 y, 9 y, 10 y (mean difference (95% CI))** Low cow's milk vs BM (ref) 12 mo: **0.30 (0.02, 0.59), p<0.05** 18 mo: **0.33 (0.03, 0.63), p<0.05** 25 mo: 0.29 (-0.01, 0.58) 31 mo: 0.27 (-0.02, 0.57) 37 mo: 0.21 (-0.08, 0.51) 43 mo: 0.16 (-0.15, 0.47) 49 mo: 0.09 (-0.21, 0.39) 61 mo: 0.14 (-0.19, 0.47) 7 y: -0.00 (-0.32, 0.32) 9 y: -0.02 (-0.33, 0.29) 10 y: 0.18 (-0.13, 0.49) High cow's milk vs BM (ref) 12 mo: **0.64 (0.35, 0.94), p<0.001** 18 mo: **0.62 (0.31, 0.93), p<0.001** 25 mo: **0.52 (0.22, 0.81), p<0.001** 31 mo: **0.55 (0.25, 0.85), p<0.001** 37 mo: **0.46 (0.16, 0.77), p<0.01** 43 mo: **0.38 (0.06, 0.70), p<0.05** 49 mo: **0.46 (0.16, 0.77), p<0.01** 61 mo: **0.43 (0.10, 0.76), p<0.05** 7 y: 0.13 (-0.20, 0.47) 9 y: **0.45 (0.14, 0.77), p<0.01** 10 y: **0.46 (0.13, 0.78), p<0.01**	**Key confounders accounted for:** SEP; sex; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; milk feeding practices; baseline anthropometry **Model adjustments:** All time points: maternal education, smoking in pregnancy, parity; At 18 mo, 43 mo, 61 mo, 7 y, 10 y: current dietary energy and protein intakes at each age (based on data availability) **Funding:** United Kingdom Medical Research Council; Wellcome Trust; University of Bristol; Wyeth Nutrition

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Hopkins, 2015[51] (Continued) PCS, Child in Focus substudy of ALSPAC, U.K. Analytic N = 1,112 (n by analysis varied from 641-948) (Excluded participants born <37 wk gestation and with missing dietary information at 8 mo) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: Low: 22.5%, Medium: 35.2%, High: 42.3% Other SEP measure(s): NR Maternal age: NR Milk feeding practices: BM at 8 mo: BM group: 396 ml/d, Cow's milk groups (high and low): 0 ml/d Child sex (female): 46% Birth weight: 3.5 (0.47) kg Birth length: 50.9 (1.97) cm Birth BMI: 13.5 (1.20) Gestational age: 100% ≥37 wk	**Exposure(s) and comparator(s):** Cow's milk (high or low) vs BM (ref) at 8 mo **Dietary assessment methods:** 3-d unweighed food records completed by child's main carer **Age(s) at dietary assessment:** 8 mo **Amounts consumed:** Cow's milk intake (mean (95% CI)) at 8 mo: High cow's milk group (≥600 ml/d): 765 (733, 798) ml/d, Low cow's milk group (<600 ml/d): 441 (413, 469) ml/d, BM group: 70 (55, 84) ml/d **Outcome(s):** Weight, height, BMI **Outcome assessment methods:** Weight and height measured by trained staff. Sex and age specific SDS calculated based on UK 1990 growth reference. **Age(s) at outcome assessment:** 12, 18, 25, 31, 37, 43, 49, 61 mo; 7, 9, 10 y	**Height (SDS) @ 12, 18, 25, 31, 37, 43, 49, 61 mo; 7 y, 9 y, 10 y (mean difference (95% CI))** Low cow's milk vs BM (ref): 12 mo: 0.13 (-0.14, 0.40) 18 mo: 0.22 (-0.06, 0.50) 25 mo: 0.20 (-0.08, 0.47) 31 mo: 0.17 (-0.10, 0.45) 37 mo: 0.16 (-0.12, 0.43) 43 mo: 0.06 (-0.23, 0.35) 49 mo: 0.02 (-0.26, 0.30) 61 mo: -0.00 (-0.30, 0.29) 7 y: -0.15 (-0.43, 0.14) 9 y: -0.17 (-0.46, 0.11) 10 y: -0.07 (-0.36, 0.22) High cow's milk vs BM (ref) 12 mo: **0.46 (0.18, 0.74), p<0.01** 18 mo: **0.58 (0.29, 0.86), p<0.001** 25 mo: **0.47 (0.18, 0.75), p<0.01** 31 mo: **0.42 (0.14, 0.71), p<0.01** 37 mo: **0.44 (0.15, 0.73), p<0.01** 43 mo: **0.38 (0.09, 0.68), p<0.05** 49 mo: **0.31 (0.02, 0.60), p<0.05** 61 mo: 0.21 (-0.09, 0.51) 7 y: 0.05 (-0.25, 0.35) 9 y: 0.12 (-0.17, 0.42) 10 y: **0.30 (0.00, 0.59), p<0.05**	**Key confounders accounted for:** SEP; sex; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; milk feeding practices; baseline anthropometry **Model adjustments:** All time points: maternal education, smoking in pregnancy, parity; At 18 mo, 43 mo, 61 mo, 7 y, 10 y: current dietary energy and protein intakes at each age (based on data availability) **Funding:** United Kingdom Medical Research Council; Wellcome Trust; University of Bristol; Wyeth Nutrition

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Hopkins, 2015[51] (Continued) PCS, Child in Focus substudy of ALSPAC, U.K. Analytic N = 1,112 (n by analysis varied from 641-948) (Excluded participants born <37 wk gestation and with missing dietary information at 8 mo) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: Low: 22.5%, Medium: 35.2%, High: 42.3% Other SEP measure(s): NR Maternal age: NR Milk feeding practices: BM at 8 mo: BM group: 396 ml/d, Cow's milk groups (high and low): 0 ml/d Child sex (female): 46% Birth weight: 3.5 (0.47) kg Birth length: 50.9 (1.97) cm Birth BMI: 13.5 (1.20) Gestational age: 100% ≥37 wk	**Exposure(s) and comparator(s):** Cow's milk (high or low) vs BM (ref) at 8 mo **Dietary assessment methods:** 3-d unweighed food records completed by child's main carer **Age(s) at dietary assessment:** 8 mo **Amounts consumed:** Cow's milk intake (mean (95% CI)) at 8 mo: High cow's milk group (≥600 ml/d): 765 (733, 798) ml/d, Low cow's milk group (<600 ml/d): 441 (413, 469) ml/d, BM group: 70 (55, 84) ml/d **Outcome(s):** Weight, height, BMI **Outcome assessment methods:** Weight and height measured by trained staff. Sex and age specific SDS calculated based on UK 1990 growth reference. **Age(s) at outcome assessment:** 12, 18, 25, 31, 37, 43, 49, 61 mo; 7, 9, 10 y	**BMI (SDS) @ 12, 18, 25, 31, 37, 43, 49, 61 mo; 7 y, 9 y, 10 y (mean difference (95% CI))** Low cow's milk vs BM (ref): 12 mo: **0.29 (0.01, 0.58), p<0.05** 18 mo: 0.25 (-0.06, 0.56) 25 mo: 0.23 (-0.07, 0.53) 31 mo: 0.23 (-0.07, 0.52) 37 mo: 0.17 (-0.13, 0.46) 43 mo: 0.16 (-0.17, 0.48) 49 mo: 0.10 (-0.20, 0.40) 61 mo: 0.20 (-0.14, 0.55) 7 y: 0.13 (-0.20, 0.46) 9 y: 0.07 (-0.24, 0.38) 10 y: 0.32 (-0.01, 0.64) **High cow's milk vs BM (ref)** 12 mo: **0.46 (0.17, 0.75), p<0.01** 18 mo: **0.35 (0.03, 0.66), p<0.05** 25 mo: 0.25 (-0.05, 0.55) 31 mo: **0.35 (0.05, 0.65), p<0.05** 37 mo: 0.25 (-0.06, 0.56) 43 mo: 0.20 (-0.14, 0.53) 49 mo: **0.38 (0.08, 0.69), p<0.05** 61 mo: **0.45 (0.10, 0.79), p<0.05** 7 y: 0.15 (-0.19, 0.50) 9 y: **0.54 (0.22, 0.86), p<0.01** 10 y: **0.44 (0.10, 0.78), p<0.05**	**Key confounders accounted for:** SEP; sex; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; milk feeding practices; baseline anthropometry **Model adjustments:** All time points: maternal education, smoking in pregnancy, parity; At 18 mo, 43 mo, 61 mo, 7 y, 10 y: current dietary energy and protein intakes at each age (based on data availability) **Funding:** United Kingdom Medical Research Council; Wellcome Trust; University of Bristol; Wyeth Nutrition

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Smith-Brown, 2018[45] PCS, Feeding Queensland Babies Study Cohort, Australia Analytic N = 25 (Reasons for exclusion NR) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: NR Child sex (female): 44% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Dairy: cow's milk, yoghurt, cheese, ice cream, dessert, etc (continuous; daily feedings) **Dietary assessment methods:** 18-item FFQ **Age(s) at dietary assessment:** 12 mo **Amounts consumed:** 2.57 (1.57) daily feedings (Range: 0.00-6.00) **Outcome(s):** FMI, FFMI, WHR, BMIZ **Outcome assessment methods:** Weight, height, and WC were measured by study personnel. Fat mass and fat free mass were measured using total body water (deuterium oxide dilution technique) converted to age- and sex-specific hydration constants. FMI and FFMI calculated by dividing fat-free/fat mass by square of height. BMIZ calculated using WHO reference data. WHR, FFMI, and FMI z-scores calculated using values calculated from NHANES. **Age(s) at outcome assessment:** 2-3 y (Mean: 2.65 y)	**BMIZ @ 2-3 y (Pearson's correlation)** r=0.29, p=0.245 **FMI Z-score @ 2-3 y (Pearson's correlation)** r=-0.24, p=0.245 **FFMI Z-score @ 2-3 y (Pearson's correlation)** **r=0.51, p=0.040** **WHR Z-score @ 2-3 y (Pearson's correlation)** r=0.26, p=0.245	**Key confounders accounted for:** None **Key confounders NOT accounted for**: SEP; sex; race and/or ethnicity; milk feeding practices; gestational age; baseline anthropometry **Model adjustments:** None **Funding:** Australian government, Danone Nutricia

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Thorisdottir, 2013[53] PCS, Iceland Analytic N = 234 (Excluded participants with incomplete dietary registration at 9 or 12 mo, anthropometry measurements in infants, or measurements of weight or height at 6 y.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: NR Maternal education: ≥12 y: ~78% Other SEP measure(s): NR Maternal age: ~31 y Milk feeding practices: BF duration: ~8 mo; EBF duration: ~4 mo; Any formula at 9 mo: ~11%, 12 mo: ~4% Child sex (female): ~53% Birth weight: ~3.7 kg Gestational age: 100% 37-41 wk Other relevant characteristics: Includes 2 cohorts (before and after changes to infant dietary guidelines regarding cow's milk/dairy in first y)	**Exposure(s) and comparator(s):** Cow's milk (continuous, per 100 g) **Dietary assessment methods:** Weighed food and fluids for 2 or 3 consecutive d **Age(s) at dietary assessment:** 9, 12 mo **Amounts consumed:** Cow's milk: 9 mo: ~79 g/d, 12 mo: ~107 g/d **Outcome(s):** BMI **Outcome assessment methods:** Weight and height measured by research personnel. **Age(s) at outcome assessment:** 6 y	**BMI @ 6 y (β (95% CI))** @ 9 mo: 0.1 (-0.1, 0.2), p=0.28 **@ 12 mo: 0.2 (0.0, 0.3), p=0.017**	**Key confounders accounted for:** SEP; sex; milk feeding practices; gestational age **Key confounders NOT accounted for:** race and/or ethnicity; baseline anthropometry **Model adjustments:** Cohort, sex, energy intake at 9 or 12 mo, birth weight, duration of BF, mother's education **Funding:** NR

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Wosje, 2001[55] PCS, U.S. Analytic N = 51 (Excluded participants lost to follow-up during the original trial, without completed 3-d diet records at 12, 18, and 24 mo, and those who consumed both 2% and whole milk after 12 mo.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race/ethnicity: White: 94%, Other: 6% Maternal education: ~14 y Other SEP measure(s): NR Maternal age: NR Milk feeding practices: NR Child sex (female): 45% Birth weight: None with SGA Gestational age: 100% term (37-42 wk) Other relevant characteristics: Secondary analysis of RCT assessing effect of timing of introduction of solid foods (3 mo vs 6 mo) on growth and body composition.	**Exposure(s) and comparator(s):** Only 2% milk vs Only whole milk **Dietary assessment methods:** 3-d diet record completed by parents **Age(s) at dietary assessment:** 12, 18, and 24 mo **Amounts consumed:** 2% milk: 55%, whole milk: 45% (Intake at 24 mo: 2% milk: 351 (186) g, whole milk: 531 (360) g) **Outcome(s):** Weight, WAZ, weight gain, WAZ change, length, LAZ, length gain, LAZ change, % body fat, % body fat change, fat mass gain **Outcome assessment methods:** Weight and length measured by study personnel. Body fat measured by DXA. Z scores calculated using National Center for Health Statistics (NCHS) growth charts. **Age(s) at outcome assessment:** 12, 18 (weight, length only), and 24 mo	2% vs whole milk **Length (cm) @ 18, 24 mo (Mean (SD))** 18 mo: 81.9 (4.8) vs 82.8 (3.2), p=NS 24 mo: 87.9 (3.4) vs 87.8 (3.2), p=NS **LAZ @ 24 mo (Mean (SD))** 24 mo: 0.14 (0.58) vs 0.15 (0.59), p=NS **Length gain (cm) from 12-24 mo (Mean (SD))** 12.4 (2.2) vs 11.7 (1.7), p=NS **LAZ change from 12-24 mo (Mean (SD))** -0.10 (0.42) vs -0.04 (0.28), p=NS **Weight (kg) @ 18, 24 mo (Mean (SD))** 18 mo: 11.4 (1.3) vs 11.6 (3.0), p=NS 24 mo: 12.8 (1.5) vs 12.7 (1.3), p=NS **WAZ @ 24 mo (Mean (SD))** 24 mo: 0.23 (0.64) vs 0.20 (0.62), p=NS **Weight gain (kg) from 12-24 mo (Mean (SD))** 3.0 (0.7) vs 2.7 (0.7) **WAZ change from 12-24 mo (Mean (SD))** 0.27 (0.35) vs 0.10 (0.31), p=NS **% body fat @ 24 mo (Mean (SD))** 24 mo: 26.5% (5.5%) vs 27.4% (5.7%), p=NS **% body fat change from 12-24 mo (Mean (SD))** -2.8 (4.2) vs -2.5 (5.0), p=NS **Fat mass gain (g) from 12-24 mo (Mean (SD))** 492 (559) vs 452 (838), p=NS	**Key confounders accounted for:** SEP; sex; gestational age; baseline anthropometry **Key confounders NOT accounted for:** race and/or ethnicity; milk feeding practices **Model adjustments:** None **Funding:** Gerber Products, NIH

[a] Abbreviations: @: at; ALSPAC: Avon Longitudinal Study of Parents and Children; BF: breast feeding; BM: breast milk; BMI: body mass index; BMIZ: body mass index z-score; CAPS: Childhood Asthma Prevention Study; CI: confidence interval; cm: centimeter; d: day; DXA: dual-energy X-ray absorptiometry; EBF: exclusive breast feeding; EM: evaporated milk; etc: *et cetera*; FFMI: fat-free mass index; FMI: fat mass index; g: gram; GUMLi: Growing-Up Milk-Lite; HC: head circumference; kg: kilogram; LAZ: length-for-age z-score; ml: milliliter; mo: month; NA: not applicable; NHID: National Health Information Database; NR: not reported; NRCT: non-randomized controlled trial; NS: non-significant; OR: odds ratio; oz: ounce; PCS: prospective cohort study; RCT: randomized controlled trial; ref: reference; SD: standard deviation; SDS: standard deviation score; SEP: socioeconomic position; SGA: small-for-gestational age; SSB: sugar-sweetened beverage; tsp: teaspoon; U.K.: United Kingdom; U.S.: United States; WAZ: weight-for-age z-score; WC: waist circumference; WHR: waist-to-height ratio; WHZ: weight-for-height z-score; wk: week; WLZ: weight-for-length z-score; y: year

Table 50. Risk of bias for randomized controlled trials (parallel) examining dairy consumption and growth, body composition, and risk of obesity[a]

Article	Randomization	Deviations from intended interventions (effect of assignment or per-protocol)	Missing outcome data	Outcome measurement	Selection of the reported result	Overall risk of bias
Larnkjaer, 2009[52]	SOME CONCERNS	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Tang, 2018[47]	SOME CONCERNS	LOW	LOW	LOW	LOW	SOME CONCERNS
Tang, 2019[33]	SOME CONCERNS	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Wall, 2019[54]	LOW	LOW	LOW	LOW	LOW	LOW

Table 51. Risk of bias for non-randomized controlled trials examining dairy consumption and growth, body composition, and risk of obesity[b]

Article	Confounding	Selection of participants	Classification of interventions	Deviations from intended interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Friel, 1997[49]	CRITICAL	LOW	LOW	LOW	MODERATE	LOW	MODERATE	CRITICAL
Friel, 1999[48]	CRITICAL	LOW	LOW	LOW	MODERATE	LOW	MODERATE	CRITICAL

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[a] Possible ratings of low, some concerns, or high determined using the "Cochrane Risk-of-bias 2.0" (RoB 2.0) (August 2019 version)" (Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng H-Y, Corbett MS, Eldridge SM, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, McAleenan A, Reeves BC, Shepperd S, Shrier I, Stewart LA, Tilling K, White IR, Whiting PF, Higgins JPT. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019; **366**: l4898.

[b] Possible ratings of low, moderate, serious, critical, or no information determined using the "Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) tool" (Sterne JAC, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, Henry D, Altman DG, Ansari MT, Boutron I, Carpenter JR, Chan AW, Churchill R, Deeks JJ, Hróbjartsson A, Kirkham J, Jüni P, Loke YK, Pigott TD, Ramsay CR, Regidor D, Rothstein HR, Sandhu L, Santaguida PL, Schünemann HJ, Shea B, Shrier I, Tugwell P, Turner L, Valentine JC, Waddington H, Waters E, Wells GA, Whiting PF, Higgins JPT. ROBINS-I: a tool for assessing risk of bias in non-randomized studies of interventions. BMJ 2016; 355; i4919; doi: 10.1136/bmj.i4919.)

Table 52. Risk of bias for observational studies examining dairy consumption and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Garden, 2011[30]	SOME CONCERNS	LOW	LOW	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Garden, 2012[29]	SOME CONCERNS	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Goh, 2022[50]	SOME CONCERNS	HIGH	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Hopkins, 2015[51]	HIGH	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Smith-Brown, 2018[45]	VERY HIGH	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	VERY HIGH
Thorisdottir, 2013[53]	SOME CONCERNS	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Wosje, 2001[55]	VERY HIGH	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	VERY HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Sugar-sweetened beverages

Twelve PCS (17 articles) met inclusion criteria and examined the relationship between the consumption of SSBs by infants and young children, up to age 24 months, and growth, body composition, and risk of obesity.[1,23,27-30,50,56-65] This data was synthesized as part of the systematic review with meta-analysis on SSB intake and growth, body composition, and risk of obesity across the lifespan; to avoid duplication of effort, details of the review of this evidence are presented in that report. Briefly, the Committee developed a conclusion statement about the relationship between SSB consumption and growth, body composition, and risk of obesity based on their review of the totality of evidence in infants, children, and adolescents (**Table 53**).

Table 53. Conclusion statement, grade for sugar-sweetened beverage consumption and growth, body composition, and risk of obesity in infants, children, and adolescents[*]

Conclusion Statement	**Sugar-sweetened beverage consumption by infants, children, and adolescents is associated with unfavorable growth patterns and body composition, and higher risk of obesity in childhood up to early adulthood. This conclusion statement is based on evidence graded as moderate.**
Grade	Moderate
Body of Evidence	5 RCTs (all in meta-analysis); 107 observational studies (72 in meta-analyses)
Consistency	Consistent directionality of findings across articles; some heterogeneity
Precision	Few concerns with precision
Risk of bias	Some concerns with risk of bias, primarily due to confounding and missing data in observational studies
Directness	Few concerns with directness across studies
Generalizability	Some concerns with generalizability to the U.S. population, particularly in the RCT data, and limited data included in meta-analyses for infants/young children

[*] Excerpted from: Deierlein AL, Raynor HA, Byrd-Bredbenner C, et al. Sugar-Sweetened Beverages and Growth, Body Composition, and Risk of Obesity: A Systematic Review with Meta-Analysis. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2024. https://doi.org/10.52570/NESR.DGAC2025.SR05

Food sources of added sugars

Description of the evidence

Four studies (from 5 articles) met inclusion criteria and examined the relationship between consumption of food sources of added sugars among infants and young children, up to age 24 months, and growth, body composition, and risk of obesity (**Table 55**).[1,27,29,30,40] All studies were PCS,[1,27,29,30,40] using data from the following cohorts: Born in Bradford 1000,[27] CAPS,[29,30] Nurture,[40] and 1 unnamed study.[1] One study was a secondary analysis of a RCT testing the impact of house dust mite avoidance and omega-3 supplementation on allergy prevention.[29,30]

Population

Two studies were conducted in the United States,[1,40] and 1 study each was conducted in Australia,[29,30] and the United Kingdom.[27] The analytic sample sizes of the studies ranged from 68[1] to 779.[27] None of the studies reported power calculations related to consumption of food sources of added sugars and the relevant outcomes.

All studies provided information on the racial and/or ethnic background of participants, and this varied across the studies. In 1 study 100% or participants were Hispanic,[1] approximately 56% and 44% of participants were Pakistani and White British, respectively, in another,[27] 71.5% of participants were Black, with the remaining participants being White (19.2%), Latina (6.5%), or of other race and/or ethnicity (8.9%) in the third,[40] and the participants' grandparents' ethnicity or country of birth was Caucasian (55%), European (9%), Indian (5%), 4% Middle Eastern (4%), Asian (4%), or undefined (24%) in the final study.[29,30] Across the 3 studies that reported maternal age, the mean age of the women tended to be in the late twenties.[1,29,40] Human milk and formula feeding practices were reported in 3 studies and tended to vary: 1 study reported that 51% exclusively breastfed for at least 1 month, 70.1% ever formula-fed, and 20.8% fed any breastmilk at 10 months,[1] a second study reported that 40% of the sample had a breastfeeding duration of less than 3 months, 16.8% for 3 up to 6 months, and 43.2% for 6 months or longer,[29] and the third reported a mean breastfeeding duration of 14.7 weeks.[40] SEP, including maternal education, was reported for 3 studies.[1,29,30,40] Mothers tended to have greater than a high school education level.[1,29,30,40] Across the 3 studies that reported other measures of SEP, 1 exclusively enrolled individuals who participated in WIC,[1] a second study reported that approximately half of the fathers had a tertiary education,[30] and a third reported that 55.4% of the sample had a household income of $20,000 or less.[40]

Regarding the characteristics of the infants and young children, the studies, when reported, noted that approximately 50% of participants were female,[1,29,30,40] mean birth weight was approximately 3.3 kilograms,[27,30] or mean birth weight for gestational age z-score was -0.31,[40] and gestational age was greater than 36 weeks.[29,40] One study reported mean baseline (age 18 months) weights and lengths of 11.6 kilograms and 83.4 centimeters, respectively,[30] while mean baseline (age 3 months) WLZ was 0.14 in a second study.[40]

Exposures and comparators

The food sources of added sugars examined varied slightly across studies. One study examined sweets, defined as cookies, cakes, and candy,[40]; a second examined sweet snacks, which included cakes, biscuits, chocolate, and sweets,[27] and a third study examined confectionery, which was defined as chocolate, jellies, and energy bars.[29,30] One study did not provide examples of the types of foods included in the measure of sweets.[1] The exposures were analyzed continuously,[1,29,30] and categorically.[27,40] The studies used a variety of assessment methods to measure consumption of food sources of added sugars, including FFQs,[1,27] an infant feeding questionnaire,[40] or 3-day weighed food records.[29,30] Most of the studies assessed consumption of food sources of added sugars multiple times from birth up to age 24 months.[1,27,40] Three studies assessed the exposure up to 12 months,[1,27,40] and 3 studies assessed the exposure between ages 12 and 24 months.[1,27,29,30]

Outcomes

Each study assessed a unique measure of growth,[27,29,30,40] body composition,[30] and risk of obesity.[1] including BMI trajectory,[29] BMI,[30] BMIZ,[27] WLZ,[40] waist circumference,[30] and risk of elevated WLZ.[1] Three studies used WHO growth standards[1,27,40] and 1 study used CDC growth charts[29] to calculate z-scores. The age of outcome assessment varied widely, ranging from age 6 months up to age 11.5 years. In all studies the outcomes were measured by research staff or nurses.

Synthesis of the evidence

The 4 studies that examined food sources of added sugars reported null or mixed findings related to growth, body composition, and risk of obesity (**Table 55**).[1,27,29,30,40] Three of the 4 studies reported null associations between confectionery,[29,30] sweet snacks,[27] and sweets[1] on growth, body composition and risk of overweight. The direction of findings of these studies were mixed, with 2 studies reporting non-significant, negative associations between confectionery[30] or cakes, biscuits, chocolate, and sweets[27] and growth or body composition, and 1 study reporting a non-significant, positive association between sweets and WLZ.[40] One study reported mixed findings, with infants “often” consuming sweets, compared to never, had significantly lower or higher WLZ that varied by the age at outcome, while comparisons between infants “sometimes” and never consuming sweets were null.[40]

Overall, the foods examined were consistent. However, the timing of the exposure assessment and outcome indicators varied across studies and were difficult to compare among the few studies that were included in this portion of the systematic review.

Conclusion statement and grade

The Committee did not draw a conclusion statement about the relationship between consumption of food sources of added sugars by infants and young children, up to age 24 months, and growth, body composition, and risk of obesity because there is not enough evidence (**Table 54**). Publication bias may be a limitation, but the small body of evidence makes it difficult to assess. Additionally, while the literature search was comprehensive, a search of the gray literature was not done, which could increase the possibility of publication bias. The risk of bias assessments for the studies that addressed this question are documented in **Table 56**.

Table 54. Conclusion statement, grade for consumption of foods with added sugars by infants and young children and growth, body composition, and risk of obesity

Conclusion Statement	**A conclusion statement cannot be drawn about the relationship between consumption of food sources of added sugars by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available.**
Grade	Grade Not Assignable
Body of Evidence	5 articles (4 studies): 4 prospective cohort studies
Rationale	There was not enough evidence available to answer this question.

Table 55. Evidence examining the relationship between consumption of food sources of added sugar and growth, body composition, and risk of obesity[a]

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Amaro-Rivera, 2019[1] PCS, U.S. (Puerto Rico) Analytic N = 68 (Excluded participants lost to follow-up) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Hispanic: 100% Maternal education: ≤HS: 32.5%, >HS: 67.5% Other SEP measure(s): WIC participation: 100% Maternal age: Parent's age: <30 y: 55.8%, ≥30 y: 44.2% Milk feeding practices: EBF for ≥1 mo: 51%, Ever FF: 70.1%, Any BF at ~10 mo: 20.8% Child sex (female): 47% Birth size: NR Gestational age: NR	**Exposure(s) and comparator(s):** Annual change (amounts) in sweets Diet Quality Index Scores (continuous) **Dietary assessment methods:** Interviewer-administered questionnaire completed by caregivers. Diet Quality Index Score based on semi-quantitative FFQ. **Age(s) at dietary assessment:** 0-5, 8-36 mo (types/amounts) **Amounts consumed:** NR **Outcome(s):** WLZ (≥1) **Outcome assessment methods:** Weight and length measured by trained research staff. Weight status assessed using WHO age- and sex-specific WLZ growth charts. Relative risk for WLZ (≥1 z-score vs <1 z-score), with underweight defined as WLZ ≤-2 SD, healthy weight status defined as WLZ >-2 and <1 SD, risk of overweight defined as WLZ between 1-<2, and overweight or obesity defined as WLZ ≥2 SD. **Age(s) at outcome assessment:** 11-36 mo (Median: 21 mo, 11-23 mo: 61.0%, 24-36 mo: 39.0%)	**WLZ (≥1 vs <1) @ 11-36 mo (RR (95% CI))** Sweets score: 1.03 (0.83, 1.27)	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; baseline anthropometry **Key confounders NOT accounted for:** gestational age **Model adjustments:** WLZ at baseline **Funding:** University of Puerto Rico Central Administration Grant; Capacity Advancement in Research Infrastructure; National Institute on Minority Health and Health Disparities

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Garden, 2011[30] PCS, CAPS, Australia Analytic N = 362 (Excluded participants with missing data on diet or anthropometrics) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Grandparents ethnicity/country of birth: Caucasian: 55%, European: 9%, Middle Eastern: 4%, Indian: 5%, Asian: 4%, Undefined: 24% Maternal education: NR Other SEP measure(s): Paternal education: ≤10 y: 33%, 11-12 y: 18%, Tertiary education: 48% Maternal age: NR Milk feeding practices: BF ≥6 mo: 42% Child sex (female): 49% Birth weight: 3,493 (492) g Gestational age: NR Other relevant characteristics: Secondary analysis of RCT (testing intervention of house dust mite avoidance and omega-3 supplementation); all children recruited at increased risk of developing asthma	**Exposure(s) and comparator(s):** Confectionary (chocolate, jellies, energy bars): Continuous (amounts; as quartiles) **Dietary assessment methods:** 3-d weighed food records **Age(s) at dietary assessment:** 18 mo **Amounts consumed:** Quartiles: g: 0, 1, 7, 15 % total energy intake: 0, 0.3, 3, 6 **Outcome(s):** BMI, WC **Outcome assessment methods:** Weight, length, and waist circumference measured by study nurses **Age(s) at outcome assessment:** 8 y	**BMI @ 8 y (β (95% CI))** Per quartile g: -0.25 (-0.49, 0.00), p for trend=0.05 % of total energy: -0.24 (-0.48, 0.01), p for trend=0.06 **WC (cm) @ 8 y (β (95% CI))** Per quartile g: -0.36 (-1.02, 0.30), p for trend=0.28 % of total energy: -0.22 (-0.87, 0.44), p for trend=0.52	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** sex, asthma study intervention group, birth weight, breastfeeding for at least 6 mo, parental obesity status, ethnicity, smoking in pregnancy and father's education, total energy intake (food intake in g only) **Funding:** The National Health and Medical Research Council of Australia; Cooperative Research Centre for Asthma; New South Wales Department of Health; Children's Hospital Westmead; University of Sydney, Faculty of Medicine; Commonwealth Department of Health and Aging

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Garden, 2012[29] PCS, CAPS, Australia Analytic N = 298 (Excluded participants who were not still participating in the study at 11.5 y or did not have dietary data.) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: NR (Australian born mother: 74%, Australian born father: 69%; Child's grandparents ethnicity/country of birth: Caucasian: ~54%, European: ~9%, Middle Eastern/Indian/Asian: ~12%, Undefined: ~25%) Maternal education: 52% tertiary educated Other SEP measure(s): Full-time employment: Mother: 49%, Father: 87% Maternal age: 29.0 (5.1) y Milk feeding practices: BF duration: 0 to <3 mo: 40%, 3 to <6 mo: 16.8%, ≥6 mo: 43.2% Child sex (female): 49% Birth weight: 100% ≥2.5 kg Gestational age: 100% ≥36 wk Other relevant characteristics: Secondary analysis of RCT (testing intervention of house dust mite avoidance and omega-3 supplementation); all children recruited at increased risk of developing asthma	**Exposure(s) and comparator(s):** Confectionary (chocolate, jellies, energy bars): Continuous (amounts) **Dietary assessment methods:** Parent/caregiver completed 3-d weighed food record (2 weekdays and 1 weekend day) **Age(s) at dietary assessment:** 18 mo **Amounts consumed:** See results for intake data **Outcome(s):** BMI trajectory **Outcome assessment methods:** Weight and height measured by study nurses. Three BMI trajectories defined using latent basis growth mixture model in relationship to CDC percentiles, stratified by sex. **Age(s) at outcome assessment:** 1, 3, 6, 9, 12, 18 mo, 2-5 y (every 6 mo), 8 y, 11.5 y	**BMI trajectory @ birth-11.5 y (median intake at 18 mo by trajectory group)** Boys: normal trajectory: 1.3 g, early and persistent trajectory: 3.3 g, late BMI increase: 4.0 g, p=0.41 Girls: normal trajectory: 4.0 g, early and persistent trajectory: 3.8 g, late BMI increase: 3.3 g, p=0.99 Results analyzed by % of total energy were similar.	**Key confounders accounted for:** SEP; sex; race/ethnicity; milk feeding practices; baseline anthropometry (types and amounts, multinomial regression only). **Key confounders NOT accounted for:** gestational age (types and amounts). **Model adjustments:** dietary intervention group, BF, parental obesity, ethnicity, smoking during pregnancy, father's education status (types and amounts, multinomial regression only) **Funding:** National Health and Medical Research Council of Australia

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Mahoney, 2018[27] PCS, Born in Bradford 1000, U.K. Analytic N = 12 mo: 722; 18 mo: 779 (Excluded participants with multiple births, missing child dietary data or outcome data, and not of White British or Pakistani ethnicity) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Pakistani: ~56%, White British: ~44% Maternal education: NR Other SEP measure(s): NR Maternal age: NR Milk feeding practices: NR Child sex (female): NR Birth weight: 3,234.15 (521.97) g Gestational age: NR	**Exposure(s) and comparator(s):** Sweet snacks, including cakes, biscuits, chocolate, sweets: ≤ vs > Median frequency **Dietary assessment methods:** FFQ completed by parents **Age(s) at dietary assessment:** 12, 18 mo **Amounts consumed:** Frequency at 12, 18 mo, respectively (Median, IQR): 0.6 (0.3, 1.1) x/d, 3.0 (2.0, 4.0) x/d **Outcome(s):** BMIZ **Outcome assessment methods:** Height, weight measured by trained researchers. Age- and sex-adjusted BMI calculated based on WHO 2006 standards. **Age(s) at outcome assessment:** 36 mo	**BMIZ @ 36 mo (β (95% CI))** Intake @ 12 mo: > vs ≤ 0.6/d: -0.05 (-0.21, 0.11), p=0.54 Intake @ 18 mo: > vs ≤ 3.0/d: 0.00 (-0.16, 0.15), p=0.99	**Key confounders accounted for:** Sex; race and/or ethnicity **Key confounders NOT accounted for:** SEP; milk feeding practices; gestational age; baseline anthropometry **Model adjustments:** Ethnicity, sex, birth weight, other key indicator food groups (formula milk; commercial savoury baby foods; commercial sweet baby foods; chips, roast and potato shapes; processed meat products; vegetables; fruit; cakes, biscuits, chocolate and sweets; crisps and savoury snacks; sugar-sweetened drinks; pure fruit juice; low-sugar drinks; water) **Funding:** NIHR

Study and Participant Characteristics	Intervention/Exposure, Comparator, and Outcome	Results	Key Confounders, Model Adjustments, Funding
Moore, 2019[40] PCS, Nurture, U.S. Analytic N = 466 (Reasons for attrition NR) Adequately powered: NR **Participant Characteristics** (Mean (SD) unless otherwise noted) Race and/or ethnicity: Black: 71.5%, White: 19.2%, Other: 8.9%; Latina: 6.5%; (Child race and/or ethnicity: Black: 68.6%, White: 15.0%, White: 14.9%, Latina: 8.9%) Maternal education: ≤ HS diploma: 47.8%; Some college: 30.3%; College graduate: 15.5%; Graduate degree: 6.3% Other SEP measure(s): Household income: ≤$20,000: 55.4%, $20,000-40,000: 19.1%, >$40,000: 16.7% Maternal age: 27.1 (5.8) y Milk feeding practices: BF duration: 14.7 (18.2) wk Child sex (female): 49% Birth weight for gestational age z score: -0.31 (0.9) Gestational age: 100% ≥37 wk	**Exposure(s) and comparator(s):** Sweets (cookies, cake, or candy): never, sometimes, often **Dietary assessment methods:** Infant feeding questionnaire from IFPS II and FITS completed by mother: home visit (3, 6, 9, 12 mo); interactive voice response telephone calls (1, 2, 4, 5, 7, 8, 10, 11 mo) **Age(s) at dietary assessment:** 1-12 mo (monthly) **Amounts consumed:** Frequency, median (IQR): 0-3 mo: 0.0 x/d (0.0, 0.0), 4-6 mo: 0.0 x/d (0.0, 0.0), 7-9 mo: 0.0 x/d (0.0, 1.0), 10-12 mo: 0.7 x/d (0.0, 1.7) **Outcome(s):** WLZ **Outcome assessment methods:** Weight and length were measured by study personnel. Age- and sex-specific WLZ calculated using WHO reference standards. **Age(s) at outcome assessment:** 3 mo, 6 mo, 9 mo, 12 mo	**WLZ @ 6 mo (β (SE))** Sweets at 4-6 mo Sometimes vs Never (ref): 0.11 (0.12), p=NS **Often vs Never (ref): -0.46 (0.17), p<0.01** **WLZ @ 9 mo (β (SE))** Sweets at 7-9 mo Sometimes vs Never (ref): -0.09 (0.14), p=NS **Often vs Never (ref): 0.48 (0.18), p<0.01** **WLZ @ 12 mo (β (SE))** Sweets at 10-12 mo Sometimes vs Never (ref): 0.04 (0.14), p=NS **Often vs Never (ref): 0.53 (0.18), p<0.01** **Sweets (often vs never) by Time interaction: p<0.01**	**Key confounders accounted for:** SEP; sex; race and/or ethnicity; milk feeding practices; gestational age **Key confounders NOT accounted for:** baseline anthropometry **Model adjustments:** birth weight-for-gestational age z-scores, total weeks of any breastfeeding **Funding:** NIH

[a] Abbreviations: @: at; β: beta; BF: breastfeeding; BMI: body mass index; CAPS: Childhood Asthma Prevention Study; CDC: Centers for Disease Control and Prevention; CI: confidence interval; d: day; EBF: exclusive breastfeeding; FF: formula feeding; FFQ: food frequency questionnaire; g: gram; HS: high school; IQR: interquartile range; kg: kilogram; mo: month; NR: not reported; PCS: prospective cohort study; RCT: randomized controlled trial; ref: reference; RR: risk ratio; SD: standard deviation; SE: standard error; SEP: socioeconomic position; U.K.: United Kingdom; U.S.: United States; WC: waist circumference; WHO: World Health Organization; WIC: Special Supplemental Nutrition Program for Women, Infants, and Children; wk: week; WLZ: weight-for-length z-score; x: times; y: year

Table 56. Risk of bias for observational studies examining consumption of food sources of added sugars and growth, body composition, and risk of obesity[a]

Article	Confounding	Exposure measurement	Selection of participants	Post-exposure interventions	Missing data	Outcome measurement	Selection of the reported result	Overall risk of bias
Amaro-Rivera, 2019[1]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Garden, 2011[30]	SOME CONCERNS	LOW	LOW	LOW	LOW	LOW	SOME CONCERNS	SOME CONCERNS
Garden 2012[29]	SOME CONCERNS	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Mahoney, 2018[27]	HIGH	LOW	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH
Moore, 2019[40]	SOME CONCERNS	SOME CONCERNS	LOW	LOW	HIGH	LOW	SOME CONCERNS	HIGH

[a] Possible ratings of low, some concerns, high, very high, no information, or not applicable determined using the "Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E)" tool (Higgins JPT, Morgan RL, Rooney AA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). *Environment International* 2024 (published online Mar 24); doi: 10.1016/j.envint.2024.108602.) *Low risk of bias except for concerns about uncontrolled confounding.

Summary of conclusion statements and grades

The Committee answered the systematic review question, “What is the relationship between complementary feeding and growth, body composition, and risk of obesity?”, with the following conclusion statements.* The grades reflect the strength of the evidence underlying the conclusion statements.

<u>Timing of the first introduction of a specific type of complementary food or beverage</u>

- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to 100% juice and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to fruit and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to vegetables and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)
- Introducing grains at or before age 4 months is associated with higher BMI z-score during childhood. This conclusion statement is based on evidence graded as limited. (Grade: Limited)
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to grains and body composition and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to foods from the protein foods group and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency in the body of evidence. (Grade: Grade Not Assignable)
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to the dairy food group and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available, and the evidence that is available has substantial concerns with consistency. (Grade: Grade Not Assignable)
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to sugar-sweetened beverages and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency in the body of evidence. (Grade: Grade Not Assignable)
- A conclusion statement cannot be drawn about the relationship between the age when infants and young children, up to age 24 months, are introduced to food sources of added sugars and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)

<u>Types and amounts of complementary foods or beverages</u>

- A conclusion statement cannot be drawn about the relationship between 100% juice consumption by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency and precision in the body of evidence. (Grade: Grade Not Assignable)
- Fruit consumption by infants and young children, up to age 24 months, is not associated with unfavorable outcomes related to growth patterns during childhood. This conclusion statement is based on evidence graded as limited. (Grade: Limited)
- A conclusion statement cannot be drawn about the relationship between fruit consumption by infants and young children, up to age 24 months, and body composition and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)

* A conclusion statement is carefully constructed, based on the evidence reviewed, to answer the systematic review question. A conclusion statement does not draw implications and should not be interpreted as dietary guidance.

- Vegetable consumption by infants and young children, up to age 24 months, is not associated with unfavorable outcomes related to growth patterns during childhood. This conclusion statement is based on evidence graded as limited. (Grade: Limited)
- A conclusion statement cannot be drawn about the relationship between vegetable consumption by infants and young children, up to age 24 months, and body composition and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)
- Grains consumption by infants and young children, from age 6 months up to age 24 months, is not associated with unfavorable outcomes related to growth patterns and risk of obesity during childhood. This conclusion statement is based on evidence graded as limited. (Grade: Limited)
- A conclusion statement cannot be drawn about the relationship between grains consumption by infants and young children, from age 6 months up to age 24 months, and outcomes related to body composition during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)
- A conclusion statement cannot be drawn about the relationship between consumption of protein foods as a food group by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency and directness in the body of evidence. (Grade: Grade Not Assignable)
- A conclusion statement cannot be drawn about the relationship between dairy consumption by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because of substantial concerns with consistency in the body of evidence. (Grade: Grade Not Assignable)
- Sugar-sweetened beverage consumption by infants, children, and adolescents is associated with unfavorable growth patterns and body composition, and higher risk of obesity in childhood up to early adulthood. This conclusion statement is based on evidence graded as moderate. (Grade: Moderate)[*]
- A conclusion statement cannot be drawn about the relationship between consumption of food sources of added sugars by infants and young children, up to age 24 months, and outcomes related to growth patterns, body composition, and risk of obesity during childhood because there is not enough evidence available. (Grade: Grade Not Assignable)

Research recommendations

The Committee identified the following research recommendations that describe the research, data, and methodological advances that are needed to strengthen the body of evidence on complementary feeding and growth, body composition, and risk of obesity.

1. Conduct rigorous studies that are designed to assess the impact of complementary foods and beverages on growth, body composition, and risk of obesity.
2. Take a finer developmental lens to the examination of consumption of complementary foods and beverages among infants and young children, particularly from age 6 to 12 months, to better understand how these foods and beverages should be incorporated and contribute to the changing diet.
3. Provide detailed information on the intervention or exposure (i.e., type, amount, frequency, and timing) as well as full daily dietary intake, as applicable.
4. Examine food groups collectively and comprehensively, such that measures reflect a wide range of foods and beverages within each group (e.g., grains, dairy, protein foods), and, in particular, examine measures of protein foods that include both animal sources (e.g., meat, poultry, seafood) and plant sources (e.g., beans, legumes).

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[*] Note: The articles identified in this systematic review were synthesized as part of the systematic review with meta-analysis on sugar-sweetened beverages and growth, body composition, and risk of obesity across the lifespan to avoid duplication of effort (Deierlein AL, Raynor HA, Byrd-Bredbenner C, et al. Sugar-Sweetened Beverages and Growth, Body Composition, and Risk of Obesity: A Systematic Review with Meta-Analysis. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2024. https://doi.org/10.52570/NESR.DGAC2025.SR05). The relevant conclusion statement from that review is presented here for completeness.

5. Measure consumption of 100% juice with greater specificity, such that 100% juice can be assessed separately from beverages such as juice drinks or juice with added sugar.
6. Measure growth, body composition, and risk of obesity at multiple time points, versus single timepoints, to examine change and trajectories in these outcomes relative to differences in complementary feeding
7. Prioritize assessment of outcomes that are most interpretable and useful for assessing growth in infants and young children, such as measures standardized for age and sex.

Acknowledgments and funding

The Committee members were involved in: establishing all aspects of the protocol, which presented the plan for how they would examine the scientific evidence, including the inclusion and exclusion criteria; reviewing all studies that met the criteria they set; deliberating on the body of evidence for each question; and writing and grading the conclusion statements. The NESR team, with assistance from Federal Liaisons (Dennis Anderson-Villaluz, MBA, RD, LDN, FAND; Hazel Hiza, PhD; Rachel Inman, MS, RD; Sarah Karp, MNSP, RD, LDN; Tessa Lasswell, MPH, RDN; TusaRebecca Pannucci, PhD, MPH, RD; Elizabeth Rahavi, RD; Kelley Scanlon, PhD, RD; Colleen Cruz, MPH, RDN) and Project Leadership (Janet de Jesus, MS, RD; Eve Stoody, PhD), supported the Committee by facilitating, executing, and documenting the work necessary to ensure the reviews were completed in accordance with NESR methodology. Contractor support was also provided by Panum Telecom, LLC, a wholly owned subsidiary of Aretum (Emily Madan, PhD).

The Committee and NESR staff thank members of the Meta-Analysis Working Group (Teresa Fung, ScD, RD; Hollie Raynor, PhD, RD, LDN; Deirdre Tobias, ScD) and supporting NESR staff (Betsy Becker, PhD; Natasha Chong Cole, PhD, MPH, RD; Brittany Kingshipp, PhD; Jielin Ming, PhD; Sara Scinto-Madonich, MS; Allison Webster, PhD, RD) for completion of the systematic reviews with meta-analysis regarding consumption of 100% juice and sugar-sweetened beverages which informed sections of this systematic review.

The Committee and NESR staff thank staff from the National Institutes of Health (NIH) for coordinating the peer review of this systematic review, and the peer reviewers for their time and expertise.

Funding: United States Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Alexandria, VA

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Appendices

Appendix 1: Abbreviations

Table A 1. List of abbreviations

Abbreviation	Full name
BMI	Body mass index
BMIZ	Body mass index z-score
CAPS	Childhood Asthma Prevention Study
CDC	Centers for Disease Control and Prevention
FFQ	Food frequency questionnaire
FPL	Federal poverty level
GEHM	Global Exploration of Human Milk
HAZ	Height-for-age z-score
HHS	United States Department of Health and Human Services
IFPS II	Infant Feeding Practices Study II
LAZ	Length-for-age z-score
LoTiS	Longitudinal Twin Study
NESR	Nutrition Evidence Systematic Review
NICHD	*Eunice Kennedy Shriver* National Institutes of Child Human Development
NRCT	Nonrandomized controlled trial
PCS	Prospective cohort study
RCT	Randomized controlled trial
SDS	Standard deviation score
SEP	Socioeconomic position
SSB	Sugar sweetened beverage
USDA	United States Department of Agriculture
WAZ	Weight-for-age z-score
WHO	World Health Organization
WHZ	Weight-for-height z-score

Abbreviation	Full name
WIC	Special Supplemental Nutrition Program for Women, Infants, and Children
WIC ITFPS-2	WIC Infant and Toddler Feeding Practices Study-2
WLZ	Weight-for-length z-score

Appendix 2: Conclusion statements from the existing systematic reviews

Table A 2. Conclusion statements from the existing systematic reviews for the research question: What is the relationship between complementary feeding and growth, body composition, and risk of obesity?

Citation	Conclusion statements and grades
English LK, Obbagy JE, Wong YP, Psota TL, Nadaud P, Johns K, Terry N, Butte NF, Dewey KG, Fleischer DM, Fox MK, Greer FR, Krebs NF, Scanlon KS, Casavale KO, Spahn JM, Stoody E. Timing of Introduction of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. April 2019. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://doi.org/10.52570/NESR.PB242018.SR0305.	• Moderate evidence suggests that first introduction of any complementary food or beverage (CFB) between 4-5 months compared to approximately 6 months of age is not associated with weight status, body composition, body circumferences, weight, or length among generally healthy, full-term infants. (Grade: Moderate) • Limited evidence suggests that introducing CFB before 4 months of age may be associated with higher odds of overweight/obesity. (Grade: Limited) • There is not enough evidence to determine the relationship between introduction of CFB at 7 months of age or older on growth, size, or body composition. (Grade: Grade Not Assignable)
English LK, Obbagy JE, Wong YP, Psota TL, Nadaud P, Johns K, Terry N, Butte NF, Dewey KG, Fleischer DM, Fox MK, Greer FR, Krebs NF, Scanlon KS, Casavale KO, Spahn JM, Stoody E. Types and Amounts of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. April 2019. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://doi.org/10.52570/NESR.PB242018.SR0306.	• Moderate evidence indicates that higher versus lower meat intake or meat versus iron-fortified cereal intake over a short duration (~3mo) during the complementary feeding period does not favorably or unfavorably influence growth, size, and/or body composition. There is insufficient evidence to determine a relationship between meat intake and prevalence/incidence of overweight or obesity. (Grade: Moderate) • Limited evidence suggests that type or amount of cereal given does not favorably or unfavorably influence growth, size, body composition, and/or prevalence/incidence of overweight or obesity. (Grade: Limited) • Moderate evidence suggests that consumption of complementary foods with different fats and/or fatty acid composition does not favorably or unfavorably influence growth, size, or body composition. There is not enough evidence to determine a relationship between consumption of complementary foods with different fats and/or fatty acid composition and/or prevalence/incidence of overweight or obesity. (Grade: Moderate) • Limited evidence suggests that sugar sweetened beverage consumption during the complementary feeding period is associated with increased risk of obesity in childhood, but is not associated with other measures of growth, size, and body composition. (Grade: Limited) • Limited evidence showed a positive association between juice intake and infant weight-for-length and child BMI z-scores. (Grade: Limited) • No conclusion could be made about the relationship between other complementary foods (vegetables, fruit, dairy products and/or cow's milk, cereal-based products, milk-cereal drink, and/or categories such as "ready-made foods") and growth, size, body composition, and/or prevalence/incidence of overweight or obesity. (Grade: Grade Not Assignable)

Appendix 3: Inclusion and exclusion criteria comparison between existing and updated systematic reviews

Table A 3. Inclusion and exclusion criteria comparison between existing[*†] and updated systematic reviews for the research question: What is the relationship between complementary feeding and growth, body composition, and risk of obesity?

Category	Existing Review	Updated Review	Change and Rationale
Study design	Included • Randomized controlled trials • Non-randomized controlled trials • Prospective cohort studies • Retrospective cohort studies • Case-control studies • Pre/post studies with a control Excluded • Cross-sectional studies • Uncontrolled studies • Pre/post studies without a control • Narrative reviews • Systematic reviews • Meta-analyses	Included • Randomized controlled trials • Non-randomized controlled trials[‡] • Prospective cohort studies • Retrospective cohort studies • Nested case-control studies Excluded • Uncontrolled trials[§] • Case-control studies • Cross-sectional studies • Ecological studies • Narrative reviews • Systematic reviews • Meta-analyses • Modeling and simulation studies	Criteria for study design were updated (inclusion of nested-case control studies and exclusion of case-control studies) to strengthen the body of evidence

[*] English LK, Obbagy JE, Wong YP, et al. Timing of Introduction of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2019. https://doi.org/10.52570/NESR.PB242018.SR0305.

[†] English LK, Obbagy JE, Wong YP, et al. Types and Amounts of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2019. https://doi.org/10.52570/NESR.PB242018.SR0306.

[‡] Including quasi-experimental and controlled before-and-after studies

[§] Including uncontrolled before-and-after studies

Category	Existing Review	Updated Review	Change and Rationale
Publication date	<u>Included</u> • January 1980 – July 2016 <u>Excluded</u> • Before January, after July 2016	<u>Included</u> • January 1980 – May 2023[*] <u>Excluded</u> • Before January 1980, after May 2023	Not Applicable
Population: Study participants	<u>Included</u> • Human subjects • Males • Females <u>Excluded</u> • Hospitalized patients, not including birth and immediate post-partum hospitalization of healthy babies	<u>Included</u> • Human <u>Excluded</u> • Non-human	No change other than formatting

[*] This review update date range encompasses the original systematic review date range, which included articles published from January 1980 to July 2016

Category	Existing Review	Updated Review	Change and Rationale

Population:
Life stage
	<u>Included</u>
	• At intervention or exposure:
	  ○ Infants (0-12 months)
	  ○ Toddlers (12-24 months)
	• At outcome:
	  ○ Infants (0-12 months)
	  ○ Toddlers (12-24 months)
	  ○ Child (2-5 years)
	  ○ Child (6-12 years)
	  ○ Adolescents (13-18 years)
	  ○ Adults (19 years and older)
	  ○ Older adults (65-79 years)
	  ○ Older adults (80+ years)
	<u>Excluded</u>
	• At intervention or exposure:
	  ○ Child (2-5 years)
	  ○ Child (6-12 years)
	  ○ Adolescents (13-18 years)
	  ○ Adults (19 years and older)
	  ○ Older adults (65-79 years)
	  ○ Older adults (80+ years)
		<u>Included</u>
		• At intervention or exposure:
		  ○ Infants and young children (birth up to 24 months)
		• At outcome:
		  ○ Infants and young children (birth up to 24 months)
		  ○ Children and adolescents (2 up to 19 years)
		  ○ Adults and older adults (19 years and older)
		<u>Excluded</u>
		• At intervention or exposure:
		  ○ Children and adolescents (2 up to 19 years)
		  ○ Adults and older adults (19 years and older)
			No change other than formatting

Category	Existing Review	Updated Review	Change and Rationale

Population: Health Status	Included
	• Studies done in generally healthy populations
	• Studies done in populations where infants were full term (≥37 weeks gestational age)
	• Studies done in populations with elevated chronic disease risk, or that enroll some participants with a disease or with the health outcome of interest
	Excluded
	• Studies that exclusively enroll subjects with a disease or with the health outcome of interest
	• Studies done in hospitalized or malnourished subjects
	• Studies of exclusively pre-term babies (gestational age <37 weeks) or babies that are small for gestational age (<2500g)
	• Studies of subjects with infectious diseases (e.g. HIV/AIDS) (or with mothers diagnosed with an infectious disease)
		Included
		• Studies that exclusively enroll participants not diagnosed with a disease[*]
		• Studies that enroll some participants:
		  ○ diagnosed with a disease;
		  ○ with severe undernutrition, failure to thrive/underweight, stunting, or wasting.
		  ○ born preterm,[†] with low birth weight,[‡] and/or small for gestational age
		  ○ and/or hospitalized for an illness, injury, or surgery
		Excluded
		• Studies that exclusively enroll participants:
		  ○ diagnosed with a disease;[§]
		  ○ with severe undernutrition, failure to thrive/underweight, stunting, or wasting;
		  ○ born preterm,[†] with low birth weight,[‡] and/or small for gestational age;
		  ○ and/or hospitalized for an illness, injury, or surgery
			No change other than formatting

[*] Studies that enroll participants who are at risk for chronic disease will be included

[†] Gestational age <37 weeks and 0/7 days

[‡] Birth weight <2500g

[§] Studies that exclusively enroll participants with obesity will be included

Category	Existing Review	Updated Review	Change and Rationale

Intervention/exposure	<u>Included</u>
	• Timing of introduction of complementary foods and beverages (CFB)*
	• Types and amounts of CFB consumed
	<u>Excluded</u>
	• Isolated consumption of human milk, infant formulas (e.g., milk-based, soy, partially hydrolyzed, extensive-hydrolyzed, amino acid based), fluid cow's milk before 12 months of age, or vitamin and mineral supplements (e.g., iron drops)
		<u>Included</u>
		• Timing of the first introduction of a *specific type* of complementary food or beverage (CFB)*
		  ○ Fruit, including 100% fruit juice
		  ○ Vegetables
		  ○ Grains
		  ○ Protein foods
		  ○ Dairy and fortified soy alternatives
		  ○ Food/beverage sources of added sugars
		• Types and amounts of CFB
		  ○ Fruit, including 100% fruit juice
		  ○ Vegetables
		  ○ Grains
		  ○ Protein foods
		  ○ Dairy and fortified soy alternatives
		  ○ Food/beverage sources of added sugars
		<u>Excluded</u>
		• Isolated consumption of human milk, infant formulas (e.g., milk-based, soy, partially hydrolyzed, extensive-hydrolyzed, amino acid based), or vitamin and mineral supplements (e.g., iron drops)
		• Dietary patterns
		• Interventions/exposures that do not address any of the following (including interventions/exposures of multiple food groups examined jointly): fruit, including 100% fruit juice, vegetables, grains, protein foods, dairy and fortified soy alternatives, or food/beverage sources of added sugars
		• Type and/or amount of food or beverage not described
		• Timing of the first introduction of *any* CFB
			Criteria for the intervention/exposure were updated to:
			identify specific interventions/exposures of interest for clarity;
			include interventions/exposures of fluid cow's milk before age 12 months;
			exclude intervention/exposures of dietary patterns to prevent duplication of effort across NESR reviews;
			exclude interventions/exposures for the timing of the first introduction of a specific type of CFB and types and amounts of CFB where the type and/or amount of food or beverage is not described for clarity;
			and exclude timing of the first introduction of any CFB as an intervention/exposure

* Complementary foods and beverages (CFB) are defined as foods and beverages (liquids, semisolids, and solids) other than human milk or infant formula provided to an infant or young child to provide nutrients and energy

Category	Existing Review	Updated Review	Change and Rationale

Comparator	Included
	• Different timing of introduction of CFB
	• Different types and amounts of CFB
	Excluded
	• Not applicable
		Included
		• Different timing of the first introduction of a *specific type* of CFB
		• Different types and amounts of CFB
		  o Consumption of a different amount of the same CFB
		  o Consumption of a different type of CFB
		Excluded
		• No comparator
			Criteria for the comparator were updated to identify specific comparisons of interest for clarity

Outcomes	Included • Weight and length/height • BMI, BMI percentile for age and z-score • Waist circumference • Weight change • Weight status change • Weight-for-age, length/stature-for-age, weight-for-length, head, arm, and thigh circumference for age • Change across more than one time point of weight-for-age, length-for-age, weight-for-length, head, arm, and thigh circumference for age • % fat mass, % fat free mass • Skinfold thickness • Incidence of healthy weight, overweight, obesity • Incidence of underweight or failure to thrive, stunting, and wasting in infants and children Excluded • Not applicable	Included Growth (in infants, young children, children, adolescents) • Height, length/stature-for-age • Weight, weight-for-age • Stunting, failure to thrive, wasting • BMI-for-age, weight-for-length/stature • Body circumferences (arm, neck, thigh) • Head circumference Body composition (in infants, young children, children, adolescents, adults, older adults) • Skinfold thickness • Fat mass, ectopic fat • Fat-free mass, lean mass • Waist circumference, waist-to-hip ratio Risk of obesity (in children, adolescents, adults, older adults) • BMI • Overweight and obesity • Underweight • Healthy/normal weight Excluded • Not applicable	No change other than formatting

Category	Existing Review	Updated Review	Change and Rationale
Directness of experimental studies	• Not applicable	Included • Randomized or non-randomized controlled trials designed to examine growth, body composition and/or risk of obesity as a primary outcome Excluded • Randomized or non-randomized controlled trials that were not designed to examine growth, body composition, and/or risk of obesity as a primary outcome (i.e., designed to examine another primary outcome)	Criteria were added to enable focus on evidence more directly designed to answer the research question
Publication status	Included • Studies published in peer-reviewed journals Excluded • Grey literature, including unpublished data, manuscripts, reports, abstracts, conference proceedings	Included • Peer-reviewed articles published in research journals Excluded • Non-peer-reviewed articles, unpublished data or manuscripts, pre-prints, reports, editorials, retracted articles, and conference abstracts or proceedings	No change other than formatting
Language	Included • Studies published in English Excluded • Studies published in languages other than English	Included • Published in English Excluded • Not published in English	No change other than formatting

Category	Existing Review	Updated Review	Change and Rationale
Country[*] [†]	Included • Studies conducted in Very High or High Human Development Countries Excluded • Studies conducted in Medium or Low Human Development Countries	Included • Studies conducted in countries classified as high or very high on the Human Development Index the year(s) the intervention/exposure data were collected Excluded • Studies conducted in countries classified as medium or low on the Human Development Index the year(s) the intervention/exposure data were collected	NESR began applying the Human Development Index classification from the year in which the intervention/exposure data were collected to account for changes in Human Development Index rankings of countries over time

[*] Updated Review: In order to determine the inclusion-exclusion criteria for country, the Human Development classification was used. This classification is based on the Human Development Index (HDI) ranking from the year the study intervention occurred or data were collected (UN Development Program. HDI 1990-2017 HDRO calculations based on data from UNDESA (2017a), UNESCO Institute for Statistics (2018), United Nations Statistics Division (2018b), World Bank (2018b), Barro and Lee (2016) and IMF (2018). Available from: http://hdr.undp.org/en/data). If the study did not report the year in which the intervention occurred or data were collected, the HDI classification for the year of publication was applied. HDI values are available from 1980, and then from 1990 to present. If a study was conducted prior to 1990, the HDI classification from 1990 was applied. If a study was conducted in 2018 or 2019, the most current HDI classification was applied. When a country was not included in the HDI ranking, the current country classification from the World Bank was used instead (The World Bank. World Bank country and lending groups. Available from: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world- country-and-lending-groups)

[†] Existing Review: This classification was based on the Human Development Index (HDI) ranking from the year 2014. When a country was not included in the Human Development Report 2014 ranking, country classification from the World Bank was used instead.

Appendix 4: Literature search strategy

Searches from existing reviews

The search conducted for an existing review identified articles published between January 1980 and July 2016. This 1 search was used in 2 systematic reviews, listed below. Both of those reviews were used in this review. For the complete search documentation, refer to:

English LK, Obbagy JE, Wong YP, et al., Timing of Introduction of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. April 2019. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://doi.org/10.52570/NESR.PB242018.SR0305.

English LK, Obbagy JE, Wong YP, et al., Types and Amounts of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. April 2019. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://doi.org/10.52570/NESR.PB242018.SR0306.

Search A

This search was conducted to update the search from the existing review (referenced above). This search was first run on October 27, 2021, and then periodically run using NESR's continuous evidence monitoring methods through May 2023.[*]

Database: PubMed
Provider: U.S. National Library of Medicine
Date(s) Searched: October 27, 2021 (initial search); October 27, 2021 – June 1, 2023 (continuous evidence monitoring)
Dates Covered: July 20, 2016 - May 31, 2023

Table A 4. Search for PubMed (Search A)

Search #	Concept	String
#1	Infant Feeding	"Infant Nutritional Physiological Phenomena"[Mesh] OR Complementary[tiab] OR supplementary[tiab] OR wean*[tiab] OR transition*[tiab] OR introduction[ti] OR introducing[tiab] OR introduced[tiab] OR "introduction of"[tiab] OR "introduction to"[tiab] OR "infant feed*"[tiab] OR "toddler feeding"[tiab] OR IYCF[tiab] OR "infant and young child feeding"[tiab]

[*] USDA Nutrition Evidence Systematic Review Branch. Chapter 10: Continuous Evidence Monitoring. In: *USDA Nutrition Evidence Systematic Review: Methodology Manual*. February 2023. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review. Available at: https://nesr.usda.gov/methodology-overview.

Search #	Concept	String
#2	Food and Beverage	“Diet”[MeSH] OR “Meals”[MeSH] OR "Food and Beverages"[Mesh] OR "Edible Grain"[Mesh] OR meal*[tiab] OR feeding*[tiab] OR food*[tiab] OR beverage*[tiab] OR eating[tiab] OR diet[tiab] OR diets[tiab] OR cereal*[tiab] OR bread*[tiab] OR whole grain*[tiab] OR juice*[tiab] OR milk[tiab] OR dairy[tiab] OR meat[tiab] OR cheese[tiab] OR yogurt[tiab] OR yoghurt*[tiab] OR fruit*[tiab] OR vegetable*[tiab] OR egg[tiab] OR eggs[tiab] OR nut[tiab] OR nuts[tiab] OR peas[tiab] OR beans[tiab] OR legume*[tiab] OR snack*[tiab] OR candy[tiab] OR "Fast Food*"[tiab] OR seeds[tiab] OR seafood[tiab] OR shellfish[tiab] OR fish[tiab] OR soymilk[tiab] OR wheat[tiab] OR “soy”[tiab] OR “soybean”[tiab]
#3	Growth, body composition, and risk of obesity (pediatric)	"Adipose Tissue"[Mesh] OR "Body Composition"[Mesh] OR "Body Weights and Measures"[MeSH:NoExp] OR "Body Fat Distribution"[Mesh] OR "Body Mass Index"[Mesh] OR "Body Size"[Mesh] OR "Skinfold Thickness"[Mesh] OR "Waist-Hip Ratio"[Mesh] OR "Growth"[Mesh:NoExp] OR anthropometr*[tiab] OR body fat[tiab] OR fat mass[tiab] OR fat free mass[tiab] OR lean mass[tiab] OR obese[tiab] OR obesity[tiab] OR underweight[tiab] OR overweight[tiab] OR weight status[tiab] OR Crown-Rump Length*[tiab] OR body mass index[tiab] OR BMI[tiab] OR adipos*[tiab] OR birth weight*[tiab] OR body weight[tiab] OR body height[tiab] OR body size[tiab] OR body composition[tiab] OR overnutrition[tiab] OR wasting[tiab] OR healthy weight[tiab] OR skin fold[tiab] OR skin folds[tiab] OR skinfold[tiab] OR skinfolds[tiab] OR "Weight Gain"[MeSH] OR "Weight Loss"[MeSH:NoExp] OR weight gain[tiab] OR weight decreas*[tiab] OR (weight[tiab] AND (loss*[tiab] OR chang*[tiab] OR trajector*[tiab])) OR "Growth Charts"[Mesh] OR "growth and development" [Subheading] OR "Growth and Development"[MeSH:NoExp] OR growth[tiab] OR "Overnutrition"[Mesh] OR overeat*[tiab] OR “over eat”[tiab] OR overfed[tiab] OR overfeed*[tiab] OR “under-nutrition”[tiab] OR undernutrition[tiab] OR growth chart*[tiab] OR stunting[tiab] OR stunted[tiab] OR weight for height[tiab] OR stature for age[tiab] OR weight for age[tiab] OR height for age[tiab] OR length for age[tiab] OR weight for length[tiab] OR failure to thrive[tiab]
#4		#1 AND #2 AND #3
#5	Limiters	#5 NOT ("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh])) NOT (editorial[ptyp] OR comment[ptyp] OR commentary[tiab] OR news[ptyp] OR letter[ptyp] OR review[ptyp] OR systematic review[ptyp] OR systematic review[ti] OR meta-analysis[ptyp] OR meta-analysis[ti] OR meta-analyses[ti] OR protocol[ti] OR protocols[ti] OR retracted publication[ptyp] OR retraction of publication[ptyp] OR retraction of publication[tiab] OR retraction notice[ti] OR“retracted publication”[ti] OR "Congress"[Publication Type] OR "Consensus Development Conference"[Publication Type] OR “conference abstract*”[tiab] OR “conference proceeding*”[tiab] OR “conference paper*”[tiab] OR "practice guideline"[ptyp] OR "practice guideline"[ti]) Language: English Publication Date: 07/20/2016 – 6/31/2023

Database: Embase

Provider: Elsevier
Date(s) Searched: October 27, 2021 (initial search); October 27, 2021 – June 1, 2023 (continuous evidence monitoring)
Dates Covered: July 20, 2016 - May 31, 2023

Table A 5. Search for Embase (Search A)

Search #	Concept	String
#1	Infant Feeding	‘Infant Nutrition’/exp OR ‘complementary’:ab,ti OR ‘supplementary’:ab,ti OR ‘wean*’:ab,ti OR ‘transition*’:ab,ti OR ‘introduction’:ti OR ‘introducing’:ab,ti OR ‘introduced’:ab,ti OR ‘introduction of’:ab,ti OR ‘introduction to’:ab,ti OR ‘infant feed*’:ab,ti OR ‘toddler feeding’:ab,ti OR ‘IYCF’:ab,ti OR ‘infant and young child feeding’:ab,ti
#2	Food and Beverage	‘diet’/exp OR ‘meal’/exp OR ‘Food’/exp OR ‘Beverages’/exp OR ‘meal*’:ab,ti OR ‘feeding*’:ab,ti OR ‘food*’:ab,ti OR ‘beverage*’:ab,ti OR ‘eating’:ab,ti OR ‘diet’:ab,ti OR ‘diets’:ab,ti OR ‘cereal*’:ab,ti OR ‘bread*’:ab,ti OR ‘whole grain*’:ab,ti OR ‘juice*’:ab,ti OR ‘milk’:ab,ti OR ‘dairy’:ab,ti OR ‘meat’:ab,ti OR ‘cheese’:ab,ti OR ‘yogurt’:ab,ti OR ‘yoghurt*’:ab,ti OR ‘fruit*’:ab,ti OR ‘vegetable*’:ab,ti OR ‘egg’:ab,ti OR ‘eggs’:ab,ti OR ‘nut’:ab,ti OR ‘nuts’:ab,ti OR ‘peas’:ab,ti OR ‘beans’:ab,ti OR ‘legume*’:ab,ti OR ‘snack*’:ab,ti OR ‘candy’:ab,ti OR ‘Fast Food*’:ab,ti OR ‘seeds’:ab,ti OR ‘seafood’:ab,ti OR ‘shellfish’:ab,ti OR ‘fish’:ab,ti OR ‘soymilk’:ab,ti OR ‘wheat’:ab,ti OR ‘soy’:ab,ti OR ‘soybean’:ab,ti
#3	Growth, body composition, and risk of obesity (pediatric)	‘anthropometr*’:ab,ti OR ‘body fat’:ab,ti OR ‘fat mass’:ab,ti OR ‘fat free mass’:ab,ti OR ‘lean mass’:ab,ti OR ‘obese’:ab,ti OR ‘obesity’:ab,ti OR ‘underweight’:ab,ti OR ‘overweight’:ab,ti OR ‘weight status’:ab,ti OR ‘Crown-Rump Length*’:ab,ti ‘body mass index’:ab,ti OR ‘BMI’:ab,ti OR ‘adipos*’:ab,ti birth weight*:ab,ti OR ‘body weight’:ab,ti OR ‘body height’:ab,ti OR ‘body size’:ab,ti OR ‘body composition’:ab,ti OR ‘overnutrition’:ab,ti OR ‘wasting’:ab,ti OR ‘healthy weight’:ab,ti OR ‘skin fold’:ab,ti OR ‘skin folds’:ab,ti OR ‘skinfold’:ab,ti OR ‘skinfolds’:ab,ti OR ‘body weight change’/exp OR (weight NEAR/4 (decreas* OR gain* OR loss* OR chang* OR trajector*)):ab,ti OR ‘weight chart’/exp OR ‘postnatal development’/exp OR ‘physical development’/exp OR ‘overnutrition’/exp OR ‘Growth Disorder’/exp OR ‘growth’:ab,ti OR ‘overeat*’:ab,ti OR ‘over eat’:ab,ti OR ‘overfed’:ab,ti OR ‘overfeed*’:ab,ti OR ‘under-nutrition’:ab,ti OR ‘undernutrition’:ab,ti OR stunting:ab,ti OR stunted:ab,ti OR ‘weight for height’:ab,ti OR ‘stature for age’:ab,ti OR ‘weight for age’:ab,ti OR ‘height for age’:ab,ti OR ‘length for age’:ab,ti OR ‘weight for length’:ab,ti OR ‘ failure to thrive’:ab,ti
#4		#1 AND #2 AND #3

Search #	Concept	String
#5	Limiters	#4 AND ([article]/lim OR [article in press]/lim) NOT ([animals]/lim NOT ([animals]/lim AND [humans]/lim)) AND [english]/lim NOT ([conference abstract]/lim OR [conference paper]/lim OR [conference review]/lim OR [editorial]/lim OR [erratum]/lim OR [letter]/lim OR [note]/lim OR 'retraction of publication':ab,ti OR 'retraction notice':ti OR 'retracted publication':ab,ti OR [review]/lim OR [systematic review]/lim OR [meta analysis]/lim OR 'practice guideline':ti) AND [2016-2023]/py

Database: Cochrane Central Register of Controlled Trials (CENTRAL)

Provider: John Wiley & Sons
Date(s) Searched: October 27, 2021 (initial search); October 27, 2021 – June 1, 2023 (continuous evidence monitoring)
Dates Covered: July 20, 2016 - May 31, 2023

Table A 6. Search for Cochrane CENTRAL (Search A)

Search #	Concept	String
#1	Infant Feeding	[mh “Infant Nutritional Physiological Phenomena”] OR (complementary OR supplementary OR wean* OR transition* OR introduction OR introducing OR introduced OR "introduction of" OR "introduction to" OR "infant feed*" OR "toddler feeding" OR IYCF OR "infant and young child feeding"):ti,ab,kw
#2	Food and Beverage	[mh “diet”] OR [mh “meals”] OR [mh “Food and Beverages”] OR (“meal*” OR “feeding*” OR “food*” OR “beverage*” OR “eating” OR “diet” OR “diets” OR “cereal*” OR “bread*” OR “whole grain*” OR “juice*” OR “milk” OR “dairy” OR “meat” OR “cheese” OR “yogurt” OR “yoghurt*” OR “fruit*” OR “vegetable*” OR “egg” OR “eggs” OR “nut” OR “nuts” OR “peas” OR “beans” OR “legume*” OR “snack*” OR “candy” OR “Fast Food*” OR “seeds” OR “seafood” OR “shellfish” OR “fish” OR “soymilk” OR “wheat” OR “soy” OR “soybean”):ti,ab,kw

Search #	Concept	String
#3	Growth, body composition, and risk of obesity (pediatric)	[mh "Adipose Tissue"] OR [mh "Body Composition"] OR [mh ^"Body Weights and Measures"] OR [mh "Body Fat Distribution"] OR [mh "Body Mass Index"] OR [mh "Body Size"] OR [mh "Skinfold Thickness"] OR [mh "Waist-Hip Ratio"] OR [mh ^Growth] OR (anthropometr* OR “body fat” OR “fat mass” OR “fat free mass” OR “lean mass” OR obese OR obesity OR underweight OR overweight OR “weight status” OR “Crown-Rump Length*” OR “body mass index” OR BMI OR adipos* OR "birth weight*" OR “body weight” OR “body height” OR “body size” OR “body composition” OR overnutrition OR wasting OR “healthy weight” OR “skin fold” OR “skin folds” OR skinfold OR skinfolds):ti,ab,kw OR [mh "Body-Weight Trajectory"] OR [mh "Weight Gain"] OR [mh ^"Weight Loss"] OR (weight NEAR/4 (decreas* OR gain* OR loss* OR chang* OR trajectory*)):ti,ab,kw OR [mh “Growth Charts”] OR [mh /GD] OR [mh ^“Growth and Development”] OR [mh Overnutrition] OR [mh “Growth Disorders”] OR (growth OR overeat* OR “over eat” OR overfed OR overfeed* OR “under-nutrition” OR undernutrition OR stunting OR stunted OR “weight for height” OR “stature for age” OR “weight for age” OR “height for age” OR “length for age” OR “weight for length” OR “failure to thrive”):ti,ab,kw
#4		#1 AND #2 AND #3 In Trials (Word variations have been searched) Year first published: 2016 - 2023

Database: CINAHL

Provider: EBSCO
Date(s) Searched: October 27, 2021 (initial search); October 27, 2021 – June 1, 2023 (continuous evidence monitoring)
Dates Covered: July 20, 2016 - May 31, 2023

Table A 7. Search for CINAHL (Search A)

Search #	Concept	String
#1	Infant Feeding	(MH "Infant Nutritional Physiology+") OR TI (“complementary” OR “supplementary” OR “wean*” OR “transition*” OR “introduction”:ti OR “introducing” OR “introduced” OR “introduction of” OR “introduction to” OR “infant feed*” OR “toddler feeding” OR “IYCF” OR “infant and young child feeding”) OR AB (“complementary” OR “supplementary” OR “wean*” OR “transition*” OR “introduction”:ti OR “introducing” OR “introduced” OR “introduction of” OR “introduction to” OR “infant feed*” OR “toddler feeding” OR “IYCF” OR “infant and young child feeding”)

Search #	Concept	String
#2	Food and Beverage	(MH "Diet+") OR (MH "Meals+") OR (MH "Food and Beverages+") OR TI (“meal*” OR “feeding*” OR “food*” OR “beverage*” OR “eating” OR “diet” OR “diets” OR “cereal*” OR “bread*” OR “whole grain*” OR “juice*” OR “milk” OR “dairy” OR “meat” OR “cheese” OR “yogurt” OR “yoghurt*” OR “fruit*” OR “vegetable*” OR “egg” OR “eggs” OR “nut” OR “nuts” OR “peas” OR “beans” OR “legume*” OR “snack*” OR “candy” OR “Fast Food*” OR “seeds” OR “seafood” OR “shellfish” OR “fish” OR “soymilk” OR “wheat” OR “soy” OR “soybean”) OR AB (“meal*” OR “feeding*” OR “food*” OR “beverage*” OR “eating” OR “diet” OR “diets” OR “cereal*” OR “bread*” OR “whole grain*” OR “juice*” OR “milk” OR “dairy” OR “meat” OR “cheese” OR “yogurt” OR “yoghurt*” OR “fruit*” OR “vegetable*” OR “egg” OR “eggs” OR “nut” OR “nuts” OR “peas” OR “beans” OR “legume*” OR “snack*” OR “candy” OR “Fast Food*” OR “seeds” OR “seafood” OR “shellfish” OR “fish” OR “soymilk” OR “wheat” OR “soy” OR “soybean”)
#3	Growth, body composition, and risk of obesity (pediatric)	(MH “Adipose Tissue+”) OR (MH “Body Composition+”) OR (MH “Body Weights and Measures”) OR (MH “Body Height”) OR (MH “Body Mass Index”) OR (MH “Body Size”) OR (MH “Body Weight+”) OR (MH “Crown-Rump Length”) OR (MH “Skinfold Thickness”) OR (MH “Obesity+”) OR (MH “Growth”) OR TI (anthropometr* OR “body fat” OR “fat mass” OR “fat free mass” OR “lean mass” OR obese OR obesity OR underweight OR overweight OR “weight status” OR “Crown-Rump Length” OR “body mass index” OR BMI OR adipos* OR “body weight” OR “body height” OR “body size” OR “body composition” OR overnutrition OR wasting OR “healthy weight” OR “skin fold” OR “skin folds” OR skinfold OR skinfolds) OR (AB anthropometr* OR “body fat” OR “fat mass” OR “fat free mass” OR “lean mass” OR obese OR obesity OR underweight OR overweight OR “weight status” OR “Crown-Rump Length” OR “body mass index” OR BMI OR adipos* OR “body weight” OR “body height” OR “body size” OR “body composition” OR overnutrition OR wasting OR “healthy weight” OR “skin fold” OR “skin folds” OR skinfold OR skinfolds) OR (MH "Weight Gain+") OR (MH "Weight Loss") OR TI (weight N4 (decreas* OR gain* OR maint* OR reduc* OR loss* OR chang*)) OR AB (weight N4 (decreas* OR gain* OR maint* OR reduc* OR loss* OR chang*)) OR (MH “Overnutrition”) OR (MH “Growth Disorders+”) OR TI (growth OR overeat* OR “over eat” OR overfed OR overfeed* OR “under-nutrition” OR undernutrition OR stunting OR stunted OR “weight for height” OR “stature for age” OR “weight for age” OR “height for age” OR “length for age” OR “weight for length” OR “failure to thrive”) OR AB (growth OR overeat* OR “over eat” OR overfed OR overfeed* OR “under-nutrition” OR undernutrition OR stunting OR stunted OR “weight for height” OR “stature for age” OR “weight for age” OR “height for age” OR “length for age” OR “weight for length” OR “failure to thrive”)
#4		S1 AND S2 AND S3

Search #	Concept	String
#5	Limiters	S4 NOT ((MH "Animals+") OR (MH "Animal Studies")) NOT ((MH "Congresses and Conferences") OR (MH "Literature Review") OR (MH "Meta Analysis") OR (MH "Systematic Review") OR (MH "News") OR (MH "Practice Guidelines") OR (MH "Retracted Publication") OR (MH "Retraction of Publication”)) Limiters - English Language, Expanders - Apply equivalent subject; Published Date July 2016 – May 31, 2023

Search B

This search was updated to expand the definition of complementary food and beverage to include all food and drink intake between 0 and 24 months, and then run against the existing search to isolate unique results.

Database: PubMed
Provider: U.S. National Library of Medicine
Date(s) Searched: June 1, 2023
Dates Covered: January 1, 1980 – May 31, 2023

Table A 8. Search for PubMed (Search B)

Search #	Concept	String
#1	Infant Feeding	"Infant Nutritional Physiological Phenomena"[Mesh] OR Complementary[tiab] OR supplementary[tiab] OR wean*[tiab] OR transition*[tiab] OR introduction[ti] OR introducing[tiab] OR introduced[tiab] OR “introduction of”[tiab] OR “introduction to”[tiab] OR “infant feed*”[tiab] OR “toddler feeding”[tiab] OR IYCF[tiab] OR “infant and young child feeding”[tiab] OR (("Infant"[MeSH] OR "Child"[MeSH] OR child*[tiab]) AND (intake*[tiab] OR consum*[tiab]))
#2	Selected Foods	“Diet”[MeSH:NoExp] OR “Meals”[MeSH] OR "Food and Beverages"[Mesh] OR "Edible Grain"[Mesh] OR meal*[tiab] OR “plant based”[tiab] OR feeding*[tiab] OR food*[tiab] OR beverage*[tiab] OR drink[tiab] OR drinks[tiab] OR eating[tiab] OR diet[tiab] OR diets[tiab] OR cereal*[tiab] OR bread*[tiab] OR whole grain*[tiab] OR juice*[tiab] OR milk[tiab] OR dairy[tiab] OR meat[tiab] OR cheese[tiab] OR yogurt[tiab] OR yoghurt*[tiab] OR fruit*[tiab] OR vegetable*[tiab] OR egg[tiab] OR eggs[tiab] OR nut[tiab] OR nuts[tiab] OR peas[tiab] OR beans[tiab] OR legume*[tiab] OR snack*[tiab] OR candy[tiab] OR "Fast Food*”[tiab] OR seeds[tiab] OR seafood[tiab] OR shellfish[tiab] OR fish[tiab] OR soymilk[tiab] OR wheat[tiab] OR “soy”[tiab] OR “soybean”[tiab]

Search #	Concept	String
#3	Growth, body composition, and risk of obesity (pediatric)	"Adipose Tissue"[Mesh] OR "Body Composition"[Mesh] OR "Body Weights and Measures"[MeSH:NoExp] OR "Body Fat Distribution"[Mesh] OR "Body Mass Index"[Mesh] OR "Body Size"[Mesh] OR "Skinfold Thickness"[Mesh] OR "Waist-Hip Ratio"[Mesh] OR "Overnutrition"[Mesh] OR "Growth"[Mesh:NoExp] OR anthropometr*[tiab] OR body fat[tiab] OR fat mass[tiab] OR fat free mass[tiab] OR lean mass[tiab] OR obese[tiab] OR obesity[tiab] OR underweight[tiab] OR overweight[tiab] OR weight status[tiab] OR head circumference[tiab] OR arm circumference[tiab] OR calf circumference[tiab] OR neck circumference[tiab] OR thigh circumference[tiab] OR waist circumference[tiab] OR waist to hip ratio[tiab] OR waist hip ratio[tiab] OR body mass index[tiab] OR BMI[tiab] OR adipos*[tiab] OR body weight[tiab] OR body height[tiab] OR body size[tiab] OR body composition[tiab] OR overnutrition[tiab] OR wasting[tiab] OR healthy weight[tiab] OR skin fold[tiab] OR skin folds[tiab] OR skinfold[tiab] OR skinfolds[tiab] OR "Body-Weight Trajectory"[Mesh] OR "Weight Gain"[MeSH] OR "Weight Loss"[MeSH:NoExp]OR weight gain*[tiab] OR weight decreas*[tiab] OR "lose weight"[tiab:~4] OR "loses weight"[tiab:~4] OR "losing weight"[tiab:~4] OR "lost weight"[tiab:~4] OR "weight loss"[tiab:~4] OR "change weight"[tiab:~4] OR "changes weight"[tiab:~4] OR "changing weight"[tiab:~4] OR "changed weight"[tiab:~4] OR “Growth Charts”[Mesh] OR growth chart*[tiab]OR stunting[tiab] OR stunted[tiab] OR weight for height[tiab] OR stature for age[tiab] OR weight for age[tiab] OR height for age[tiab] OR length for age[tiab] OR weight for length[tiab] OR failure to thrive[tiab]
#4		#1 AND #2 AND #3
#5	Updated search NOT existing search	
#6		#5 NOT ("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh])) NOT (editorial[ptyp] OR comment[ptyp] OR commentary[tiab] OR news[ptyp] OR letter[ptyp] OR review[ptyp] OR systematic review[ptyp] OR systematic review[ti] OR meta-analysis[ptyp] OR meta-analysis[ti] OR meta-analyses[ti] OR protocol[ti] OR protocols[ti] OR retracted publication[ptyp] OR retraction of publication[ptyp] OR retraction of publication[tiab] OR retraction notice[ti] OR“retracted publication”[ti] OR "Congress"[Publication Type] OR "Consensus Development Conference"[Publication Type] OR “conference abstract*”[tiab] OR “conference proceeding*”[tiab] OR “conference paper*”[tiab] OR "practice guideline"[ptyp] OR "practice guideline"[ti]) Language: English Publication Date: 1980/01/01- 3000/12/12

Database: Embase

Provider: Elsevier
Date(s) Searched:
Date(s) Searched: June 1, 2023
Dates Covered: January 1, 1980 – May 31, 2023

Table A 9. Search for Embase (Search B)

Search #	Concept	String
#1	Infant Feeding	'Infant Nutrition'/exp OR 'complementary':ab,ti OR 'supplementary':ab,ti OR 'wean*':ab,ti OR 'transition*':ab,ti OR 'introduction':ti OR 'introducing':ab,ti OR 'introduced':ab,ti OR 'introduction of':ab,ti OR 'introduction to':ab,ti OR 'infant feed*':ab,ti OR 'toddler feeding':ab,ti OR 'IYCF':ab,ti OR 'infant and young child feeding':ab,ti OR (('Child'/exp OR child*:ab,ti) AND ('intake*':ab,ti OR 'consum*':ab,ti))
#2	Selected Foods	'diet'/de OR 'meal'/exp OR 'Food'/exp OR 'Beverages'/exp OR 'meal*':ab,ti OR 'plant based':ab,ti OR 'feeding*':ab,ti OR 'food*':ab,ti OR 'beverage*':ab,ti OR 'drink':ab,ti OR 'drinks':ab,ti OR 'eating':ab,ti OR 'diet':ab,ti OR 'diets':ab,ti OR 'cereal*':ab,ti OR 'bread*':ab,ti OR 'whole grain*':ab,ti OR 'juice*':ab,ti OR 'milk':ab,ti OR 'dairy':ab,ti OR 'meat':ab,ti OR 'cheese':ab,ti OR 'yogurt':ab,ti OR 'yoghurt*':ab,ti OR 'fruit*':ab,ti OR 'vegetable*':ab,ti OR 'egg':ab,ti OR 'eggs':ab,ti OR 'nut':ab,ti OR 'nuts':ab,ti OR 'peas':ab,ti OR 'beans':ab,ti OR 'legume*':ab,ti OR 'snack*':ab,ti OR 'candy':ab,ti OR 'Fast Food*':ab,ti OR 'seeds':ab,ti OR 'seafood':ab,ti OR 'shellfish':ab,ti OR 'fish':ab,ti OR 'soymilk':ab,ti OR 'wheat':ab,ti OR 'soy':ab,ti OR 'soybean':ab,ti
#3	Growth, body composition, and risk of obesity (pediatric)	'adipose tissue'/exp OR 'body composition'/exp OR 'anthropometry'/de OR 'body mass'/exp OR 'anthropometric parameters'/exp OR 'skinfold thickness'/exp OR 'overnutrition'/exp OR 'growth'/de OR 'anthropometr*':ab,ti OR 'body fat':ab,ti OR 'fat mass':ab,ti OR 'fat free mass':ab,ti OR 'lean mass':ab,ti OR 'obese':ab,ti OR 'obesity':ab,ti OR 'underweight':ab,ti OR 'overweight':ab,ti OR 'weight status':ab,ti OR 'head circumference':ab,ti OR 'arm circumference':ab,ti OR 'calf circumference':ab,ti OR 'neck circumference':ab,ti OR 'thigh circumference':ab,ti OR 'waist circumference':ab,ti OR 'waist to hip ratio':ab,ti OR 'waist hip ratio':ab,ti OR 'body mass index':ab,ti OR 'BMI':ab,ti OR 'adipos*':ab,ti OR 'body weight':ab,ti OR 'body height':ab,ti OR 'body size':ab,ti OR 'body composition':ab,ti OR 'overnutrition':ab,ti OR 'wasting':ab,ti OR 'healthy weight':ab,ti OR 'skin fold*':ab,ti OR 'skinfold*':ab,ti OR 'body weight management'/exp OR 'body weight change'/exp OR (weight NEAR/4 (decreas* OR gain* OR loss* OR chang*)):ab,ti OR 'weight chart'/exp OR 'growth chart*':ab,ti OR stunting:ab,ti OR stunted:ab,ti OR 'weight for height':ab,ti OR 'stature for age':ab,ti OR 'weight for age':ab,ti OR 'height for age':ab,ti OR 'length for age':ab,ti OR 'weight for length':ab,ti OR ' failure to thrive':ab,ti
#4		#1 AND #2 AND #3

Search #	Concept	String
#5	Updated search NOT existing search	
#6		#5 AND ([article]/lim OR [article in press]/lim) NOT ([animals]/lim NOT ([animals]/lim AND [humans]/lim)) AND [english]/lim NOT ([conference abstract]/lim OR [conference paper]/lim OR [conference review]/lim OR [editorial]/lim OR [erratum]/lim OR [letter]/lim OR [note]/lim OR 'retraction of publication':ab,ti OR 'retraction notice':ti OR 'retracted publication':ab,ti OR [review]/lim OR [systematic review]/lim OR [meta analysis]/lim OR 'practice guideline':ti) AND [1980-2023]/py

Database: Cochrane Central Register of Controlled Trials (CENTRAL)

Provider: John Wiley & Sons
Date(s) Searched: June 1, 2023
Dates Covered: January 1, 1980 – May 31, 2023

Table A 10. Search for Cochrane CENTRAL (Search B)

Search #	Concept	String
#1	Infant Feeding	[mh “Infant Nutritional Physiological Phenomena”] OR (complementary OR supplementary OR wean* OR transition* OR introduction OR introducing OR introduced OR "introduction of" OR "introduction to" OR "infant feed*" OR "toddler feeding" OR IYCF OR "infant and young child feeding"):ti,ab,kw OR (([mh "Infant"] OR [mh "Child"] OR child*:ti,ab,kw) AND (intake* OR consum*)):ti,ab,kw
#2	Selected Foods	[mh ^“diet”] OR [mh “meals”] OR [mh “Food and Beverages”] OR (meal* OR “plant based” OR feeding* OR “food*” OR beverage* OR drink OR drinks OR “eating” OR “diet” OR “diets” OR cereal* OR bread* OR “whole grain” OR “whole grains” OR juice* OR “milk” OR “dairy” OR “meat” OR “cheese” OR yogurt* OR yoghurt* OR fruit* OR vegetable* OR “egg” OR “eggs” OR “nut” OR “nuts” OR “peas” OR “beans” OR legume* OR “snack*” OR “candy” OR “Fast Food” OR “fast foods” OR “seeds” OR “seafood” OR “shellfish” OR “fish” OR “soymilk” OR “wheat” OR “soy” OR “soybean”):ti,ab,kw

Search #	Concept	String
#3	Growth, body composition, and risk of obesity (pediatric)	[mh "Adipose Tissue"] OR [mh "Body Composition"] OR [mh ^"Body Weights and Measures"] OR [mh "Body Fat Distribution"] OR [mh "Body Mass Index"] OR [mh "Body Size"] OR [mh "Skinfold Thickness"] OR [mh "Waist-Hip Ratio"] OR [mh Overnutrition] OR [mh ^Growth] OR (anthropometr* OR "body fat" OR "fat mass" OR "fat free mass" OR "lean mass" OR obese OR obesity OR underweight OR overweight OR "weight status" OR "head circumference" OR "arm circumference" OR "calf circumference" OR "neck circumference" OR "thigh circumference" OR "waist circumference" OR "waist to hip ratio" OR "waist hip ratio" OR "body mass index" OR BMI OR adipos* OR "body weight" OR "body height" OR "body size" OR "body composition" OR overnutrition OR wasting OR "healthy weight" OR "skin fold" OR "skin folds" OR skinfold OR skinfolds):ti,ab,kw OR [mh "Body-Weight Trajectory"] OR [mh "Weight Gain"] OR [mh ^"Weight Loss"] OR ((weight NEAR/4 (decreas* OR gain* OR loss* OR chang*)) OR [mh "Growth Charts"] OR "growth chart*" OR stunting OR stunted OR "weight for height" OR "stature for age" OR "weight for age" OR "height for age" OR "length for age" OR "weight for length" OR " failure to thrive"):ti,ab,kw
#4		#1 AND #2 AND #3
#5	Updated search NOT existing search	
#6		#5 In Trials (Word variations have been searched) Date Range: 1980-2023 Language: English

<u>Database: CINAHL</u>

Provider: EBSCO
Date(s) Searched: June 1, 2023
Dates Covered: January 1, 1980 – May 31, 2023

Table A 11. Search for CINAHL (Search B)

Search #	Concept	String
#1	Infant Feeding	(MH "Infant Nutritional Physiology+") OR TI ("complementary" OR "supplementary" OR "wean*" OR "transition*" OR "introduction":ti OR "introducing" OR "introduced" OR "introduction of" OR "introduction to" OR "infant feed*" OR "toddler feeding" OR "IYCF" OR "infant and young child feeding") OR AB ("complementary" OR "supplementary" OR "wean*" OR "transition*" OR "introduction":ti OR "introducing" OR "introduced" OR "introduction of" OR "introduction to" OR "infant feed*" OR "toddler feeding" OR "IYCF" OR "infant and young child feeding") OR TI (((MH "Child") OR child*)) AND (intake*[tiab] OR consum*)) OR AB (((MH "Child") OR child*)) AND (intake*[tiab] OR consum*))

Search #	Concept	String
#2	Selected Foods	(MH "Diet") OR (MH "Meals+") OR (MH "Food and Beverages+") OR TI ("meal*" OR "plant based" OR "feeding*" OR "food*" OR "beverage*" OR "drink" OR "drinks" OR "eating" OR "diet" OR "diets" OR "cereal*" OR "bread*" OR "whole grain*" OR "juice*" OR "milk" OR "dairy" OR "meat" OR "cheese" OR "yogurt" OR "yoghurt*" OR "fruit*" OR "vegetable*" OR "egg" OR "eggs" OR "nut" OR "nuts" OR "peas" OR "beans" OR "legume*" OR "snack*" OR "candy" OR "Fast Food*" OR "seeds" OR "seafood" OR "shellfish" OR "fish" OR "soymilk" OR "wheat" OR "soy" OR "soybean") OR AB ("meal*" OR "plant based" OR "feeding*" OR "food*" OR "beverage*" OR "drink" OR "drinks" OR "eating" OR "diet" OR "diets" OR "cereal*" OR "bread*" OR "whole grain*" OR "juice*" OR "milk" OR "dairy" OR "meat" OR "cheese" OR "yogurt" OR "yoghurt*" OR "fruit*" OR "vegetable*" OR "egg" OR "eggs" OR "nut" OR "nuts" OR "peas" OR "beans" OR "legume*" OR "snack*" OR "candy" OR "Fast Food*" OR "seeds" OR "seafood" OR "shellfish" OR "fish" OR "soymilk" OR "wheat" OR "soy" OR "soybean")
#3	Growth, body composition, and risk of obesity (pediatric)	(MH "Adipose Tissue+") OR (MH "Body Composition+") OR (MH "Body Weights and Measures") OR (MH "Arm Circumference") OR (MH "Body Height") OR (MH "Body Mass Index") OR (MH "Body Size") OR (MH "Body Weight+") OR (MH "Crown-Rump Length") OR (MH "Waist Circumference") OR (MH "Waist-Hip Ratio") OR (MH "Skinfold Thickness") OR (MH "Obesity+") OR (MH "Overnutrition") OR (MH "Growth") OR (TI anthropometr* OR "body fat" OR "fat mass" OR "fat free mass" OR "lean mass" OR obese OR obesity OR underweight OR overweight OR "weight status" OR "head circumference" OR "arm circumference" OR "calf circumference" OR "neck circumference" OR "thigh circumference" OR "waist circumference" OR "waist to hip ratio" OR "waist hip ratio" OR "body mass index" OR BMI OR adipos* OR "body weight" OR "body height" OR "body size" OR "body composition" OR overnutrition OR wasting OR "healthy weight" OR "skin fold" OR "skin folds" OR skinfold OR skinfolds) OR (AB anthropometr* OR "body fat" OR "fat mass" OR "fat free mass" OR "lean mass" OR obese OR obesity OR underweight OR overweight OR "weight status" OR "head circumference" OR "arm circumference" OR "calf circumference" OR "neck circumference" OR "thigh circumference" OR "waist circumference" OR "waist to hip ratio" OR "waist hip ratio" OR "body mass index" OR BMI OR adipos* OR "body weight" OR "body height" OR "body size" OR "body composition" OR overnutrition OR wasting OR "healthy weight" OR "skin fold" OR "skin folds" OR skinfold OR skinfolds) OR (MH "Body Weight Changes") OR (MH "Weight Gain+") OR (MH "Weight Loss") OR (TI (weight N4 (decreas* OR gain* OR loss* OR chang*))) OR (AB (weight N4 (decreas* OR gain* OR loss* OR chang*))) OR (TI "growth chart*" OR stunting OR stunted OR "weight for height" OR "stature for age" OR "weight for age" OR "height for age" OR "length for age" OR "weight for length" OR "failure to thrive") OR (AB "growth chart*" OR stunting OR stunted OR "weight for height" OR "stature for age" OR "weight for age" OR "height for age" OR "length for age" OR "weight for length" OR "failure to thrive")
#4		S1 AND S2 AND S3

Search #	Concept	String
#5	Updated search NOT existing search	
#6		S5 NOT ((MH “Animals+”) OR (MH “Animal Studies”)) NOT ((MH “Congresses and Conferences”) OR (MH “Literature Review”) OR (MH “Meta Analysis”) OR (MH “Systematic Review”) OR (MH “News”) OR (MH “Practice Guidelines”) OR (MH “Retracted Publication”) OR (MH “Retraction of Publication”)) Limiters – English Language, Expanders – Apply equivalent subject Publication Year: 1980-2023

Appendix 5: Excluded articles

The existing systematic reviews*† for this question included 113 total articles. However, after applying the inclusion and exclusion criteria established for the update to that review, 90 articles were no longer eligible for inclusion (**Table A 12**). The majority of these articles were excluded based on the intervention or exposure, as the systematic review inclusion and exclusion criteria were updated to remove first introduction of any complementary food or beverage as an intervention or exposure in this systematic review.

Table A 12. Excluded articles from the existing systematic reviews due to updated eligibility criteria

	Citation	Rationale
1	Abraham EC, Godwin J, Sherriff A, Armstrong J. Infant feeding in relation to eating patterns in the second year of life and weight status in the fourth year. *Public Health Nutr*. 2012;15(9):1705-14. doi: 10.1017/S1368980012002686	Intervention/exposure
2	Agras WS, Kraemer HC, Berkowitz RI, Hammer LD. Influence of early feeding style on adiposity at 6 years of age. *J Pediatr*. 1990;116(5):805-9. doi: 10.1016/s0022-3476(05)82677-0	Intervention/exposure
3	Atkins LA, McNaughton SA, Campbell KJ, Szymlek-Gay EA. Iron intakes of Australian infants and toddlers: Findings from the Melbourne Infant Feeding, Activity and Nutrition Trial (InFANT) Program. *Br J Nutr*. 2016;115(2):285-93. doi: 10.1017/S0007114515004286	Intervention/exposure
4	Bainbridge RR, Mimouni FB, Landi T, Crossman M, Harris L, Tsang RC. Effect of rice cereal feedings on bone mineralization and calcium homeostasis in cow milk formula fed infants. *J Am Coll Nutr*. 1996;15:383-8. doi: 10.1080/07315724.1996.10718613	Directness of experimental studies
5	Baird J, Poole J, Robinson S, et al. Milk feeding and dietary patterns predict weight and fat gains in infancy. *Paediatr Perinat Epidemiol*. 2008;22(6):575-86. doi: 10.1111/j.1365-3016.2008.00963.x	Study design
6	Baker JL, Michaelsen KF, Rasmussen KM, Sorensen TIA. Maternal prepregnant body mass index, duration of breastfeeding, and timing of complementary food introduction are associated with infant weight gain. *Am J Clin Nutr*. 2004;80(6):1579-88. doi: 10.1093/ajcn/80.6.1579	Intervention/exposure
7	Bammann K, Peplies J, De Henauw S, et al. Early life course risk factors for childhood obesity: the IDEFICS case-control study. *PloS One*. 2014;9(2):e86914. doi: 10.1371/journal.pone.0086914	Study design
8	Barrera CM, Perrine CG, Li R, Scanlon KS. Age at Introduction to Solid Foods and Child Obesity at 6 Years. *Child Obes*. 2016;12(3):188-92. doi: 10.1089/chi.2016.0021	Intervention/exposure
9	Barton SJ, Howard PK, Rayens MK. The effects of infant feeding decisions on infant growth. *J Spec Pediatr Nurs*. 2002;7(2):64-70. doi: 10.1111/j.1744-6155.2002.tb00152.x	Study design
10	Bell LK, Golley RK, Daniels L, Magarey AM. Dietary patterns of Australian children aged 14 and 24 months, and associations with socio-demographic factors and adiposity. *Eur J Clin Nutr*. 2013;67(6):638-45. doi: 10.1038/ejcn.2013.23	Intervention/exposure
11	Burdette HL, Whitaker RC, Hall WC, Daniels SR. Breastfeeding, introduction of complementary foods, and adiposity at 5 y of age. *Am J Clin Nutr*. 2006;83(3):550-8. doi: 10.1093/ajcn.83.3.550	Intervention/exposure
12	Dagnelie PC, van Staveren WA. Macrobiotic nutrition and child health: results of a population-based, mixed-longitudinal cohort study in The Netherlands. *Am J Clin Nutr*. 1994;59(5 Suppl):1187s-96s. Doi: 10.1093/ajcn/59.5.1187S	Intervention/exposure
13	Davidsson L, Mackenzie J, Kastenmayer P, et al. Dietary fiber in weaning cereals: a study of the effect on stool characteristics and absorption of energy, nitrogen, and minerals in healthy infants. *J Pediatr Gastroenterol Nutr*. 1996;22(2):167-79. doi: 10.1097/00005176-199602000-00008	Comparator
14	de Beer M, Vrijkotte TG, Fall CH, van Eijsden M, Osmond C, Gemke RJ. Associations of infant feeding and timing of linear growth and relative weight gain during early life with childhood body composition. *Int J Obes*. 2015;39:586-92. doi: 10.1038/ijo.2014.200	Intervention/exposure
15	Dube K, Schwartz J, Mueller MJ, Kalhoff H, Kersting M. Complementary food with low (8%) or high (12%) meat content as source of dietary iron: a double-blinded randomized controlled trial. *Eur J Nutr*. 2010;49(1):11-8. doi: 10.1007/s00394-009-0043-9	Directness of experimental studies

* English LK, Obbagy JE, Wong YP, et al. Timing of Introduction of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2019. https://doi.org/10.52570/NESR.PB242018.SR0305.

† English LK, Obbagy JE, Wong YP, et al. Types and Amounts of Complementary Foods and Beverages and Growth, Size, and Body Composition: A Systematic Review. U.S. Department of Agriculture, Food and Nutrition Service, Center for Nutrition Policy and Promotion, Nutrition Evidence Systematic Review; 2019. https://doi.org/10.52570/NESR.PB242018.SR0306.

	Citation	Rationale
16	Durmus B, Ay L, Duijts L, et al. Infant diet and subcutaneous fat mass in early childhood: the Generation R Study. *Eur J Clin Nutr*. 2012;66:253-60. doi: 10.1038/ejcn.2011.174	Intervention/exposure
17	Durmus B, Heppe DH, Gishti O, et al. General and abdominal fat outcomes in school-age children associated with infant breastfeeding patterns. *Am J Clin Nutr*. 2014;99(6):1351-8. doi: 10.3945/ajcn.113.075937	Intervention/exposure
18	Engelmann MD, Sandstrom B, Michaelsen KF. Meat intake and iron status in late infancy: an intervention study. *J Pediatr Gastroenterol Nutr*. 1998;26(1):26-33. doi: 10.1097/00005176-199801000-00005	Directness of experimental studies
19	Fairley L, Santorelli G, Lawlor DA, et al. The relationship between early life modifiable risk factors for childhood obesity, ethnicity and body mass index at age 3 years: findings from the Born in Bradford birth cohort study. *BMC Obes*. 2015;2:9. doi: 10.1186/s40608-015-0037-5	Intervention/exposure
20	Fawzi WW, Forman MR, Levy A, Graubard BI, Naggan L, Berendes HW. Maternal anthropometry and infant feeding practices in Israel in relation to growth in infancy: the North African Infant Feeding Study. *Am J Clin Nutr*. 1997;65(6):1731-7. doi: 10.1093/ajcn/65.6.1731	Intervention/exposure
21	Ferris AG, Laus MJ, Hosmer DW, Beal VA. The effect of diet on weight gain in infancy. Am J Clin Nut. 1980;33(12):2635-42. doi: 10.1093/ajcn/33.12.2635	Intervention/exposure
22	Forsyth JS, Ogston SA, Clark A, Florey CD, Howie PW. Relation between early introduction of solid food to infants and their weight and illnesses during the first two years of life. *BMJ*. 1993;306(6892):1572-6. doi: 10.1136/bmj.306.6892.1572	Intervention/exposure
23	Friel JK, Gibson RS, Kawash GF, Watts J. Dietary zinc intake and growth during infancy. *J Pediatr Gastroenterol Nutr*. 1985;4(5):746-51. doi: 10.1097/00005176-198510000-00011	Intervention/exposure
24	Gibbs BG, Forste R. Socioeconomic status, infant feeding practices and early childhood obesity. *Pediatr Obes*. 2014;9(2):135-46. doi: 10.1111/j.2047-6310.2013.00155.x	Intervention/exposure
25	Golley, RK, Smithers, LG, Mittinty, MN, Emmett P, Northstone K, Lynch JW. Diet quality of U.K. infants is associated with dietary, adiposity, cardiovascular, and cognitive outcomes measured at 7-8 years of age. *J Nutr*. 2013;143(10):1611-7. doi: 10.3945/jn.112.170605	Intervention/exposure
26	Griffiths LJ, Hawkins SS, Cole TJ, Dezateux C. Risk factors for rapid weight gain in preschool children: findings from a UK-wide prospective study. *Int J Obes*. 2010;34(4):624-32. doi: 10.1038/ijo.2010.10	Intervention/exposure
27	Griffiths LJ, Smeeth L, Sherburne Hawkins S, Cole TJ, Dezateux, C. Effects of infant feeding practice on weight gain from birth to 3 years. *Arch Dis Child*. 2009;94(8):577-82. doi: 10.1136/adc.2008.137554	Intervention/exposure
28	Grote V, Schiess SA, Closa-Monasterolo R, et al. The introduction of solid food and growth in the first 2 y of life in formula-fed children: analysis of data from a European cohort study. *Am J Clin Nutr*. 2011;94(6 Suppl):1785s-93s. doi: 10.3945/ajcn.110.000810	Intervention/exposure
29	Gungor DE, Paul IM, Birch LL, Bartok CJ. Risky vs rapid growth in infancy: refining pediatric screening for childhood overweight. *Arch Pediatr Adolesc Med*. 2010;164:1091-7. doi: 10.1001/archpediatrics.2010.238	Intervention/exposure
30	Harendra de Silva DG, Rajindrajith S, Pathmeswaran A, Karunasekera W. An intervention study to monitor weight gain in infants using a home based complementary food recipe and a hand blender. *Ceylon Med J*. 2007;52(3):79-83. doi: 10.4038/cmj.v52i3.963	Country
31	Haschke F, van't Hof MA. Euro-Growth references for breast-fed boys and girls: influence of breast-feeding and solids on growth until 36 months of age. Euro-Growth Study Group. *J Pediatr Gastroenterol Nutr*. 2000;31 Suppl 1:S60-71. doi: 10.1097/00005176-200007001-00006	Intervention/exposure
32	Hawkins SS, Cole TJ, Law C. An ecological systems approach to examining risk factors for early childhood overweight: findings from the UK Millennium Cohort Study. *J Epidemiol Community Health*. 2009;63:147-55. doi: 10.1136/jech.2008.077917	Intervention/exposure
33	Heinig MJ, Nommsen LA, Peerson JM, Lonnerdal B, Dewey KG. Intake and growth of breast-fed and formula-fed infants in relation to the timing of introduction of complementary foods: the DARLING study. Davis Area Research on Lactation, Infant Nutrition and Growth. *Acta Paediatr*. 1993;82(12):999-1006. doi: 10.1111/j.1651-2227.1993.tb12798.x	Intervention/exposure
34	Hertrampf E, Olivares M, Pizarro F, et al. Haemoglobin fortified cereal: a source of available iron to breast-fed infants. *Eur J Clin Nutr*. 1990;44(11):793-8.	Directness of experimental studies
35	Hoffman DR, Theuer RC, Castaneda YS, et al. Maturation of visual acuity is accelerated in breast-fed term infants fed baby food containing DHA-enriched egg yolk. *J Nutr*. 2004;134(9):2307-13. doi: 10.1093/jn/134.9.2307	Directness of experimental studies
36	Huh SY, Rifas-Shiman SL, Taveras EM, Oken E, Gillman MW. Timing of solid food introduction and risk of obesity in preschool-aged children. *Pediatrics*. 2011;127(3):e544-51. doi: 10.1542/peds.2010-0740	Intervention/exposure

	Citation	Rationale
37	Hui LL, Nelson EA, Yu LM, Li AM, Fok TF. Risk factors for childhood overweight in 6- to 7-y-old Hong Kong children. *Int J Obes Relat Metab Disord.* 2003;27(11):1411-8. doi: 10.1038/sj.ijo.0802423	Study design
38	Iannotti LL, Zavaleta N, Leon Z, Caulfield LE. Growth and body composition of Peruvian infants in a periurban setting. *Food Nutr Bull*. 2009;30(3):245-53. doi: 10.1177/156482650903000305	Country
39	Imai CM, Gunnarsdottir I, Thorisdottir B, Halldorsson TI, Thorsdottir I. Associations between infant feeding practice prior to six months and body mass index at six years of age. *Nutrients*. 2014;6(4):1608-17. doi: 10.3390/nu6041608	Intervention/exposure
40	Johnson L, van Jaarsveld CHM, Llewellyn CH, Cole TJ, Wardle J. Associations between infant feeding and the size, tempo and velocity of infant weight gain: SITAR analysis of the Gemini twin birth cohort. *Int J Obes*. 2014;38(7):980-7. doi: 10.1038/ijo.2014.61	Study design
41	Jonsdottir OH, Kleinman RE, Wells JC, et al. Exclusive breastfeeding for 4 versus 6 months and growth in early childhood. *Acta Paediatr*. 2014;103(1):105-11. doi: 10.1111/apa.12433	Intervention/exposure
42	Jonsdottir OH, Thorsdottir I, Gunnlaugsson G, Fewtrell MS, Hibberd PL, Kleinman RE. Exclusive breastfeeding and developmental and behavioral status in early childhood. *Nutrients*. 2013;5(11):4414-28. doi: 10.3390/nu5114414	Intervention/exposure
43	Jonsdottir OH, Thorsdottir I, Hibberd PL, et al. Timing of the introduction of complementary foods in infancy: a randomized controlled trial. *Pediatrics*. 2012;130(6):1038-45. doi: 10.1542/peds.2011-3838	Intervention/exposure
44	Kalies H, Heinrich J, Borte N, et al. The effect of breastfeeding on weight gain in infants: results of a birth cohort study. *Eur J Med Res*. 2005;10(1):36-42.	Intervention/exposure
45	Khadivzadeh T, Parsai S. Effect of exclusive breastfeeding and complementary feeding on infant growth and morbidity. *East Mediterr Health J*. 2004;10(3):289-94.	Country
46	Kramer MS, Barr RG, Leduc DG, Boisjoly C, McVey-White L, Pless IB. Determinants of weight and adiposity in the first year of life. *J Pediatr*. 1985;106(1):10-4. doi: 10.1016/s0022-3476(85)80456-x	Intervention/exposure
47	Kramer MS, Barr RG, Leduc DG, Boisjoly C, Pless IB. Infant determinants of childhood weight and adiposity. *J Pediatr*. 1985;107(1):104-7. doi: 10.1016/s0022-3476(85)80627-2	Intervention/exposure
48	Kramer MS, Guo T, Platt RW, et al. Feeding effects on growth during infancy. *J Pediatr*. 2004;145(5):600-5. doi: 10.1016/j.jpeds.2004.06.069	Country
49	Lauver MA, Hizon L, Bulla A, Connell C, Wagoner B. Infant feeding practices: the effect on six month weight. *J Kans Med Soc*. 1981;82(9):403-6.	Intervention/exposure
50	Layte R, Bennett A, McCrory C, Kearney J. Social class variation in the predictors of rapid growth in infancy and obesity at age 3 years. *Int J Obes*. 2014;38(1):82-90. doi: 10.1038/ijo.2013.160	Intervention/exposure
51	Leary SD, Lawlor DA, Davey Smith G, Brion MJ, Ness AR. Behavioural early-life exposures and body composition at age 15 years. *Nutr Diabetes*. 2015;5:e150. doi: 10.1038/nutd.2014.47	Intervention/exposure
52	Libuda L, Mesch CM, Stimming M, et al. Fatty acid supply with complementary foods and LC-PUFA status in healthy infants: results of a randomised controlled trial. *Eur J Nutr*. 2016;55:1633-44. doi: 10.1007/s00394-015-0982-2	Directness of experimental studies
53	Lind T, Persson L, Lonnerdal B, Stenlund H, Hernell O. Effects of weaning cereals with different phytate content on growth, development and morbidity: a randomized intervention trial in infants from 6 to 12 months of age. *Acta Pediatr*. 2004;93(12):1575-82. doi: 10.1080/08035250410018355	Directness of experimental studies
54	Liu DS, Bates CJ, Yin TA, Wang XB, Lu CQ. Nutritional efficacy of a fortified weaning rusk in a rural area near Beijing. *Am J Clin Nutr*. 1993;57(4):506-11. doi: 10.1093/ajcn/57.4.506	Country
55	Lonnerdal B, Chen CL. Effects of formula protein level and ratio on infant growth, plasma amino acids and serum trace elements. II. Follow-up formula. *Acta Paediatr Scand*. 1990;79(3):266-73. doi: 10.1111/j.1651-2227.1990.tb11455.x	Country
56	Makela J, Vaarno J, Kaljonen A, Niinikoski H, Lagstrom H. Maternal overweight impacts infant feeding patterns--the STEPS Study. *Eur J Clin Nutr*. 2014;68:43-9. doi: 10.1038/ejcn.2013.229	Intervention/exposure
57	Makrides M, Hawkes JS, Neumann MA, Gibson RA. Nutritional effect of including egg yolk in the weaning diet of breast-fed and formula-fed infants: a randomized controlled trial. *Am J Clin Nutr*. 2002;75(6):1084-92. doi: 10.1093/ajcn/75.6.1084	Directness of experimental studies
58	Makrides M, Leeson R, Gibson RA, Simmer K. A randomized controlled clinical trial of increased dietary iron in breast-fed infants. *J Pediatr*. 1998;133(4):559-62. doi: 10.1016/s0022-3476(98)70069-1	Intervention/exposure
59	Moss BG, Yeaton WH. Early childhood healthy and obese weight status: potentially protective benefits of breastfeeding and delaying solid foods. *Matern Child Health J*. 2014;18(5):1224-32. doi: 10.1007/s10995-013-1357-z	Intervention/exposure
60	Neutzling MB, Hallal PRC, Araujo CLP, et al. Infant feeding and obesity at 11 years: prospective birth cohort study. *Int J Pediatr Obes*. 2009;4(3):143-9. doi: 10.1080/17477160802453530	Country

	Citation	Rationale
61	Olaya GA, Lawson M, Fewtrell MS. Efficacy and safety of new complementary feeding guidelines with an emphasis on red meat consumption: a randomized trial in Bogota, Colombia. *Am J Clin Nutr*. 2013;98(4):983-93. doi: 10.3945/ajcn.112.053595	Intervention/exposure
62	Piwoz EG, Creed de Kanashiro H, Lopez de Romana GL, Black RE, Brown KH. Feeding practices and growth among low-income Peruvian infants: a comparison of internationally-recommended definitions. *Int J Epidemiol*. 1996;25(1):103-14. doi: 10.1093/ije/25.1.103	Country
63	Quandt SA. The effect of beikost on the diet of breast-fed infants. *J Am Diet Assoc*. 1984;84(1):47-51	Intervention/exposure
64	Reilly JJ, Armstrong J, Dorosty AR, et al. Early life risk factors for obesity in childhood: cohort study. *BMJ*. 2005;330(7504):1357. doi: 10.1136/bmj.38470.670903.E0	Intervention/exposure
65	Robinson SM, Marriott LD, Crozier SR, et al. Variations in infant feeding practice are associated with body composition in childhood: a prospective cohort study. *J Clin Endocrinol Metab*. 2009;94:2799-805. doi: 10.1210/jc.2009-0030	Intervention/exposure
66	Rose CM, Savage JS, Birch LL. Patterns of early dietary exposures have implications for maternal and child weight outcomes. *Obesity*. 2016;24(2):430-8. doi: 10.1002/oby.21349	Intervention/exposure
67	Salmenpera L, Perheentupa J, Siimes MA. Exclusively breast-fed healthy infants grow slower than reference infants. *Pediatr Res*. 1985;19(3):307-12. doi: 10.1203/00006450-198503000-00011	Intervention/exposure
68	Schwartz J, Dube K, Sichert-Hellert W, et al. Modification of dietary polyunsaturated fatty acids via complementary food enhances n-3 long-chain polyunsaturated fatty acid synthesis in healthy infants: a double blinded randomised controlled trial. *Arch Dis Child*. 2009;94(11):876-82. doi: 10.1136/adc.2008.146027	Directness of experimental studies
69	Seach KA, Dharmage SC, Lowe AJ, Dixon JB. Delayed introduction of solid feeding reduces child overweight and obesity at 10 years. *Int J Obes*. 2010;34(10):1475-9. doi: 10.1038/ijo.2010.101	Intervention/exposure
70	Tang M, Krebs NF. High protein intake from meat as complementary food increases growth but not adiposity in breastfed infants: a randomized trial. *Am J Clin Nutr*. 2014;100(5):1322-8. doi: 10.3945/ajcn.114.088807	Directness of experimental studies
71	Tantracheewathorn S. Growth of breast-fed and formula-fed infants compared with national growth references of Thai children. *J Med Assoc Thai*. 2005;88(2):168-75.	Intervention/exposure; Country
72	van Rossem L, Kiefte-de Jong JC, Looman CW, et al. Weight change before and after the introduction of solids: results from a longitudinal birth cohort. *Br J Nutr*. 2013;109:370-5. doi: 10.1017/S0007114512001055	Intervention/exposure
73	Victora CG, Morris SS, Barros FC, Horta BL, Weiderpass E, Tomasi E. Breast-feeding and growth in Brazilian infants. *Am J Clin Nutr*. 1998;67(3):452-8. doi: 10.1093/ajcn/67.3.452	Country
74	Villalpando S, Lopez-Alarcon M. Growth faltering is prevented by breast-feeding in underprivileged infants from Mexico City. *J Nutr*. 2000;130(3):546-52. doi: 10.1093/jn/130.3.546	Country
75	Virtanen MA, Svahn CJ, Viinikka LU, Raiha NC, Siimes MA, Axelsson IE. Iron-fortified and unfortified cow's milk: effects on iron intakes and iron status in young children. *Acta Paediatr*. 2001;90(7):724-31.	Intervention/exposure
76	Walter T, Dallman PR, Pizarro F, et al. Effectiveness of iron-fortified infant cereal in prevention of iron deficiency anemia. *Pediatrics*. 1993;91(5):976-82.	Comparator
77	Warrington S, Storey DM. Comparative studies on Asian and Caucasian children. 2: Nutrition, feeding practices and health. *Eur J Clin Nutr*. 1988;42(1):69-79.	Intervention/exposure
78	Wells JC, Jonsdottir OH, Hibberd PL, et al. Randomized controlled trial of 4 compared with 6 mo of exclusive breastfeeding in Iceland: differences in breast-milk intake by stable-isotope probe. *Am J Clin Nutr*. 2012;96(1):73-9. doi: 10.3945/ajcn.111.030403	Intervention/exposure
79	Wells JC, Stanley M, Laidlaw AS, Day JM, Davies PS. Energy intake in early infancy and childhood fatness. *Int J Obes Relat Metab Disord*. 1998;22(5):387-92. doi: 10.1038/sj.ijo.0800572	Intervention/exposure
80	Wen LM, Baur LA, Rissel C, Xu H, Simpson JM. Correlates of body mass index and overweight and obesity of children aged 2 years: findings from the healthy beginnings trial. *Obesity*. 2014;22(7):1723-30. doi: 10.1002/oby.20700	Intervention/exposure
81	Wen X, Kong KL, Eiden RD, Sharm NN, Xie C. Sociodemographic differences and infant dietary patterns. *Pediatrics*. 2014;134(5):e1387-98. doi: 10.1542/peds.2014-1045	Intervention/exposure
82	Wilson AC, Forsyth JS, Greene SA, Irvine L, Hau C, Howie PW. Relation of infant diet to childhood health: seven year follow up of cohort of children in Dundee infant feeding study. *BMJ*. 1998;316(7124):21-5. doi: 10.1136/bmj.316.7124.21	Intervention/exposure
83	Wolman PG. Feeding practices in infancy and prevalence of obesity in preschool children. *J Am Diet Assoc*. 1984;84(4):436-8.	Intervention/exposure
84	World Health Organization. Growth of healthy infants and the timing, type, and frequency of complementary foods. *Am J Clin Nutr*. 2002;76(3):620-7. doi: 10.1093/ajcn/76.3.620	Intervention/exposure

	Citation	Rationale
85	Worobey J, Lopez MI, Hoffman DJ. Maternal behavior and infant weight gain in the first year. *J Nutr Educ Behav*. 2009;41(3):169-75. doi: 10.1016/j.jneb.2008.06.005	Intervention/exposure
86	Worobey J, Pena J, Ramos I, Espinosa C. Infant difficulty and early weight gain: does fussing promote overfeeding? *Matern Child Nutr*. 2014;10:295-303. doi: 10.1111/j.1740-8709.2012.00410.x	Intervention/exposure
87	Yeung DL, Pennell MD, Leung M, Hall J. Infant fatness and feeding practices: a longitudinal assessment. *J Am Diet Assoc*. 1981;79(5):531-5.	Intervention/exposure
88	Yeung GS, Zlotkin SH. Efficacy of meat and iron-fortified commercial cereal to prevent iron depletion in cow milk-fed infants 6 to 12 months of age: a randomized controlled trial. *Can J Public Health*. 2000;91(4):263-7. doi: 10.1007/BF03404285	Directness of experimental studies; Intervention/exposure
89	Zheng JS, Liu H, Zhao YM, et al. Complementary feeding and childhood adiposity in preschool-aged children in a large Chinese cohort. *J Pediatr*. 2015;166(2):326-31.e2. doi: 10.1016/j.jpeds.2014.11.010	Country
90	Zhou L, He G, Zhang J, et al. Risk factors of obesity in preschool children in an urban area in China. *Eur J Pediatr*. 2011;170(11):1401-6. doi: 10.1007/s00431-011-1416-7	Country

The following table (**Table A 13**) lists the articles excluded after full-text screening for the updated systematic review question. At least 1 reason for exclusion is provided for each article, though this may not reflect all possible reasons. Information about articles excluded after title and abstract screening is available upon request.

Table A 13. Articles excluded after full-text screening

	Citation	Rationale
1	Adams ED, Lipman TH. The Impact of Timing of Introduction of Solids on Infant Body Mass Index. MCN Am J Matern Child Nurs. 2017. 42(3):186-186.	Study design
2	Aldana-Parra F, Vega GO, Fewtrell M. Associations between maternal BMI, breastfeeding practices and infant anthropometric status in Colombia; secondary analysis of ENSIN 2010. BMC Public Health. 2020. 20(1):232.	Study design
3	Alderete, E, Bejarano, I, Rodríguez, A. Beverage intake and obesity in early childhood: evidence form primary health care clients in Northwest Argentina. J Dev Orig Health Dis. 2016. 7(3):244-252.	Age at intervention/exposure
4	Anderson CE, Whaley SE, Crespi CM, Wang MC, Chaparro MP. Every month matters: longitudinal associations between exclusive breastfeeding duration, child growth and obesity among WIC-participating children. J Epidemiol Community Health. 2020. 74(10):785-791.	Intervention/exposure
5	Anderson CE, Whaley SE, Crespi CM, Wang MC, Chaparro MP. Mixed Infant Feeding Is Not Associated With Increased Risk of Decelerated Growth Among WIC-Participating Children in Southern California. 2021. 8:723501.	Intervention/exposure
6	Appak YC, Aksoy B, Tinaztepe T, et al. Evaluation of the frequency of obesity and associated factors in children of obese and overweight mothers. Journal of Pediatric Research. 2019. 6(3):228-233.	Study design
7	Ardıç C, Omar E. Obesity frequency and related risk factors in primary school children. European Research Journal. 2019. 5(3):467-472.	Study design
8	Ardic C, Usta O, Omar E, Yildiz C, Memis E. Effects of infant feeding practices and maternal characteristics on early childhood obesity. Arch Argent Pediatr. 2019. 117(1):26-33.	Intervention/exposure
9	Aris IM, Bernard JY, Chen LW, et al. Modifiable risk factors in the first 1000 days for subsequent risk of childhood overweight in an Asian cohort: significance of parental overweight status. Int J Obes (Lond). 2018. 42(1):44-51.	Intervention/exposure
10	Aris IM, Soh SE, Tint MT, et al. Associations of infant milk feed type on early postnatal growth of offspring exposed and unexposed to gestational diabetes in utero. Eur J Nutr. 2017. 56(1):55-64.	Intervention/exposure
11	Arredondo A, Lugo OBR, Orozco E, de la Rosa CPT. Breastfeeding and feeding practices in the first year of life and its association with overweight and obesity of children in Mexico. Rev Bras Saude Mater Infant. 2021. 21(4):1109. doi:10.1590/1806-93042021000400009.	Study design
12	Ashman AM, Collins CE, Weatherall L, et al. A cohort of Indigenous Australian women and their children through pregnancy and beyond: the Gomeroi gaaynggal study. J Dev Orig Health Dis. 2016. 7(4):357-68.	Intervention/exposure, Outcome
13	Ashman AM, Collins CE, Weatherall LJ, et al. Dietary intakes and anthropometric measures of Indigenous Australian women and their infants in the Gomeroi gaaynggal cohort. J Dev Orig Health Dis. 2016. 7(5):481-497.	Study design

	Citation	Rationale
14	Atkin LM, Davies PS. Diet composition and body composition in preschool children. Am J Clin Nutr. 2000. 72(1):15-21.	Age at intervention/exposure
15	Atkins LA, McNaughton SA, Campbell KJ, Szymlek-Gay EA. Iron intakes of Australian infants and toddlers: findings from the Melbourne Infant Feeding, Activity and Nutrition Trial (InFANT) Program. Br J Nutr. 2016. 115(2):285-293.	Outcome
16	Augusto ÉO, Bonucci VG, Cardoso RV, Morais MB. Complementary feeding and nutritional status of infants on cow's milk proteins elimination diet. Rev Paul Pediatr. 2022. 40:e20200429.	Study design, Intervention/exposure, Outcome
17	Azad MB, Vehling L, Chan D, et al. Infant Feeding and Weight Gain: Separating Breast Milk From Breastfeeding and Formula From Food. Pediatrics. 2018. 142(4):e20181092.	Intervention/exposure
18	Azad MB. Infant Feeding and the Developmental Origins of Chronic Disease in the CHILD Cohort: Role of Human Milk Bioactives and Gut Microbiota. Breastfeeding Medicine. 2019. 14(S1):S22-S24.	Study design
19	Bably MB, Paul R, Laditka SB, Racine EF. Factors Associated with the Initiation of Added Sugar among Low-Income Young Children Participating in the Special Supplemental Nutrition Program for Women, Infants, and Children in the US. Nutrients. 2021. 13(11):3888.	Outcome
20	Bably MB, Laditka SB, Paul R, Racine EF. Age of Bottle Cessation and BMI-for-Age Percentile among Children Aged Thirty-Six Months Participating in WIC. Child Obes. 2022. 18(3):197-205. doi:10.1089/chi.2021.0119.	Intervention/exposure
21	Baran J, Weres A, Czenczek-Lewandowska E, et al. Early Eating Patterns and Overweight and Obesity in a Sample of Preschool Children in South-East Poland. Int J Environ Res Public Health. 2019. 16(17):3064.	Study design, Age at intervention/exposure
22	Barbosa C, Costa A, Hetherington MM, Oliveira A. Association of early feeding practices with dietary patterns of 7-year-olds from the birth cohort Generation XXI. Appetite. 2022. 171:105909.	Outcome
23	Barrera CM, Perrine CG, Li R, Scanlon KS. Age at Introduction to Solid Foods and Child Obesity at 6 Years. Child Obes. 2016. 12(3):188-192.	Duplicate data
24	Barrett, KJ, Thompson, AL. Infant eating behaviors and Milk feeding independently predict infant size. Am J Hum Biol. 2022. 34(4):e23678. doi:10.1002/ajhb.23678.	Intervention/exposure
25	Barros VO, Amorim MR, Melo AO, Tavares JS, Silva AC, Alves JG. Abdominal Fat Distribution among Breastfed and Formula-Fed Infants. Breastfeeding Medicine. 2016. 11(5):231-234.	Intervention/exposure
26	Barroso M, Beth SA, Voortman T, et al. Dietary Patterns After the Weaning and Lactation Period Are Associated With Celiac Disease Autoimmunity in Children. Gastroenterology. 2018. 154(8):2087-2096 e7.	Outcome
27	Beck AL, Fernandez A, Rojina J, Cabana M. Randomized Controlled Trial of a Clinic-Based Intervention to Promote Healthy Beverage Consumption Among Latino Children. Clin Pediatr (Phila). 2017. 56(9):838-844.	Age at intervention/exposure
28	Beleza LO, Ribeiro LM, Paula RAP, Guarda L, Vieira GB, Costa KSF. Profile of at-risk newborns attended by nurses in outpatient follow-up clinic: a retrospective cohort study. Rev Lat Am Enfermagem. 2019. 27:e3113.	Intervention/exposure
29	Bell KA, Wagner CL, Feldman HA, Shypailo RJ, Belfort MB. Associations of infant feeding with trajectories of body composition and growth. Am J Clin Nutr. 2017. 106(2):491-498.	Intervention/exposure
30	Bell LK, Schammer C, Devenish G, et al. Dietary patterns and risk of obesity and early childhood caries in Australian toddlers: Findings from an australian cohort study. Nutrients. 2019. 11(11):2828.	Intervention/exposure
31	Bell S, Yew SSY, Devenish G, Ha D, Do L, Scott J. Duration of Breastfeeding, but Not Timing of Solid Food, Reduces the Risk of Overweight and Obesity in Children Aged 24 to 36 Months: Findings from an Australian Cohort Study. Int J Environ Res Public Health. 2018. 15(4):599.	Intervention/exposure
32	Bel-Serrat S, Mouratidou T, Börnhorst C, et al. Food consumption and cardiovascular risk factors in European children: the IDEFICS study. Pediatr Obes. 2013. 8(3):225-236.	Age at intervention/exposure
33	Bentil HJ, Steiner-Asiedu M, Lartey A. Comparison of the complementary feeding practices between mothers with twins and mothers with singletons. Pan Afr Med J. 2016. 24:52.	Country
34	Berkey CS, Gardner JD, Frazier AL, Colditz GA. Relation of childhood diet and body size to menarche and adolescent growth in girls. Am J Epidemiol. 2000. 152(5):446-52.	Intervention/exposure
35	Bernabe E, Ballantyne H, Longbottom C, Pitts NB. Early Introduction of Sugar-Sweetened Beverages and Caries Trajectories from Age 12 to 48 Months. J Dent Res. 2020. 99(8):898-906.	Outcome
36	Besharat Pour M, Bergström A, Bottai M, Magnusson J, Kull I, Moradi T. Age at adiposity rebound and body mass index trajectory from early childhood to adolescence; differences by breastfeeding and maternal immigration background. Pediatr Obes. 2017. 12(1):75-84.	Intervention/exposure
37	Betoko A, Lioret S, Heude B, et al. Influence of infant feeding patterns over the first year of life on growth from birth to 5 years. Pediatr Obes. 2017. 12 Suppl 1:94-101.	Intervention/exposure

	Citation	Rationale
38	Beyerlein A, Uusitalo UM, Virtanen SM, et al. Intake of Energy and Protein is Associated with Overweight Risk at Age 5.5 Years: Results from the Prospective TEDDY Study. Obesity. 2017. 25(8):1435-1441.	Intervention/exposure
39	Bhargava A. Protein and micronutrient intakes are associated with child growth and morbidity from infancy to adulthood in the philippines. J Nutr. 2016. 146(1):133-141.	Country
40	Black MM, Hager ER, Wang Y, et al. Toddler obesity prevention: A two-generation randomized attention-controlled trial. Matern Child Nutr. 2021. 17(1):e13075.	Intervention/exposure
41	Bloomfield FH, Agostoni C. The potential impact of feeding formula-fed infants according to published recommendations. Pediatr Res. 2020. 88(4):526-528.	Study design
42	Bong MW, Karim NA, Noor IM. Nutritional status and complementary feeding among Penan infants and young children in rural Sarawak, Malaysia. Malays J Nutr. 2018. 24(4):539-550.	Study design
43	Boulton TJ, Magarey AM. Effects of differences in dietary fat on growth, energy and nutrient intake from infancy to eight years of age. Acta Paediatr. 1995. 84(2):146-50.	Intervention/exposure
44	Bournez M, Ksiazek E, Wagner S, et al. Factors associated with the introduction of complementary feeding in the French ELFE cohort study. Matern Child Nutr. 2018. 14(2):e12536.	Outcome
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47	Breastmilk Lipid May Affect Early Childhood Obesity. Today's Dietitian. 2021. 23(2):58-58.	Study design, Intervention/exposure, Publication status
48	Breij LM, Abrahamse-Berkeveld M, Acton D, De Lucia Rolfe E, Ong KK, Hokken-Koelega ACS. Impact of Early Infant Growth, Duration of Breastfeeding and Maternal Factors on Total Body Fat Mass and Visceral Fat at 3 and 6 Months of Age. Ann Nutr Metab. 2017. 71(3-4):203-210.	Intervention/exposure
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52	Budree S, Goddard E, Brittain K, Cader S, Myer L, Zar HJ. Infant feeding practices in a South African birth cohort-A longitudinal study. Matern Child Nutr. 2017. 13(3):e12371.	Country
53	Büyük Yaytokgil Ş, Güvenir H, Çuhaci Çakir B, et al. The Effect of an Elimination Diet on Early Childhood Growth in Children with Egg and/or Cow's Milk Allergies. Asthma Allergy Immunology. 2022. 20(1):16-24.	Study design
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55	Byrne R, Zhou Y, Perry R, Mauch C, Magarey A. Beverage intake of Australian children and relationship with intake of fruit, vegetables, milk and body weight at 2, 3.7 and 5 years of age. Nutr Diet. 2018. 75(2):159-166.	Age at intervention/exposure
56	Camier A, Cissé AH, Lioret S, et al. Infant feeding practices associated with adiposity peak and rebound in the EDEN mother-child cohort. Int J Obes. 2022. 46(4):809-16.	Intervention/exposure
57	Campbell KJ, Lioret S, McNaughton SA, et al. A parent-focused intervention to reduce infant obesity risk behaviors: a randomized trial. Pediatrics. 2013. 131(4):652-660.	Intervention/exposure
58	Cantoral A, Téllez-Rojo MM, Ettinger AS, Hu H, Hernández-Ávila M, Peterson K. Early introduction and cumulative consumption of sugar-sweetened beverages during the pre-school period and risk of obesity at 8-14 years of age. Pediatr Obes. 2016. 11(1):68-74.	Duplicate data
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60	Carrut BR, Skinner JD. The role of dietary calcium and other nutrients in moderating body fat in preschool children. Int J Obes. 2001. 25(4):559-566.	Age at intervention/exposure
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63	Cervo MMC, Mendoza DS, Barrios EB, Panlasigui LN. Effects of Nutrient-Fortified Milk-Based Formula on the Nutritional Status and Psychomotor Skills of Preschool Children. J Nutr Metab. 2017. 2017:6456738.	Age at intervention/exposure
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66	Chaparro MP, Anderson CE, Crespi CM, Wang MC, Whaley SE. The new child food package is associated with reduced obesity risk among formula fed infants participating in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) in Los Angeles County, California, 2003-2016. Int J Behav Nutr Phys Act. 2020. 17(1):18.	Intervention/exposure
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68	Chen Y, Han L, Su W, et al. Breastfeeding on childhood obesity in children were large-for-gestational age: retrospective study from birth to 4 years. Sci Rep. 2022. 12(1):4226. doi:10.1038/s41598-022-08275-0.	Intervention/exposure
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70	Cheng Z, Shi L, Li Y, Wang Y, Zhang J. Using structural equation modelling to assess factors influencing children's growth and nutrition in rural China. Public Health Nutr. 2018. 21(6):1167-1175.	Intervention/exposure
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74	Cloutier MM, Wiley JF, Kuo CL, Cornelius T, Wang Z, Gorin AA. Outcomes of an early childhood obesity prevention program in a low-income community: a pilot, randomized trial. Pediatr Obes. 2018. 13(11):677-685.	Intervention/exposure
75	Cont G, Paviotti G, Montico M, et al. TAS2R38 bitter taste genotype is associated with complementary feeding behavior in infants. Genes Nutr. 2019. 14:13.	Intervention/exposure, Outcome
76	Costa CS, Campagnolo PD, Lumey LH, Vitolo MR. Effect of maternal dietary counselling during the 1st year of life on glucose profile and insulin resistance at the age of 8 years: a randomised field trial. Br J Nutr. 2017. 117(1):134-141.	Country
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78	Cummings JR, Faith MS, Lipsky LM, Liu A, Mooney JT, Nansel TR. Prospective relations of maternal reward-related eating, pregnancy ultra-processed food intake and weight indicators, and feeding mode with infant appetitive traits. Int J Behav Nutr Phys Act. 2022. 19(1):100. doi:10.1186/s12966-022-01334-9.	Outcome
79	Dagnelie PC, van Staveren WA, Vergote FJ, et al. Nutritional status of infants aged 4 to 18 months on macrobiotic diets and matched omnivorous control infants: a population-based mixed-longitudinal study. II. Growth and psychomotor development. Eur J Clin Nutr. 1989. 43(5):325-38.	Intervention/exposure
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81	Damsgaard CT, Papadaki A, Jensen SM, et al. Higher protein diets consumed ad libitum improve cardiovascular risk markers in children of overweight parents from eight European countries. J Nutr. 2013. 143(6):810-817.	Age at intervention/exposure
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84	Daniels L, Taylor RW, Williams SM, et al. Modified Version of Baby-Led Weaning Does Not Result in Lower Zinc Intake or Status in Infants: A Randomized Controlled Trial. J Acad Nutr Diet. 2018. 118(6):1006-1016 e1.	Outcome
85	Davidsson L, Mackenzie J, Kastenmayer P, et al. Dietary fiber in weaning cereals: A study of the effect on stool characteristics and absorption of energy, nitrogen, and minerals in healthy infants. J Pediatr Gastroenterol Nutr. 1996. 22(2):167-179.	Intervention/exposure
86	Davis KE, Klingenberg A, Massey-Stokes M, et al. The Baby Bites Text Messaging Project with randomized controlled trial: texting to improve infant feeding practices. mHealth. 2023. 9:11. doi:10.21037/MHEALTH-22-31.	Intervention/exposure
87	de Beer M, Vrijkotte TG, Fall CH, van Eijsden M, Osmond C, Gemke RJ. Associations of Infant Feeding and Timing of Weight Gain and Linear Growth during Early Life with Childhood Blood Pressure: Findings from a Prospective Population Based Cohort Study. PLoS One. 2016. 11(11):e0166281.	Outcome
88	de Beer M, Vrijkotte TG, Fall CH, van Eijsden M, Osmond C, Gemke RJ. Correction: Associations of Infant Feeding and Timing of Weight Gain and Linear Growth during Early Life with Childhood Blood Pressure: Findings from a Prospective Population Based Cohort Study. PLoS One. 2016. 11(12):e0168920.	Outcome
89	De Boer MD, Scharf RJ, Demmer RT. Sugar-sweetened beverages and weight gain in 2-to 5-year-old children. Pediatrics. 2013. 132(3):413-420.	Age at intervention/exposure
90	de Faria DPB, Sillos MD, da Graça Leite Speridião P, de Morais MB. Outcome of food intake and nutritional status after discontinuation of a cow's-milk-free diet post negative oral food challenge in infants and children. Allergol Immunopathol (Madr). 2022. 50(1):1. doi:10.15586/aei.v50i1.471.	Intervention/exposure, Age at intervention/exposure
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93	de Miranda Pereira TA, Gomes Freire AK, Santos Gonçalves VS. Exclusive breastfeeding and underweight in children under six months old monitored in primary health care in Brazil, 2017. 2021. Rev Paul Pediatr. 39:e2019293. doi:10.1590/1984-0462/2021/39/2019293.	Study design, Intervention/exposure
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95	de Silva-Sanigorski AM, Bell AC, Kremer P, et al. Reducing obesity in early childhood: results from Romp & Chomp, an Australian community-wide intervention program. Am J Clin Nutr. 2010. 91(4):831-40.	Intervention/exposure
96	de Vasconcellos MT. Body mass index: its relationship with food consumption and socioeconomic variables in Brazil. Eur J Clin Nutr. 1994. 48(Suppl 3):S115-23.	Country
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100	Diana A, Mallard SR, Haszard JJ, et al. Consumption of fortified infant foods reduces dietary diversity but has a positive effect on subsequent growth in infants from Sumedang district, Indonesia. PLoS One. 2017. 12(4):e0175952.	Country
101	Differding MK, Doyon M, Bouchard L, et al. Potential interaction between timing of infant complementary feeding and breastfeeding duration in determination of early childhood gut microbiota composition and BMI. Pediatr Obes. 2020. 15(8):e12642.	Intervention/exposure
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104	Dogan E, Yilmaz G, Caylan N, Turgut M, Gokcay G, Oguz MM. Baby-led complementary feeding: Randomized controlled study. Pediatr Int. 2018. 60(12):1073-1080.	Intervention/exposure
105	Donkor HM, Grundt JH, Júlíusson PB, et al. Social and somatic determinants of underweight, overweight and obesity at 5 years of age: A Norwegian regional cohort study. BMJ Open. 2017. 7(8):e014548.	Intervention/exposure, Age at intervention/exposure
106	Dourado BLLFS, De Melo JMM, Longo-Silva G, de Menezes RCE, da Silveira JAC. Early-life determinants of excessive weight gain among low-income children: Examining the adherence of theoretical frameworks to empirical data using structural equation modelling. Pediatr Obes. 2022. 17(8):e12912. doi:10.1111/ijpo.12912.	Intervention/exposure
107	Dugas C, Kearney M, Mercier R, et al. Early life nutrition, glycemic and anthropometric profiles of children exposed to gestational diabetes mellitus in utero. Early Hum Dev. 2018. 118:37-41.	Intervention/exposure
108	Dugas C, Perron J, Marc I, Weisnagel SJ, Robitaille J. Association between early introduction of fruit juice during infancy and childhood consumption of sweet-tasting foods and beverages among children exposed and unexposed to gestational diabetes mellitus in utero. Appetite. 2019. 132:190-195.	Study design, Outcome
109	Durão C, Severo M, Oliveira A, et al. Evaluating the effect of energy-dense foods consumption on preschool children's body mass index: a prospective analysis from 2 to 4 years of age. Eur J Nutr. 2015. 54(5):835-843.	Age at intervention/exposure
110	Eckhardt CL, Suchindran C, Gordon-Larsen P, Adair LS. The association between diet and height in the postinfancy period changes with age and socioeconomic status in Filipino youths. J Nutr. 2005. 135(9):2192-8.	Country
111	El-Gamal FM, Babader R, Al-Shaikh M, Al-Harbi A, Al-Kaf J, Al-Kaf W. Study determinants of increased Z-Score of Body Mass Index in preschool-age children. BMC Res Notes. 2020. 13(1):186.	Study design
112	Elliott LJ, Keown-Stoneman CDG, Birken CS, Jenkins DJA, Borkhoff CM, Maguire JL. Vegetarian Diet, Growth, and Nutrition in Early Childhood: A Longitudinal Cohort Study. Pediatrics. 2022. 149(6):e2021052598.	Intervention/exposure
113	Emmett PM. Dietary Patterns during Complementary Feeding and Later Outcomes. Nestle Nutr Inst Workshop Ser. 2016. 85:145-154.	Study design
114	Ercan N, Tel Adiguzel K. Effect of early childhood cow's milk elimination diet on eating behaviours, nutrition and growth status at age 2-6 years. J Hum Nutr Diet. 2022. 35(2):300-309.	Study design
115	Eun Kyo H, Ju Hee K, Hey-Sung B, et al. Association between complementary food introduction before age 4 months and body mass index at age 5-7 years: a retrospective population-based longitudinal cohort study. 2023. 36(3):787-97.	Intervention/exposure
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117	Fabiansen C, Phelan KPQ, Cichon B, et al. Short Malnourished Children and Fat Accumulation With Food Supplementation. Pediatrics. 2018. 142(3):e20180679.	Country
118	Fahmida U, Htet MK, Ferguson E, et al. Effect of an Integrated Package of Nutrition Behavior Change Interventions on Infant and Young Child Feeding Practices and Child Growth from Birth to 18 Months: Cohort Evaluation of the Baduta Cluster Randomized Controlled Trial in East Java, Indonesia. Nutrients. 2020. 12(12):3851.	Country
119	Faienza MF, Colaianni V, Di Ciaula A, et al. Different Variation of Intra-familial Body Mass Index subjected to Covid-19 Lockdown. J Gastrointestin Liver Dis. 2022. 31(2):198-205.	Age at intervention/exposure
120	Faith MS, Dennison BA, Edmunds LS, Stratton HH. Fruit juice intake predicts increased adiposity gain in children from low-income families: weight status-by-environment interaction. Pediatrics. 2006. 118(5):2066-75.	Age at intervention/exposure
121	Fangupo LJ, Heath ALM, Williams SM, et al. Impact of an early-life intervention on the nutrition behaviors of 2-y-old children: A randomized controlled trial1,2. Am J Clin Nutr. 2015. 102(3):704-712.	Intervention/exposure
122	Feeney M, Du Toit G, Roberts G, et al. Impact of peanut consumption in the LEAP Study: Feasibility, growth, and nutrition. J Allergy Clin Immunol. 2016. 138(4):1108-1118.	Directness of experimental studies
123	Feldman-Winter L, Burnham L, Grossman X, Matlak S, Chen N, Merewood A. Weight gain in the first week of life predicts overweight at 2 years: A prospective cohort study. Matern Child Nutr. 2018. 14(1):e12472.	Intervention/exposure
124	Feng J, Gong Z, Wang Y, Huo J, Zhuo Q. Complementary Feeding and Malnutrition among Infants and Young Children Aged 6–23 Months in Rural Areas of China. Nutrients. 2022. 14(9):1807. doi:10.3390/nu14091807.	Study design

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125	Ferguson MC, O'Shea KJ, Hammer LD, et al. The Impact of Following Solid Food Feeding Guides on BMI Among Infants: A Simulation Study. Am J Prev Med. 2019. 57(3):355-364.	Study design, Population
126	Ferreira SS, Marchioni DML, Wall CR, et al. Prevalence and maternal determinants of early and late introduction of complementary foods: Results from the Growing Up in New Zealand cohort study. Br J Nutr. 2023. 129(3):491-502.	Outcome
127	Fitzgibbon ML, Stolley MR, Schiffer L, Van Horn L, KauferChristoffel K, Dyer A. Two-year follow-up results for Hip-Hop to Health Jr.: a randomized controlled trial for overweight prevention in preschool minority children. J Pediatr. 2005. 146(5):618-25.	Age at intervention/exposure
128	Flaherman VJ, Cabana MD, McCulloch CE, Paul IM. Effect of Early Limited Formula on Breastfeeding Duration in the First Year of Life: A Randomized Clinical Trial. JAMA Pediatr. 2019. 173(8):729-735.	Intervention/exposure
129	Fletcher S, Wright C, Jones A, Parkinson K, Adamson A. Tracking of toddler fruit and vegetable preferences to intake and adiposity later in childhood. Matern Child Nutr. 2017. 13(2):n/a-N.PAG.	Intervention/exposure, Outcome
130	Flores-Barrantes P, Iguacel I, Iglesia-Altaba I, Moreno LA, Rodriguez G. Rapid Weight Gain, Infant Feeding Practices, and Subsequent Body Mass Index Trajectories: The CALINA Study. Nutrients. 2020. 12(10):3178.	Intervention/exposure
131	Fogel A, McCrickerd K, Aris IM, et al. Eating behaviors moderate the associations between risk factors in the first 1000 days and adiposity outcomes at 6 years of age. Am J Clin Nutr. 2020. 111(5):997-1006.	Intervention/exposure
132	Fonseca PCA, Carvalho CA, Ribeiro SAV, et al. Determinants of the mean growth rate of children under the age of six months: a cohort study. Cien Saude Colet. 2017. 22(8):2713-2726.	Study design
133	Forbes JD, Azad MB, Vehling L, et al. Association of Exposure to Formula in the Hospital and Subsequent Infant Feeding Practices With Gut Microbiota and Risk of Overweight in the First Year of Life. JAMA Pediatr. 2018. 172(7):e181161.	Intervention/exposure
134	Freedman DS, Srinivasan SR, Cresanta JL, Webber LS, Berenson GS. Cardiovascular risk factors from birth to 7 years of age: the Bogalusa Heart Study. Serum lipids and lipoproteins. Pediatrics. 1987. 80(5 Pt 2):789-96.	Outcome
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136	Geurtsen ML, Santos S, Gaillard R, Felix JF, Jaddoe VWV. Associations Between Intake of Sugar-Containing Beverages in Infancy With Liver Fat Accumulation at School Age. Hepatology. 2021. 73(2):560-570.	Outcome
137	Ghodsi D, Omidvar N, Rashidian A, Eini-Zinab H, Raghfar H, Aghayan M. Effectiveness of the national food supplementary program on children growth and nutritional status in Iran. Matern Child Nutr. 2018. 14(3):e12591.	Intervention/exposure
138	Gibson LA, Hernandez Alava M, Kelly MP, Campbell MJ. The effects of breastfeeding on childhood BMI: a propensity score matching approach. J Public Health (Oxf). 2017. 39(4):e152-e160.	Intervention/exposure
139	Giorgini E, Fisberg M, De Paula RA, Ferreira AM, Valle J, Braga JA. The use of sweet rolls fortified with iron bis-glycinate chelate in the prevention of iron deficiency anemia in preschool children. Arch Latinoam Nutr. 2001. 51(1 Suppl 1):48-53.	Country
140	Giovannini M, Riva E, Banderali G, et al. Feeding practices of infants through the first year of life in Italy. Acta Paediatrica, International Journal of Paediatrics. 2004. 93(4):492-497.	Outcome
141	Gishti O, Gaillard R, Durmuş B, et al. Infant diet and metabolic outcomes in school-age children. the Generation R Study. Eur J Clin Nutr. 2014. 68(9):1008-1015.	Outcome
142	Goetz AR, Mara CA, Stark LJ. Greater Breastfeeding in Early Infancy Is Associated with Slower Weight Gain among High Birth Weight Infants. J Pediatr. 2018. 201:27-33 e4.	Intervention/exposure
143	Goetz AR, Rybak TM, Peugh JL, Stark LJ. Early-life determinants of excess weight in children born heavy. Pediatr Obes. 2020. 15(2):e12580.	Intervention/exposure
144	Golding J, Iles-Caven Y, Ellis G, Gregory S, Nowicki S. The relationship between parental locus of control and adolescent obesity: a longitudinal pre-birth cohort. Int J Obes (Lond). 2019. 43(4):724-734.	Intervention/exposure
145	Golova N, Eskander J, Pho A, et al. Preventing the Early Introduction of Juice and Sugar-Sweetened Beverages in Infants' Diets: A Randomized Controlled Trial. 2023. 62(4):276-87.	Intervention/exposure
146	Gomez-Martin M, Herrero-Morin D, Solis G, et al. Longitudinal Study Depicting Differences in Complementary Feeding and Anthropometric Parameters in Late Preterm Infants up to 2 Years of Age. Nutrients. 2021. 13(3):982.	Intervention/exposure, Health status

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147	Goncalves VSS, Silva SA, Andrade RCS, Spaniol AM, Nilson EAF, Moura IF. Food intake and underweight markers in children under 6 months old monitored via the Food and Nutrition Surveillance System, Brazil, 2015. Epidemiol Serv Saude. 2019. 28(2):e2018358.	Study design
148	Goyena EA, Barba CVC, Talavera MTM, Paunlagui MM, Rola AC, Tandang NA. Effects of micronutrient powder and complementary food blend on growth and micronutrient status of Filipino rural children: a randomised controlled trial. Malays J Nutr. 2018. 24(4):475-492.	Country
149	Graf MD, Karp SM, Lutenbacher M, Wasser H, Bushaw A, Dietrich MS. Clinical strategies for addressing obesity in infants and toddlers. Nurse Pract. 2021. 46(2):28-33.	Study design
150	Graham GG, MacLean WC, Jr, Lopez de Romaña. Prolonged consumption by infants of wheat-based diets with and without casein or lysine supplementation. J Nutr. 1981. 111(11):1917-27.	Intervention/exposure
151	Granziera F, Guzzardi MA, Iozzo P. Associations between the mediterranean diet pattern and weight status and cognitive development in preschool children. Nutrients. 2021. 13(11):3723. doi:10.3390/nu13113723.	Study design, Age at intervention/exposure
152	Gregory JE, Paxton SJ, Brozovic AM. Maternal feeding practices predict fruit and vegetable consumption in young children. Results of a 12-month longitudinal study. Appetite. 2011. 57(1):167-172.	Intervention/exposure
153	Gridneva Z, Rea A, Hepworth AR, et al. Relationships between Breastfeeding Patterns and Maternal and Infant Body Composition over the First 12 Months of Lactation. Nutrients. 2018. 10(1):45.	Intervention/exposure
154	Grieken A, Renders CM, Gaar VM, Hirasing RA, Raat H. Associations between the home environment and children's sweet beverage consumption at 2-year follow-up: the ' Be active, eat right' study. Pediatr Obes. 2015. 10(2):126-133.	Age at intervention/exposure
155	Gross RS, Mendelsohn AL, Gross MB, Scheinmann R, Messito MJ. Randomized Controlled Trial of a Primary Care-Based Child Obesity Prevention Intervention on Infant Feeding Practices. J Pediatr. 2016. 174:171-177.e2.	Intervention/exposure
156	Guedes JRD, Höfelmann DA, Madruga FP, et al. Associated factors with dietary patterns among children under 2 years of age: A study in childcare centres and homes of South Brazil. J Nutr Sci. 2021. 10:e37.	Study design
157	Guerrero AD, Mao C, Fuller B, Bridges M, Franke T, Kuo AA. Racial and Ethnic Disparities in Early Childhood Obesity: Growth Trajectories in Body Mass Index. Journal of racial and ethnic health disparities. 2016. 3(1):129-137.	Age at intervention/exposure
158	Gunderson EP, Greenspan LC, Faith MS, Hurston, SR, Quesenberry CP, Jr, Swift Offspring Study Investigators. Breastfeeding and growth during infancy among offspring of mothers with gestational diabetes mellitus: a prospective cohort study. Pediatr Obes. 2018. 13(8):492-504.	Intervention/exposure, Outcome
159	Gunnell L, Neher J, Safranek S, Guthmann R. Does breastfeeding affect the risk of childhood obesity?. J Fam Pract. 2016. 65(12):931-932.	Study design, Publication status
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163	Haro-Mora JJ, García-Escobar E, Porras N, et al. Children whose diet contained olive oil had a lower likelihood of increasing their body mass index Z-score over 1 year. Eur J Endocrinol. 2011. 165(3):435-439.	Age at intervention/exposure
164	Harrison M, Brodribb W, Davies PSW, Hepworth J. Impact of Maternal Infant Weight Perception on Infant Feeding and Dietary Intake. Matern Child Health J. 2018. 22(8):1135-1145.	Study design
165	Harrison M, Brodribb W, Davies PSW, Hepworth J. Relationships between parental feeding practices, infant weight concern, infant dietary behaviour and body weight: Findings from the Feeding A Baby (FAB) Study. Obes Res Clin Pract. 2019. 13(1):86-86.	Publication status
166	Hasnain SR, Singer MR, Bradlee ML, Moore LL. Beverage intake in early childhood and change in body fat from preschool to adolescence. Childhood Obesity. 2014. 10(1):42-49.	Age at intervention/exposure
167	Hastuti, Hadju V, Citrakesumasari, Maddeppungeng M. Stunting prevalence and its relationship to birth length of 18-23 months old infants in Indonesia. Enferm Clin. 2020. 30:205-209.	Country
168	Haszard JJ, Diana A, Daniels L, Houghton LA, Gibson RS. Development of a nutrient quality score for the complementary diets of Indonesian infants and relationships with linear growth and stunting: a longitudinal analysis. Br J Nutr. 2019. 122(1):71-77.	Country

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170	Hazrati S, Khan F, Huddleston K, et al. Clinical and social factors associated with excess weight in Hispanic and non-Hispanic White children. Pediatr Res. 2019. 85(3):256-261.	Study design, Intervention/exposure
171	Headey D, Hirvonen K, Hoddinott J. Animal Sourced Foods and Child Stunting. Am J Agric Econ. 2018. 100(5):1302-1319.	Study design
172	Heerman WJ, Sneed NM, Sommer EC, et al. Ultra-processed food consumption and BMI-Z among children at risk for obesity from low-income households. Pediatr Obes. 2023. 18(8):e13037.	Age at intervention/exposure
173	Helle C, Hillesund ER, Wills AK, Overby NC. Evaluation of an eHealth intervention aiming to promote healthy food habits from infancy -the Norwegian randomized controlled trial Early Food for Future Health. Int J Behav Nutr Phys Act. 2019. 16(1):1.	Intervention/exposure
174	Helle C, Hillesund ER, Wills AK, Overby NC. Examining the effects of an eHealth intervention from infant age 6 to 12 months on child eating behaviors and maternal feeding practices one year after cessation: The Norwegian randomized controlled trial Early Food for Future Health. PLoS One. 2019. 14(8):e0220437.	Intervention/exposure, Outcome
175	Herath MP, Ahuja KDK, Beckett JM, Jayasinghe S, Byrne NM, Hills AP. Determinants of Infant Adiposity across the First 6 Months of Life: Evidence from the Baby-bod study. J Clin Med. 2021. 10(8):1770.	Intervention/exposure
176	Herber C, Bogler L, Subramanian SV, Vollmer S. Association between milk consumption and child growth for children aged 6-59 months. Sci Rep. 2020. 10(1):6730.	Study design
177	Herr RM, De Bock F, Diehl K, et al. Associations of individual factors and early childhood education and care (ECEC) centres characteristics with preschoolers' BMI in Germany. BMC Public Health. 2022. 22(1):1415.	Age at intervention/exposure
178	Hesketh KD, Salmon J, McNaughton SA, et al. Long-term outcomes (2 and 3.5 years post-intervention) of the INFANT early childhood intervention to improve health behaviors and reduce obesity: Cluster randomised controlled trial follow-up. Int J Behav Nutr Phys Act. 2020. 17(1):95.	Intervention/exposure
179	Hoffman DJ. Nutrients in Complementary Feeding Protect Against Wasting, but Not Stunting: Results from a Multi-Country Longitudinal Cohort Study. J Nutr. 2021. 151(1):5-6.	Study design
180	Hoffmann J, Gunther J, Stecher L, et al. Infant growth during the first year of life following a pregnancy lifestyle intervention in routine care-Findings from the cluster-randomised GeliS trial. Pediatr Obes. 2021. 16(2):e12705.	Intervention/exposure
181	Hohman EE, Paul IM, Birch LL, Savage JS. INSIGHT responsive parenting intervention is associated with healthier patterns of dietary exposures in infants. Obesity (Silver Spring). 2017. 25(1):185-191.	Intervention/exposure
182	Hollen LI, Din Zu, Jones LR, Emond AM, Emmett P. Are diet and feeding behaviours associated with the onset of and recovery from slow weight gain in early infancy?. Br J Nutr. 2014. 111(9):1696-704.	Study design
183	Hollis JL, Crozier SR, Inskip HM, et al. Age at introduction of solid foods and feeding difficulties in childhood: findings from the Southampton Women's Survey. Br J Nutr. 2016. 116(4):743-50.	Outcome
184	Horan MK, Donnelly JM, McGowan CA, Gibney ER, McAuliffe FM. The association between maternal nutrition and lifestyle during pregnancy and 2-year-old offspring adiposity: analysis from the ROLO study. Journal of Public Health (Germany). 2016. 24(5):427-436.	Intervention/exposure
185	Horodynski MA, Pierce SJ, Reyes-Gastelum D, Olson B, Shattuck M. Feeding Practices and Infant Growth: Quantifying the Effects of Breastfeeding Termination and Complementary Food Introduction on BMI z-Score Growth Velocity through Growth Curve Models. Child Obes. 2017. 13(6):490-498.	Intervention/exposure
186	Horst CH, Obermann-de Boer GL, Kromhout D. Type of milk feeding and nutrient intake during infancy. The Leiden Pre-School Children Study. Acta Paediatr Scand. 1987. 76(6):865-871.	Outcome
187	Hose AJ, Pagani G, Karvonen AM, et al. Excessive Unbalanced Meat Consumption in the First Year of Life Increases Asthma Risk in the PASTURE and LUKAS2 Birth Cohorts. Front Immunol. 2021. 12:651709.	Outcome
188	Hu J, Aris IM, Lin PD, et al. Longitudinal associations of modifiable risk factors in the first 1000 days with weight status and metabolic risk in early adolescence. Am J Clin Nutr. 2020. 113(1):113-22.	Intervention/exposure
189	Huang H, Gao Y, Zhu N, et al. The Effects of Breastfeeding for Four Months on Thinness, Overweight, and Obesity in Children Aged 3 to 6 Years: A Retrospective Cohort Study from National Physical Fitness Surveillance of Jiangsu Province, China. Nutrients. 2022. 14(19):4154. doi:10.3390/nu14194154.	Study design, Intervention/exposure
190	Huang H, Wan Mohamed Radzi CW, Salarzadeh Jenatabadi H. Family Environment and Childhood Obesity: A New Framework with Structural Equation Modeling. Int J Environ Res Public Health. 2017. 14(2):181.	Study design
191	Huang J, Zhang Z, Wu Y, et al. Early feeding of larger volumes of formula milk is associated with greater body weight or overweight in later infancy. Nutr J. 2018. 17(1):12.	Intervention/exposure

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193	Hughes SO, Power TG, Beck AD, et al. Twelve-Month Efficacy of an Obesity Prevention Program Targeting Hispanic Families With Preschoolers From Low-Income Backgrounds. J Nutr Educ Behav. 2021. 53(8):677-690.	Age at intervention/exposure
194	Huh SY, Rifas-Shiman SL, Rich-Edwards JW, Taveras EM, Gillman MW. Prospective association between milk intake and adiposity in preschool-aged children. J Am Diet Assoc. 2010. 110(4):563-70.	Age at intervention/exposure
195	Huvinen E, Tuomaala A-K, Bergman PH, et al. Ascending Growth is Associated with Offspring Adiposity in Pregnancies Complicated with Obesity or Gestational Diabetes. J Clin Endocrinol Metab. 2021. 106(5):E1993. doi:10.1210/clinem/dgaa979.	Intervention/exposure
196	Hyczko AV, Ruggiero CF, Hohman EE, et al. Sex Differences in Maternal Restrictive Feeding Practices in the Intervention Nurses Start Infants Growing on Healthy Trajectories Study. Acad Pediatr. 2021. 21(6):1070-1076.	Intervention/exposure
197	Iannotti LL, Chapnick M, Nicholas J, et al. Egg intervention effect on linear growth no longer present after two years. Matern Child Nutr. 2020. 16(2):e12925.	Directness of experimental studies
198	Iannotti LL, Lutter CK, Stewart CP, et al. Eggs in Early Complementary Feeding and Child Growth: A Randomized Controlled Trial. Pediatrics. 2017. 140(1):e20163459.	Directness of experimental studies
199	Iguacel I, Chung A, Gearon E, Moreno LA, Peeters A, Backholer K. Influence of early-life risk factors on socioeconomic inequalities in weight gain. J Public Health (Oxf). 2018. 40(4):e447-e455.	Intervention/exposure
200	Iguacel I, Monje L, Cabero MJ, et al. Feeding patterns and growth trajectories in breast-fed and formula-fed infants during the introduction of complementary food. Nutr Hosp. 2019. 36(4):777-785.	Intervention/exposure
201	Irct20190705044103N, . Smartphone-based maternal education directed at complementary feeding among malnourished children below 3 years of age in Urmia, Iran. http://www.who.int/trialsearch/Trial2.aspx?TrialID=IRCT20190705044103N1. 2019.	Publication status
202	Isong IA, Rao SR, Bind MA, Avendaño M, Kawachi I, Richmond TK. Racial and ethnic disparities in early childhood obesity. Pediatrics. 2018. 141(1):e20170865.	Intervention/exposure
203	Iszatt N, Stigum H, Govarts E, et al. Perinatal exposure to dioxins and dioxin-like compounds and infant growth and body mass index at seven years: A pooled analysis of three European birth cohorts. Environ Int. 2016. 94:399-407.	Intervention/exposure
204	Jansen EC, Kasper N, Lumeng JC, et al. Changes in household food insecurity are related to changes in BMI and diet quality among Michigan Head Start preschoolers in a sex-specific manner. Soc Sci Med. 2017. 181:168-176.	Age at intervention/exposure
205	Jansen PW, Derks IPM, Batenburg A, et al. Using Food to Soothe in Infancy is Prospectively Associated with Childhood BMI in a Population-Based Cohort. J Nutr. 2019. 149(5):788-794.	Intervention/exposure
206	Jardí C, Aranda N, Bedmar C, et al. Consumption of free sugars and excess weight in infants. A longitudinal study. Anales de Pediatria. 2019. 90(3):165-172.	Intervention/exposure
207	Jayanti R, Yanuaringsih GP, Olivia N, Jundapri K, Ariandini S, Munir R. Determinants of stunting in indonesian toddlers. Indian Journal of Forensic Medicine and Toxicology. 2021. 15(3):3954-3959.	Study design
208	Jen V, Braun KVE, Karagounis LG, et al. Longitudinal association of dietary protein intake in infancy and adiposity throughout childhood. Clinical Nutrition. 2019. 38(3):1296-1302.	Intervention/exposure
209	Jia N, Gu G, Zhao L, et al. Longitudinal study of breastfeeding and growth in 0-6 month infants. Asia Pac J Clin Nutr. 2018. 27(6):1294-1301.	Intervention/exposure
210	Jiang H, Li M, Wen LM, et al. A Community-Based Short Message Service Intervention to Improve Mothers' Feeding Practices for Obesity Prevention: Quasi-Experimental Study. JMIR Mhealth Uhealth. 2019. 7(6):e13828.	Intervention/exposure
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212	Joanna Briggs Institute. Effective dietary interventions for managing overweight and obesity in children. Nurs N Z. 2007. 13(5):30-31.	Study design
213	Johansson U, Ohlund I, Hernell O, Lonnerdal B, Lindberg L, Lind T. Protein-Reduced Complementary Foods Based on Nordic Ingredients Combined with Systematic Introduction of Taste Portions Increase Intake of Fruits and Vegetables in 9 Month Old Infants: A Randomised Controlled Trial. Nutrients. 2019. 11(6):1255.	Intervention/exposure
214	Johansson U, Ohlund I, Lindberg L, Hernell O, Lonnerdal B, Lind T. A randomised, controlled trial of a Nordic, protein-reduced complementary diet: effects on dietary intake, biomarkers and growth until 18 months of age. J Pediatr Gastroenterol Nutr. 2022. 74(2):914-915.	Publication status

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215	Jones LR, Emmett PM, Hays NP, Shahkhalili Y, Taylor CM. Association of Nutrition in Early Childhood with Body Composition and Leptin in Later Childhood and Early Adulthood. Nutrients. 2021. 13(9):3264.	Intervention/exposure
216	Jones LJ, VanWassenhove-Paetzold J, Thomas K, et al. Impact of a fruit and vegetable prescription program on health outcomes and behaviors in young navajo children. Curr Dev in Nutr. 2020. 4(8):nzaa109.	Age at intervention/exposure
217	Jones SW, Lee M, Brown A. Spoonfeeding is associated with increased infant weight but only amongst formula-fed infants. Matern Child Nutr. 2020. 16(3):e12941.	Intervention/exposure
218	Kaar JL, Sauder KA, Shapiro AL, et al. Infant Feeding Practices In a Diverse Group of Women: The Healthy Start Study. Clin Med Insights Pediatr. 2019. 13:1179556518824362.	Intervention/exposure, Outcome
219	Kaar JL, Schmiege SJ, Vadiveloo M, Simon SL, Tovar A. Sleep duration mediates the relationship between health behavior patterns and obesity. Sleep Health. 2018. 4(5):442-447.	Study design, Intervention/exposure, Age at intervention/exposure
220	Kalhoff H, Mesch CM, Stimming M, et al. Effects of LC-PUFA supply via complementary food on infant development—a food based intervention (RCT) embedded in a total diet concept. Eur J Clin Nutr. 2020. 74(5):682-690.	Outcome
221	Kang S, Lee SW, Cha HR, Kim SH, Han MY, Park MJ. Growth in Exclusively Breastfed and Non-exclusively Breastfed Children: Comparisons with WHO Child Growth Standards and Korean National Growth Charts. J Korean Med Sci. 2021. 36(47):e315.	Study design, Intervention/exposure
222	Kartasurya MI, Pangestuti DR, Kusumawati A, et al. Cadres outreach program to mothers improve nutritional status of under Two Year Old Children. Indian Journal of Public Health Research and Development. 2019. 10(3):917-922.	Intervention/exposure, Country
223	Kasman M, Heuberger B, Mack-Crane W, et al. Using a Microsimulation of Energy Balance to Explore the Influence of Prenatal Sugar-Sweetened Beverage Intake on Child BMI. Obesity. 2021. 29(4):731-739.	Age at intervention/exposure
224	Katan MB, e Ruyter JC, Kuijper LD, Chow CC, Hall KD, Olthof MR. Impact of Masked Replacement of Sugar-Sweetened with Sugar-Free Beverages on Body Weight Increases with Initial BMI: secondary Analysis of Data from an 18 Month Double-Blind Trial in Children. PLoS One. 2016. 11(7):e0159771.	Age at intervention/exposure
225	Kattelmann KK, Ho M, Specker BL. Effect of timing of introduction of complementary foods on iron and zinc status of formula fed infants at 12, 24, and 36 months of age. J Am Diet Assoc. 2001. 101(4):443-447.	Outcome
226	Kaul P, Bowker SL, Savu A, Yeung RO, Donovan LE, Ryan EA. Association between maternal diabetes, being large for gestational age and breast-feeding on being overweight or obese in childhood. Diabetologia. 2019. 62(2):249-258.	Intervention/exposure
227	Kavey RE. How sweet it is: sugar-sweetened beverage consumption, obesity, and cardiovascular risk in childhood. J Am Diet Assoc. 2010. 110(10):1456-60.	Study design
228	Kavle JA, Flax VL, Abdelmegeid A, et al. Factors associated with early growth in Egyptian infants: Implications for addressing the dual burden of malnutrition. Matern Child Nutr. 2016. 12(1):139-151.	Country
229	Kay MC, Wasser H, Adair LS, et al. Consumption of obesogenic foods in non-Hispanic black mother-infant dyads. Matern Child Nutr. 2018. 14(1):e12482.	Outcome
230	Kelleher CC, Viljoen K, Khalil H, et al. Longitudinal follow-up of the relationship between dietary intake and growth and development in the lifeways cross-generation cohort study 2001-2013. Proc Nutr Soc. 2014. 73(1):118-131.	Study design
231	Kerr JA, Long C, Clifford SA, et al. Early-life exposures predicting onset and resol of childhood overweight or obesity. Arch Dis Child. 2017. 102(10):922-929.	Intervention/exposure
232	Kheir F, Feeley N, Maximova K, Drapeau V, Henderson M, Van Hulst A. Breastfeeding duration in infancy and dietary intake in childhood and adolescence. Appetite. 2021. 158:104999.	Intervention/exposure, Outcome
233	Khor GL, Lee SS. Complementary Foods and Milk-Based Formulas Provide Excess Protein but Suboptimal Key Micronutrients and Essential Fatty Acids in the Intakes of Infants and Toddlers from Urban Settings in Malaysia. Nutrients. 2021. 13(7):2354.	Study design
234	Kim JH, Lee SW, Lee JE, Ha EK, Han MY, Lee E. Breastmilk Feeding during the First 4 to 6 Months of Age and Childhood Disease Burden until 10 Years of Age. Nutrients. 2021. 13(8):2825.	Intervention/exposure
235	Kim-Herrera EY, Ramírez-Silva I, Rodríguez-Oliveros G, et al. Parental Feeding Styles and Their Association With Complementary Feeding Practices and Growth in Mexican Children. Front Pediatr. 2021. 9:786397.	Intervention/exposure, Outcome
236	Kiraly CM, Turk MT, Kalarchian MA, Shaffer C. Exploring Factors Linked to Weight Status in Salvadoran Infants. Hisp Health Care Int. 2021. 19(2):95-104.	Study design, Country

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237	Kittisakmontri K, Lanigan J, Wells JCK, Manowong S, Kaewarree S, Fewtrell M. Quantity and Source of Protein during Complementary Feeding and Infant Growth: Evidence from a Population Facing Double Burden of Malnutrition. Nutrients. 2022. 14(19):3948.	Intervention/exposure
238	Kittisakmontri K, Lanigan J, Fewtrell M. Potential mediators of associations between protein intake from different food sources and infant growth during the complementary feeding period; evidence from a middle-income country. J Pediatr Gastroenterol Nutr. 2022. 74:991-992.	Publication status
239	Kjaer TW, Faurholt-Jepsen D, Medrano R, et al. Higher Birthweight and Maternal Pre-pregnancy BMI Persist with Obesity Association at Age 9 in High Risk Latino Children. J Immigr Minor Health. 2019. 21(1):89-97.	Intervention/exposure
240	Kloeblen-Tarver AS. Fruit juice consumption not related to growth among preschool-aged children enrolled in the WIC program...including commentary by Skinner JD and Carruth BR. J Am Diet Assoc. 2001. 101(9):996-996.	Study design
241	Kong KL, Fazzino TL, Rohde KM, Morris KS. The Prevalence of Hyperpalatable Baby Foods and Exposure During Infancy: A Preliminary Investigation. Front Psychol. 2021. 12:614607.	Study design, Outcome
242	Kostecka M, Jackowska I, Kostecka J. Factors Affecting Complementary Feeding of Infants. A Pilot Study Conducted after the Introduction of New Infant Feeding Guidelines in Poland. Nutrients. 2020. 13(1):61.	Outcome
243	Kramer MS, Davies N, Oken E, et al. Infant feeding and growth: putting the horse before the cart. Am J Clin Nutr. 2018. 107(4):635-639.	Intervention/exposure
244	Krasevec J, An X, Kumapley R, Begin F, Frongillo EA. Diet quality and risk of stunting among infants and young children in low- and middle-income countries. Matern Child Nutr. 2017. 13 Suppl 2:e12430.	Study design
245	Kuniyoshi Y, Kikuya M, Matsubara H, et al. Association of Feeding Practice with Childhood Overweight and/or Obesity in Affected Areas Before and After the Great East Japan Earthquake. Breastfeed Med. 2019. 14(6):382-389.	Study design, Intervention/exposure
246	Kusumawardani DA, Luthfiyana NU. Child feeding practices and stunting: A case-control study in jember regency of Indonesia. Indian Journal of Public Health Research and Development. 2020. 11(6):226-231.	Study design, Country
247	Laadjel R, Taleb S. Factors associated with the age of initiation of food diversification in children aged 6 to 60 months in eastern Algeria: Correlation to nutritional status. Nutrition Clinique et Metabolisme. 2020. 34(3):238-247.	Study design, Language
248	Lagström H, Seppänen R, Jokinen E, et al. Influence of dietary fat on the nutrient intake and growth of children from 1 to 5 y of age: the Special Turku Coronary Risk Factor Intervention Project. Am J Clin Nutr. 1999. 69(3):516-23.	Intervention/exposure
249	Lahiri A, Chakraborty A. Predictors of Weight Velocity in the First 6 Months of Life in a Rural Block of West Bengal: A Longitudinal Study. Indian J Community Med. 2019. 44(2):92-96.	Country
250	Laitinen J, Pietiläinen K, Wadsworth M, Sovio U, Järvelin MR. Predictors of abdominal obesity among 31-y-old men and women born in Northern Finland in 1966. Eur J Clin Nutr. 2004. 58(1):180-90.	Age at intervention/exposure
251	Lakshman R, Sharp SJ, Whittle F, et al. Randomised controlled trial of a theory-based behavioural intervention to reduce formula milk intake. Arch Dis Child. 2018. 103(11):1054-1060.	Intervention/exposure
252	Lapinleimu H, Jokinen E, Myyrinmaa A, et al. Individualized dietary counselling of families: serum cholesterol concentration and growth of children aged 7-13 months. Acta Paediatr. 1994. 83(4):383-8.	Intervention/exposure
253	Lapinleimu H, Viikari J, Jokinen E, et al. Prospective randomised trial in 1062 infants of diet low in saturated fat and cholesterol. Lancet. 1995. 345(8948):471-6.	Intervention/exposure
254	Larsson MW, Lind MV, Larnkjaer A, et al. Excessive Weight Gain Followed by Catch-Down in Exclusively Breastfed Infants: An Exploratory Study. Nutrients. 2018. 10(9):1290.	Intervention/exposure
255	Laws RA, Denney-Wilson EA, Taki S, et al. Key Lessons and Impact of the Growing Healthy mHealth Program on Milk Feeding, Timing of Introduction of Solids, and Infant Growth: Quasi-Experimental Study. JMIR Mhealth Uhealth. 2018. 6(4):e78.	Intervention/exposure, Outcome
256	Lee H, Zavaleta N, Chen SY, Lonnerdal B, Slupsky C. Effect of bovine milk fat globule membranes as a complementary food on the serum metabolome and immune markers of 6-11-month-old Peruvian infants. NPJ Sci Food. 2018. 2:6.	Intervention/exposure, Outcome
257	Lee I, Bang K-S, Moon H, Kim J. Risk Factors for Obesity Among Children Aged 24 to 80 months in Korea: A Decision Tree Analysis. J Pediatr Nurs. 2019. 46:e15-e23.	Study design, Age at intervention/exposure
258	Lee WT, Leung SS, Lui SS, Lau J. Relationship between long-term calcium intake and bone mineral content of children aged from birth to 5 years. Br J Nutr. 1993. 70(1):235-48.	Intervention/exposure

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259	Leermakers ETM, van den Hooven EH, Franco OH, et al. A priori and a posteriori derived dietary patterns in infancy and cardiometabolic health in childhood: The role of body composition. Clin Nutr. 2018. 37(5):1589-1595.	Outcome
260	Leung SS, Chan SM, Lui S, Lee WT, Davies DP. Growth and nutrition of Hong Kong children aged 0-7 years. J Paediatr Child Health. 2000. 36(1):56-65.	Intervention/exposure
261	Leung TF, Ulfman LH, Chong MKC, et al. A randomized controlled trial of different young child formulas on upper respiratory and gastrointestinal tract infections in Chinese toddlers. Pediatr Allergy Immunol. 2020. 31(7):745-754.	Outcome, Comparator
262	Lev-Ari L, Bachner-Melman R, Zohar AH, Ebstein R, Mankuta D. Weight gain, feeding and eating in the first year of life of babies of smoking and non-smoking mothers. Early Hum Dev. 2019. 140:104889.	Intervention/exposure
263	Levine AA. Excessive fruit juice consumption: how can something that causes failure to thrive be associated with obesity?. J Pediatr Gastroenterol Nutr. 1997. 25(5):554-5.	Study design
264	Li Ming W. A bottle-weaning counselling intervention for parents of 12-month-old infants reduces bottle use at age 24 months but has no effect on child weight. Evidence based nursing. 2015. 18(1):14-14.	Study design, Intervention/exposure
265	Lim SX, Toh JY, van Lee L, et al. Food Sources of Energy and Macronutrient Intakes among Infants from 6 to 12 Months of Age: The Growing Up in Singapore Towards Healthy Outcomes (GUSTO) Study. Int J Environ Res Public Health. 2018. 15(3):488.	Outcome
266	Linares AM, Rayens MK, Moylan JS, Miller CS. Degree of Agreement Between Infant Serum and Salivary Concentration of Leptin and Adiponectin and Its Association With Infants' Feeding. Biol Res Nurs. 2021. 23(3):541. doi:10.1177/1099800420973366.	Intervention/exposure, Outcome
267	Lind MV, Larnkjær A, Mølgaard C, Michaelsen KF. Early Nutrition and Its Effect on Growth, Body Composition, and Later Obesity. World Rev Nutr Diet. 2017. 116:118-133.	Study design, Publication status
268	Liu J, Liu J, Frongillo EA, Jr, et al. Body mass index trajectories during the first year of life and their determining factors. Am J Hum Biol. 2019. 31(1):e23188.	Intervention/exposure
269	Lopes AF, Rocha EMB, da Silva JPC, Nascimento VG, Bertoli C, Leone C. Breastfeeding, complementary food introduction and overweight in preschool children. Arch Latinoam Nutr. 2016. 66(3):195-200.	Study design, Language
270	Lopez de Romaña G, Graham GC, Madrid S, MacLean WC. Prolonged consumption of potato-based diets by infants and small children. J Nutr. 1981. 111(8):1430-6.	Country
271	Lovell AL, Milne T, Matsuyama M, et al. Protein Intake, IGF-1 Concentrations, and Growth in the Second Year of Life in Children Receiving Growing Up Milk - Lite (GUMLi) or Cow's Milk (CM) Intervention. Front Nutr. 2021. 8:666228.	Duplicate data
272	Luque V, Escribano J, Closa-Monasterolo R, et al. Unhealthy dietary patterns established in infancy track to mid-childhood: The EU childhood obesity project. J Nutr. 2018. 148(5):752-759.	Outcome
273	Ma JQ, Zhou LL, Hu YQ, Liu SS, Sheng XY. Association between feeding practices and weight status in young children. BMC Pediatr. 2015. 15:97.	Intervention/exposure
274	Machuca H, Arevalo S, Hackley B, et al. Well Baby Group Care: Evaluation of a Promising Intervention for Primary Obesity Prevention in Toddlers. Child Obes. 2016. 12(3):171-178.	Intervention/exposure
275	Maciel BLL, Costa PN, Filho JQ, et al. Higher Energy and Zinc Intakes from Complementary Feeding Are Associated with Decreased Risk of Undernutrition in Children from South America, Africa, and Asia. J Nutr. 2021. 151(1):170-178.	Country
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278	Maier IB, Özel Y, Wagnerberger S, Bischoff SC, Bergheim I. Dietary pattern and leisure time activity of overweight and normal weight children in Germany: Sex-specific differences. Nutr J. 2013. 12(1):14.	Age at intervention/exposure
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	Citation	Rationale
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282	Mandal B, Powell LM. Child care choices, food intake, and children's obesity status in the United States. Econ Hum Biol. 2014. 14(1):50-61.	Age at intervention/exposure
283	Mannan H, Sacre Y, Attieh R, Farah D. Infant-Feeding Patterns and the Effects of Early Introduction to Formula and Solid Foods on Childhood Overweight or Obesity among 10-Years-Olds in a Low Socioeconomic Area of Lebanon: An Exploratory Analysis. Children. 2022. 9(7):1030.	Study design
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285	Mardali F, Hosseini-Baharanchi FS, Dehnad A, Shidfar F, Mohammadi S, Găman M-A. Comparison of the key modifiable factors in the first 1000 days predicting subsequent overweight and obesity in pre-school children in Tehran: A case control study. Br J Nutr. 2022. 128(5):955-63. doi:10.1017/S0007114521003937.	Study design
286	Marshall TA, Eichenberger-Gilmore JM, Broffitt BA, Warren JJ, Levy SM. Dental caries and childhood obesity: roles of diet and socioeconomic status. Community Dent Oral Epidemiol. 2007. 35(6):449-58.	Study design
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	Citation	Rationale
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302	Moore LL, Bradlee ML, Gao D, Singer MR. Effects of average childhood dairy intake on adolescent bone health. J Pediatr. 2008. 153(5):667-73.	Age at intervention/exposure
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304	Mora-Urda AI, Acevedo P, Montero Lopez MP. Relationship between prenatal and postnatal conditions and accelerated postnatal growth. Impact on the rigidity of the arterial wall and obesity in childhood. J Dev Orig Health Dis. 2019. 10(4):436-446.	Study design, Intervention/exposure
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306	Morgan K, Zhou SM, Hill R, Lyons RA, Paranjothy S, Brophy ST. Identifying prenatal and postnatal determinants of infant growth: A structural equation modelling based cohort analysis. Int J Environ Res Public Health. 2021. 18(19):10265.	Study design
307	Morgan RE. Does consumption of high-fructose corn syrup beverages cause obesity in children?. Pediatr Obes. 2013. 8(4):249-254.	Study design
308	Morgen CS, Angquist L, Baker JL, Andersen AN, Sorensen TIA, Michaelsen KF. Breastfeeding and complementary feeding in relation to body mass index and overweight at ages 7 and 11 y: a path analysis within the Danish National Birth Cohort. Am J Clin Nutr. 2018. 107(3):313-322.	Intervention/exposure
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318	Nct. Complementary Weaning With Adult Food Typical of the Mediterranean Diet. https://clinicaltrials.gov/show/NCT05297357. 2022.	Publication status
319	Nct. INFANT HEALTH- Promoting Mental Health and Healthy Weight in Infancy Through Sensitive Parenting. https://clinicaltrials.gov/show/NCT04601779. 2020.	Study design
320	Neri D, Oliveira FLC, Carvalho AM, Somarriba GA, Scott GB, Miller TL. Associations Between Dietary Intake Before 6 Months of Age and Rapid Weight Gain Among HIV-exposed Uninfected Infants. J Pediatr Gastroenterol Nutr. 2017. 65(5):e104-e109.	Study design
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323	Ngaisyah RD, Rohman A. Effect of fish consumption as a local food alternative for the reduction of stunting in toddlers. Pakistan Journal of Nutrition. 2019. 18(5):496-500.	Country
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326	Nguyen AN, van Langeveld AWB, de Vries JHM, et al. Dietary taste patterns in early childhood: the Generation R Study. Am J Clin Nutr. 2020. 113(1):63-9.	Study design, Intervention/exposure
327	Nguyen T, Sokal-Gutierrez K, Lahiff M, Fernald L, Ivey SL. Early childhood factors associated with obesity at age 8 in Vietnamese children: The Young Lives Cohort Study. BMC Public Health. 2021. 21(1):301.	Country
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329	Nicklas TA, Farris RP, Smoak CG, et al. Dietary factors relate to cardiovascular risk factors in early life. Bogalusa Heart Study. Arteriosclerosis. 1988. 8(2):193-9.	Intervention/exposure
330	Nnanyelugo DO. Nutritional practices and food intake measurements and their relationship to socio-economic grouping, location and their apparent nutritional adequacy in children. Appetite. 1982. 3(3):229-241.	Country
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333	Nur R, Rusydi M, Fajriah RN, et al. Effects of family planning and baby care behavior on stunting in early married couples. Open Access Macedonian Journal of Medical Sciences. 2021. 9:467-473.	Study design, Country
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336	Odar Stough C, Bolling C, Zion C, Stark LJ. Comparison of High and Normal Birth Weight Infants on Eating, Feeding Practices, and Subsequent Weight. Matern Child Health J. 2018. 22(12):1805-1814.	Study design
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338	Okronipa H, Quezada-Sanchez AD, Johnson SL, et al. Effect of Added Sugar on the Consumption of A Lipid-Based Nutrient Supplement Among 7-24-Month-Old Children. Nutrients. 2020. 12(10):3069.	Intervention/exposure, Outcome
339	Okubo H, Crozier SR, Harvey NC, et al. Diet quality across early childhood and adiposity at 6 years: The Southampton Women's Survey. Int J Obes. 2015. 39(10):1456-1462.	Intervention/exposure
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341	Onifade OM, Pringle KG, Rollo ME, Collins CE, Schumacher T, Rae KM. Dietary intake of Indigenous Australian infants and young children in the Gomeroi gaaynggal cohort. Nutr Diet. 2021. 78(4):386. doi:10.1111/1747-0080.12673.	Outcome
342	Orlandi SP, Gonzalez-Chica DA, Buffarini R, et al. Breastfeeding and complementary feeding associated with body composition in 18-19 years old adolescents in the 1993 Pelotas Birth Cohort. BMC Nutr. 2017. 3:84.	Country
343	Ortega-Garcia JA, Kloosterman N, Alvarez L, et al. Full Breastfeeding and Obesity in Children: A Prospective Study from Birth to 6 Years. Child Obes. 2018. 14(5):327-337.	Intervention/exposure
344	Ortelan N, Augusto RA, Souza JMP. Factors associated with the evolution of weight of children in a supplementary feeding program. Rev Bras Epidemiol. 2019. 22:e190002.	Country, Health status
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347	Padilha LL, Vianna EO, Vale ATM, Nascimento JXPT, da Silva AAM, Ribeiro CCC. Pathways in the association between sugar sweetened beverages and child asthma traits in the 2nd year of life: Findings from the BRISA cohort. Pediatr Allergy Immunol. 2020. 31(5):480-488.	Outcome
348	Pahkala K, Laitinen TT, Niinikoski H, et al. Effects of 20-year infancy-onset dietary counselling on cardiometabolic risk factors in the Special Turku Coronary Risk Factor Intervention Project (STRIP): 6-year post-intervention follow-up. Lancet Child Adolesc Health. 2020. 4(5):359-369.	Intervention/exposure
349	Palacios C, Campos M, Gibby C, Melendez M, Lee JE, Banna J. Effect of a Multi-Site Trial using Short Message Service (SMS) on Infant Feeding Practices and Weight Gain in Low-Income Minorities. J Am Coll Nutr. 2018. 37(7):605-613.	Intervention/exposure
350	Pang WW, McCrickerd K, Quah PL, et al. Is breastfeeding associated with later child eating behaviours?. Appetite. 2020. 150:104653.	Intervention/exposure, Outcome
351	Papanikolaou Y, Fulgoni VL, 3rd. Egg Consumption in Infants is Associated with Longer Recumbent Length and Greater Intake of Several Nutrients Essential in Growth and Development. Nutrients. 2018. 10(6):719.	Study design
352	Papoutsou S, Savva SC, Hunsberger M, et al. Timing of solid food introduction and association with later childhood overweight and obesity: The IDEFICS study. Matern Child Nutr. 2018. 14(1):e12471.	Study design
353	Park SJ, Lee HJ. Exclusive breastfeeding and partial breastfeeding reduce the risk of overweight in childhood: A nationwide longitudinal study in Korea. Obes Res Clin Pract. 2018. 12(2):222-228.	Intervention/exposure
354	Parkes A, Sweeting H, Young R, Wight D. Does parenting help to explain socioeconomic inequalities in children's body mass index trajectories? Longitudinal analysis using the Growing Up in Scotland study. J Epidemiol Community Health. 2016. 70(9):868-873.	Age at intervention/exposure
355	Patel N, Dalrymple KV, Briley AL, et al. Mode of infant feeding, eating behaviour and anthropometry in infants at 6-months of age born to obese women - a secondary analysis of the UPBEAT trial. BMC Pregnancy Childbirth. 2018. 18(1):355.	Study design, Intervention/exposure
356	Pedroso J, Gubert MB. Cross-cultural adaptation and validation of the Infant Feeding Style Questionnaire in Brazil. PLoS One. 2021. 16(9):e0257991.	Intervention/exposure, Outcome
357	Penny ME, Jimenez MM, Marin RM. Early rapid weight gain and subsequent overweight and obesity in middle childhood in Peru. BMC Obes. 2016. 3:55.	Age at intervention/exposure, Country
358	Pereyra González I, Farías-Antúnez S, Buffarini R, et al. Ultra-processed food consumption and the incidence of obesity in two cohorts of Latin-American young children: A longitudinal study. J Pediatr Nurs. 2023. 69:e120-e126. doi:10.1016/j.pedn.2022.12.018.	Intervention/exposure, Age at intervention/exposure
359	Pereyra-González I, Mattei J. Combined intake of sugar-sweetened beverages and sugar-containing ultra-processed foods is associated with an increase in body mass index during early childhood. Pediatr Obes. 2023. 18(6):e13025.	Age at intervention/exposure
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361	Phillips F. Giving sound food advice for infants and toddlers. Nursing in Practice: The Journal for Today's Primary Care Nurse. 2018.	Study design
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363	Pietrobelli A, Agosti M, MeNu Group. Nutrition in the First 1000 Days: Ten Practices to Minimize Obesity Emerging from Published Science. Int J Environ Res Public Health. 2017. 14(12):1491.	Study design
364	Pillay L, Moodley D, Emel LM, Nkwanyana NM, Naidoo K. Growth patterns and clinical outcomes in association with breastfeeding duration in HIV exposed and unexposed infants: a cohort study in KwaZulu Natal, South Africa. BMC Pediatr. 2021. 21(1):183. doi:10.1186/s12887-021-02662-8.	Country
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367	Pineros-Leano M, Grafft N, Aguayo L. Childhood obesity risk factors by race and ethnicity. Obesity. 2022. 30(8):1670-1680.	Age at intervention/exposure
368	Pirilä S, Taskinen M, Viljakainen H, et al. Infant Milk feeding influences adult bone health: A prospective study from birth to 32 years. PLoS One. 2011. 6(4):e19068.	Outcome

	Citation	Rationale
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370	Pluymen LPM, Wijga AH, Gehring U, Koppelman GH, Smit HA, van Rossem L. Early introduction of complementary foods and childhood overweight in breastfed and formula-fed infants in the Netherlands: the PIAMA birth cohort study. Eur J Nutr. 2018. 57(5):1985-1993.	Intervention/exposure
371	Qasem W, Azad MB, Hossain Z, et al. Assessment of complementary feeding of Canadian infants: effects on microbiome & oxidative stress, a randomized controlled trial. BMC Pediatr. 2017. 17(1):54.	Directness of experimental studies
372	Qu P, Mi B, Wang D, et al. Association between the Infant and Child Feeding Index (ICFI) and nutritional status of 6- to 35-month-old children in rural western China. PLoS One. 2017. 12(2):e0171984.	Study design, Country
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375	Ra JS. Evaluation of a Mobile-based Maternal Feeding Education Program for Overweight Prevention in Infants. Asian Nurs Res. 2021. 15(2):136-43.	Intervention/exposure
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377	Rahmani S, Medise BE, Sjarif DR. Association between growing-up milk consumption and overweight and obesity in children aged 2-3 years. J Pediatr Gastroenterol Nutr. 2022. 74:1128-1128.	Study design
378	Reifsnider E, McCormick DP, Cullen KW, et al. Randomized Controlled Trial to Prevent Infant Overweight in a High-Risk Population. Acad Pediatr. 2018. 18(3):324-333.	Intervention/exposure
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380	Riaño-Galán I, Fernández-Somoano A, Rodríguez-Dehli C, Valvi D, Vrijheid M, Tardón A. Proatherogenic Lipid Profile in Early Childhood: Association with Weight Status at 4 Years and Parental Obesity. J Pediatr. 2017. 187:153-157.e2.	Intervention/exposure
381	Richard SA, McCormick BJJ, Murray-Kolb LE, et al. Characteristics associated with the transition to partial breastfeeding prior to 6 months of age: Data from seven sites in a birth cohort study. Matern Child Nutr. 2021. 17(3):e13166.	Intervention/exposure, Country
382	Riedlova J, Paulova M, Vignerova J, et al. The Low Prevalence of Overweight and Obesity in Czech Breastfed Infants and Young Children: An Anthropological Survey. Int J Environ Res Public Health. 2019. 16(21):4198.	Study design, Intervention/exposure
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384	Rivera JA, Shamah T, Villalpando S, Monterrubio E. Effectiveness of a large-scale iron-fortified milk distribution program on anemia and iron deficiency in low-income young children in Mexico. Am J Clin Nutr. 2010. 91(2):431-439.	Outcome
385	Robert RC, Penny ME, Barbagelatta G, Gainer SA. Feeding Homemade Sugar Sweetened Beverages in Addition to Breastfeeding: Survey Results from Caregivers of Infants and Young Children in Peri-Urban Lima, Peru. Matern Child Health J. 2023. 27(12):2105-12.	Study design
386	Robertson A, Parlesak A, Greiner T, Kent G, Cattaneo A. Biodiverse food solutions to enhance complementary feeding. Matern Child Nutr. 2016. 12(3):639-640.	Study design, Publication status
387	Robinson SL, Sundaram R, Putnick DL, et al. Predictors of Age at Juice Introduction and Associations with Subsequent Beverage Intake in Early and Middle Childhood. J Nutr. 2021. 151(11):3516-23.	Outcome
388	Roche ML, Marquis GS, Gyorkos TW, Blouin B, Sarsoza J, Kuhnlein HV. A Community-Based Positive Deviance/Hearth Infant and Young Child Nutrition Intervention in Ecuador Improved Diet and Reduced Underweight. J Nutr Educ Behav. 2017. 49(3):196-203 e1.	Intervention/exposure
389	Rodd C, Feely A, Becker AB, et al. World Health Organization growth standards: How do Canadian children measure up?. Paediatrics and Child Health (Canada). 2021. 26(5):E208-E214.	Intervention/exposure, Outcome

	Citation	Rationale
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391	Rodriguez-Cano AM, Mier-Cabrera J, Munoz-Manrique C, Cardona-Perez A, Villalobos-Alcazar G, Perichart-Perera O. Anthropometric and clinical correlates of fat mass in healthy term infants at 6 months of age. BMC Pediatr. 2019. 19(1):60.	Study design, Intervention/exposure
392	Rodriguez-Cano AM, Mier-Cabrera J, Rodriguez-Hernandez C, Allegre-Davalos AL, Munoz-Manrique C, Perichart-Perera O. Complementary feeding practices and their association with adiposity indicators at 12 months of age. J Dev Orig Health Dis. 2021. 12(5):780-787.	Intervention/exposure
393	Rogers I, Emmett P, Gunnell D, Dunger D, Holly J. Milk as a food for growth? The insulin-like growth factors link. Public Health Nutr. 2006. 9(3):359-68.	Age at intervention/exposure
394	Rogers S, Ramsay M, Blissett J. The Montreal Children's Hospital Feeding Scale: Relationships with parental report of child eating behaviours and observed feeding interactions. Appetite. 2018. 125:201-209.	Intervention/exposure, Outcome
395	Rogers SL, Blissett J. Breastfeeding duration and its relation to weight gain, eating behaviours and positive maternal feeding practices in infancy. Appetite. 2017. 108:399-406.	Intervention/exposure, Outcome
396	Rohde JF, Larsen SC, Ängquist L, et al. Effects of the Healthy Start randomized intervention on dietary intake among obesity-prone normal-weight children. Public Health Nutr. 2017. 20(16):2988-2997.	Age at intervention/exposure
397	Rolland-Cachera MF. Breast feeding and growth trajectories: importance of the time frame of observation. Pediatr Res. 2020. 87(3):436-437.	Study design
398	Rolland-Cachera MF, Deheeger M, Akrout M, Bellisle F. Influence of macronutrients on adiposity development: a follow up study of nutrition and growth from 10 months to 8 years of age. Int J Obes Relat Metab Disord. 1995. 19(8):573-8.	Intervention/exposure
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400	Rollins BY, Francis LA. Off the Charts: Identifying and Visualizing Body Mass Index Trajectories of Rural, Poor Youth. J Pediatr. 2021. 228:147-154 e2.	Intervention/exposure
401	Rose CM, Birch LL, Savage JS. Dietary patterns in infancy are associated with child diet and weight outcomes at 6 years. Int J Obes (Lond). 2017. 41(5):783-788.	Intervention/exposure
402	Rose CM, Savage JS, Birch LL. Patterns of early dietary exposures have implications for maternal and child weight outcomes. Obesity. 2016. 24(2):430-438.	Duplicate data
403	Rosenstock S, Ingalls A, Foy Cuddy R, et al. Effect of a Home-Visiting Intervention to Reduce Early Childhood Obesity Among Native American Children: A Randomized Clinical Trial. JAMA Pediatr. 2021. 175(2):133-142.	Intervention/exposure
404	Ruottinen S, Niinikoski H, Lagström H, et al. High sucrose intake is associated with poor quality of diet and growth between 13 months and 9 years of age: the special Turku Coronary Risk Factor Intervention Project. Pediatrics. 2008. 121(6):e1676-85.	Intervention/exposure
405	Rush E, Paterson J, Obolonkin V. Food frequency information--relationships to body composition and apparent growth in 4-year-old children in the Pacific Island Family Study. N Z Med J. 2008. 121(1281):63-71.	Age at intervention/exposure
406	Russo MD, Ahrens W, De Henauw S, et al. The impact of adding sugars to milk and fruit on adiposity and diet quality in children: A cross-sectional and longitudinal analysis of the identification and prevention of dietary-and lifestyle-induced health effects in children and infants (IDEFICS) study. Nutrients. 2018. 10(10):1350.	Age at intervention/exposure
407	Rybak TM, Goetz AR, Stark LJ. Examining patterns of postnatal feeding in relation to infant's weight during the first year. Appetite. 2021. 166:105473.	Intervention/exposure
408	Rzehak P, Oddy WH, Mearin ML, et al. Infant feeding and growth trajectory patterns in childhood and body composition in young adulthood. Am J Clin Nutr. 2017. 106(2):568-580.	Intervention/exposure
409	Saelens BE, Couch SC, Wosje KS, Stark LJ, Daniels SR. Relations among milk and non-milk beverage consumption, calcium, and relative weight in high-weight status children. J Clin Psychol Med Settings. 2006. 13(2):117-125.	Age at intervention/exposure
410	Salahuddin M, Perez A, Ranjit N, Hoelscher DM, Kelder SH. The associations of large-for-gestational-age and infant feeding practices with children's body mass index z-score trajectories: the Early Childhood Longitudinal Study, Birth Cohort. Clin Obes. 2017. 7(5):307-315.	Intervention/exposure

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412	Salvo D, Ranjit N, Nielsen A, Akhavan N, van den Berg A. Characterizing Micro-scale Disparities in Childhood Obesity: Examining the Influence of Multilevel Factors on 4-Year Changes in BMI, Healthy Eating, and Physical Activity, Among a Cohort of Children Residing in Disadvantaged Urban Enclaves. Front Public Health. 2019. 7:301.	Age at intervention/exposure
413	Samano R, Chico-Barba G, Martinez-Rojano H, et al. Factors Associated With Weight, Length, and BMI Change in Adolescents' Offspring in Their First Year of Life. Front Pediatr. 2021. 9:709933.	Intervention/exposure
414	Sanchez-Escobedo S, Azcorra H, Bogin B, et al. Birth weight, birth order, and age at first solid food introduction influence child growth and body composition in 6- to 8-year-old Maya children: The importance of the first 1000 days of life. Am J Hum Biol. 2020. 32(5):e23385.	Study design
415	Sanchez-Siles LM, Bernal MJ, Gil D, et al. Are Sugar-Reduced and Whole Grain Infant Cereals Sensorially Accepted at Weaning? A Randomized Controlled Cross-Over Trial. Nutrients. 2020. 12(6):1883.	Intervention/exposure, Outcome
416	Sanders TAB, Purves R. An anthropometric and dietary assessment of the nutritional status of vegan preschool children. J Hum Nutr. 1981. 35(5):349-357.	Age at intervention/exposure
417	Sangalli CN, Leffa PS, Valmorbida JL, Lumey LH, Vitolo MR. Impact of promoting healthy infant feeding practices on energy intake and anthropometric measures of children up to 6 years of age: A randomised controlled trial. J Hum Nutr Diet. 2021. 34(5):771-783.	Intervention/exposure
418	Santos LP, Assuncao MCF, Matijasevich A, Santos IS, Barros AJD. Dietary intake patterns of children aged 6 years and their association with socioeconomic and demographic characteristics, early feeding practices and body mass index. BMC Public Health. 2016. 16(1):1055.	Intervention/exposure, Age at intervention/exposure, Outcome
419	Santos LP, Ong KK, Santos IS, Matijasevich A, Barros AJD. Effects of dietary intake patterns from 1 to 4 years on BMI z-score and body shape at age of 6 years: a prospective birth cohort study from Brazil. Eur J Nutr. 2019. 58(4):1723-1734.	Country
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421	Sata M, Yamagishi K, Sairenchi T, et al. Breastfeeding in Infancy in Relation to Subsequent Physical Size: A 20-year Follow-up of the Ibaraki Children's Cohort Study (IBACHIL). Journal of epidemiology. 2023. 33(2):63. doi:10.2188/jea.JE20200562.	Intervention/exposure
422	Sauder KA, Kaar JL, Starling AP, Ringham BM, Glueck DH, Dabelea D. Predictors of Infant Body Composition at 5 Months of Age: The Healthy Start Study. J Pediatr. 2017. 183:94-99 e1.	Study design, Intervention/exposure
423	Saure C, Armeno M, Barcala C, Giudici V, Mazza CS. Excessive weight gain in exclusively breast-fed infants. J Pediatr Endocrinol Metab. 2017. 30(7):719-724.	Study design, Intervention/exposure
424	Savage JS, Birch LL, Marini M, Anzman-Frasca S, Paul IM. Effect of the INSIGHT Responsive Parenting Intervention on Rapid Infant Weight Gain and Overweight Status at Age 1 Year: A Randomized Clinical Trial. JAMA Pediatr. 2016. 170(8):742-9.	Intervention/exposure
425	Sazawal S, Dhingra U, Dhingra P, et al. Micronutrient fortified milk improves iron status, anemia and growth among children 1-4 years: a double masked, randomized, controlled trial. PLoS One. 2010. 5(8):e12167.	Country
426	Scharf RJ, Demmer RT, DeBoer MD. Longitudinal evaluation of milk type consumed and weight status in preschoolers. Arch Dis Child. 2013. 98(5):335-340.	Age at intervention/exposure
427	Schneider BC, Gatica-Dominguez G, Assuncao MCF, et al. Introduction to complementary feeding in the first year of life and risk of overweight at 24 months of age: changes from 2004 to 2015 Pelotas (Brazil) Birth Cohorts. Br J Nutr. 2020. 124(6):620-630.	Intervention/exposure
428	Schneider-Worthington CR, Berger PK, Goran MI, Salvy SJ. Learning to overeat in infancy: Concurrent and prospective relationships between maternal BMI, feeding practices and child eating response among Hispanic mothers and children. Pediatr Obes. 2021. 16(6):e12756.	Intervention/exposure, Outcome
429	Scully H, Alberdi G, Segurado R, et al. Child Care Exposure Influences Childhood Adiposity at 2 Years: Analysis from the ROLO Study. Child Obes. 2017. 13(2):93-101.	Study design
430	See VHL, Mori TA, Prescott SL, Beilin LJ, Burrows S, Huang RC. Cardiometabolic risk factors at 5 years after omega-3 fatty acid supplementation in infancy. Pediatrics. 2018. 142(1):e20162623.	Intervention/exposure
431	Sekhobo JP. Estimation of WIC effects in multilevel, cross-sector obesity prevention interventions. Obesity. 2017. 25(7):1157-1158.	Study design

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432	Seyyedi N, Rahimi B, Eslamlou HRF, Afshar HL, Spreco A, Timpka T. Smartphone-Based Maternal Education for the Complementary Feeding of Undernourished Children Under 3 Years of Age in Food-Secure Communities: Randomised Controlled Trial in Urmia, Iran. Nutrients. 2020. 12(2):587.	Intervention/exposure, Age at intervention/exposure, Health status
433	Shashaj B, Graziani MP, Contoli B, et al. Energy Balance–Related Behaviors, Perinatal, Sociodemographic, and Parental Risk Factors Associated with Obesity in Italian Preschoolers. J Am Coll Nutr. 2016. 35(4):362-371.	Study design, Age at intervention/exposure
434	Shashaj B, Contoli B, Raponi M, et al. Energy Balance-Related Behaviors, Perinatal, Sociodemographic, and Parental Risk Factors Associated with Obesity in Italian Preschoolers. J Am Coll Nutr. 2016. 35(4):362-371.	Age at intervention/exposure
435	Shefferly A, Scharf RJ, Deboer MD. Longitudinal evaluation of 100% fruit juice consumption on BMI status in 2-5-year-old children. Pediatr Obes. 2016. 11(3):221-227.	Age at intervention/exposure
436	Shin KO, Oh SY, Park HS. Empirically derived major dietary patterns and their associations with overweight in Korean preschool children. Br J Nutr. 2007. 98(2):416-21.	Age at intervention/exposure
437	Shinn LM, Tangney CC, Busche C, Sharp CM, Mullen MC. Demographic Correlates of Infant Feeding Practices and Growth Performance in the First Year of Life. Int J Pediatr. 2018. 2018:6569204.	Intervention/exposure
438	Simoneau G, Moodie EEM, Platt RW, Chakraborty B. Non-regular inference for dynamic weighted ordinary least squares: understanding the impact of solid food intake in infancy on childhood weight. Biostatistics. 2018. 19(2):233-246.	Study design, Country
439	Simpson RJ, Diedericks I, Haresign H. Evaluation of the first 3 years of Nutri-eSTEP usage (2013-2016). Canadian Journal of Dietetic Practice & Research. 2018. 79(3):150-150.	Publication status
440	Singhal A. The Impact of Human Milk Feeding on Long-Term Risk of Obesity and Cardiovascular Disease. Breastfeed Med. 2019. 14(S1):S9-S10.	Study design
441	Sirkka O, Hof MH, Vrijkotte T, et al. Feeding patterns and BMI trajectories during infancy: a multi-ethnic, prospective birth cohort. BMC Pediatr. 2021. 21(1):34.	Intervention/exposure
442	Sirkka O, Vrijkotte T, Halberstadt J, et al. Prospective associations of age at complementary feeding and exclusive breastfeeding duration with body mass index at 5-6 years within different risk groups. Pediatr Obes. 2018. 13(8):522-529.	Intervention/exposure
443	Sirkka O, Vrijkotte T, Houtum LV, et al. Infant Feeding and Ethnic Differences in Body Mass Index during Childhood: A Prospective Study. Nutrients. 2021. 13(7):2291.	Intervention/exposure
444	Siziba LP, Baumgartner J, Ricci C, et al. Associations of plasma total phospholipid fatty acid patterns with feeding practices, growth, and psychomotor development in 6-month-old South African infants. Matern Child Nutr. 2019. 15(3):e12763.	Study design, Country
445	Skinner JD, Bounds W, Carruth BR, Ziegler P. Longitudinal calcium intake is negatively related to children's body fat indexes. J Am Diet Assoc. 2003. 103(12):1626-31.	Age at intervention/exposure
446	Smith-Brown P, Morrison M, Krause L, Davies PSW. Microbiota and Body Composition During the Period of Complementary Feeding. J Pediatr Gastroenterol Nutr. 2019. 69(6):726-732.	Study design
447	Smuts CM, Matsungo TM, Malan L, et al. Effect of small-quantity lipid-based nutrient supplements on growth, psychomotor development, iron status, and morbidity among 6- to 12-mo-old infants in South Africa: a randomized controlled trial. Am J Clin Nutr. 2019. 109(1):55-68.	Country
448	Soares S, Santos AC, Peres FS, Barros H, Fraga S. Early life socioeconomic circumstances and cardiometabolic health in childhood: Evidence from the Generation XXI cohort. Prev Med. 2020. 133:106002.	Intervention/exposure
449	Specht IO, Rohde JF, Olsen NJ, Heitmann BL. Duration of exclusive breastfeeding may be related to eating behaviour and dietary intake in obesity prone normal weight young children. PLoS One. 2018. 13(7):e0200388.	Intervention/exposure, Age at intervention/exposure
450	Stearns JC, Zulyniak MA, de Souza RJ, et al. Ethnic and diet-related differences in the healthy infant microbiome. Genome Med. 2017. 9(1):32.	Study design, Outcome
451	Stroobant W, Braun KV, Kiefte-de Jong JC, et al. Intake of Different Types of Fatty Acids in Infancy Is Not Associated with Growth, Adiposity, or Cardiometabolic Health up to 6 Years of Age. J Nutr. 2017. 147(3):413-420.	Intervention/exposure
452	Strucińska M, Rowicka G. Dietary intake of vitamin D in obese children aged 1-3 years. Roczniki Państwowego Zakładu Higieny. 2015. 66(4):353-360.	Study design
453	Sun C, Foskey RJ, Allen KJ, et al. The Impact of Timing of Introduction of Solids on Infant Body Mass Index. J Pediatr. 2016. 179:104-110.e1.	Study design
454	Susanto T, Syahrul, Sulistyorini L, Rondhianto, Yudisianto A. Local-food-based complementary feeding for the nutritional status of children ages 6-36 months in rural areas of Indonesia. Korean J Pediatr. 2017. 60(10):320-326.	Country

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455	Susatia B, Riswari RM. Green Bean Juice as Supplementary Food to Increase the Weight of Underweight Toddlers. Open Access Macedonian Journal of Medical Sciences. 2021. 9(G):297. doi:10.3889/oamjms.2021.7494.	Study design
456	Svensson V, Sobko T, Ek A, et al. Obesogenic dietary intake in families with 1-year-old infants at high and low obesity risk based on parental weight status: baseline data from a longitudinal intervention (Early STOPP). Eur J Nutr. 2016. 55(2):781-792.	Study design
457	Switkowski KM, Jacques PF, Must A, Fleisch A, Oken E. Associations of protein intake in early childhood with body composition, height, and insulin-like growth factor i in mid-childhood and early adolescence. Am J Clin Nutr. 2019. 109(4):1154-1163.	Intervention/exposure, Age at intervention/exposure
458	Syrad H, Llewellyn CH, van Jaarsveld CH, Johnson L, Jebb SA, Wardle J. Energy and nutrient intakes of young children in the UK: findings from the Gemini twin cohort. Br J Nutr. 2016. 115(10):1843-50.	Outcome
459	Tahir MJ, Michels KB, Willett WC, Forman MR. Age at Introduction of Solid Food and Obesity Throughout the Life Course. Obesity (Silver Spring). 2018. 26(10):1611-1618.	Study design
460	Talavera JO, Garcia-Vilchis MJ, Labrada-Alba TS, Olvera-Flores F, Martinez-Jaureguiberry MF, Salgado-Enriquez B. Moderate acute malnutrition prevention with a ready-to-use supplementary food in pre-school children from rural communities. Gac Med Mex. 2020. 156(6):499-508.	Age at intervention/exposure
461	Tang M, Ma C, Weinheimer-Haus EM, et al. Different gut microbiota in U.S. formula-fed infants consuming a meat vs. dairy-based complementary foods: A randomized controlled trial. Front Nutr. 2023. 9:1063518.	Duplicate data
462	Tang M. The impact of complementary feeding foods of animal origin on growth and the risk of overweight in infants. Anim Front. 2019. 9(4):5-11.	Study design
463	Taverno Ross SE, Barone Gibbs B, Documet PI, Pate RR. ANDALE Pittsburgh: results of a promotora-led, home-based intervention to promote a healthy weight in Latino preschool children. BMC Public Health. 2018. 18(1):360.	Age at intervention/exposure
464	Tawia S, McGuire E. Early weight loss and weight gain in healthy, full-term, exclusively breastfed infants. Australian Midwifery News. 2016. 16(2):35-36.	Study design
465	Taylor RW, Gray AR, Heath ALM, et al. Sleep, nutrition, and physical activity interventions to prevent obesity in infancy: Follow-up of the Prevention of Overweight in Infancy (POI) randomized controlled trial at ages 3.5 and 5 y. Am J Clin Nutr. 2018. 108(2):228-236.	Intervention/exposure
466	Taylor RW, Williams SM, Fangupo LJ, et al. Effect of a Baby-Led Approach to Complementary Feeding on Infant Growth and Overweight: A Randomized Clinical Trial. JAMA Pediatr. 2017. 171(9):838-846.	Intervention/exposure
467	Tctr . Nutrition Education Intervention to Improve Child Feeding Practice and Nutritional Status of Children Age 6-23 Months in Indonesia. http://www.who.int/trialsearch/Trial2.aspx?TrialID=TCTR20200213003. 2020.	Publication status
468	Temples HS, Willoughby D, Holaday B, et al. Breastfeeding and Growth of Children in the Peri/postnatal Epigenetic Twins Study (PETS): Theoretical Epigenetic Mechanisms. J Hum Lact. 2016. 32(3):481-8.	Study design, Intervention/exposure
469	Thaweekul P, Sinlapamongkolkul P, Tonglim J, Sritipsukho P. Associations between the infant and young child feeding index and nutritional status. Pediatr Int. 2021. 63(8):958-964.	Study design
470	Thompson AL, Wasser H, Nulty A, Bentley ME. Feeding style profiles are associated with maternal and infant characteristics and infant feeding practices and weight outcomes in African American mothers and infants. Appetite. 2021. 160:105084.	Intervention/exposure
471	Thomson JL, Goodman MH, Tussing-Humphreys LM, Landry AS. Infant growth outcomes from birth to 12 months of age: findings from the Delta Healthy Sprouts randomized comparative impact trial. Obesity Science and Practice. 2018. 4(4):299-307.	Intervention/exposure
472	Thorisdottir B, Gunnarsdottir I, Palsson GI, Halldorsson TI, Thorsdottir I. Animal protein intake at 12 months is associated with growth factors at the age of six. Acta Paediatr. 2014. 103(5):512-7.	Intervention/exposure
473	Tian Q, Gao X, Sha T, et al. Effect of feeding patterns on growth and nutritional status of children aged 0-24 months: A Chinese cohort study. PLoS One. 2019. 14(11):e0224968.	Intervention/exposure
474	Ţincu, IF, Păcurar D, Ţincu RC, Becheanu C. Influence of Protein Intake during Complementary Feeding on Body Size and IGF-I Levels in Twelve-month-old Infants. Balkan Med J. 2020. 37(1):54-55.	Study design
475	Trabulsi JC, Smethers AD, Eosso JR, Papas MA, Stallings VA, Mennella JA. Impact of early rapid weight gain on odds for overweight at one year differs between breastfed and formula-fed infants. Pediatr Obes. 2020. 15(10):e12688.	Intervention/exposure
476	Trier C, Fonvig CE, Bøjsøe C, et al. No influence of sugar, snacks and fast food intake on the degree of obesity or treatment effect in childhood obesity. Pediatr Obes. 2016. 11(6):506-512.	Age at intervention/exposure

	Citation	Rationale
477	Ua-Areechit T, Suteerojntrakool O, Pongcharoen T, et al. Breastfeeding duration is associated with higher adiposity at 6-8 months of age. Matern Child Nutr. 2023. 19(1):e13438.	Study design
478	Usheva N, Galcheva S, Cardon G, et al. Complementary Feeding and Overweight in European Preschoolers: The ToyBox-Study. Nutrients. 2021. 13(4):1199.	Study design
479	Vadiveloo M, Tovar A, Ostbye T, Benjamin-Neelon SE. Associations between timing and quality of solid food introduction with infant weight-for-length z-scores at 12 months: Findings from the Nurture cohort. Appetite. 2019. 141:104299.	Intervention/exposure
480	Vafa M, Heshmati J, Sadeghi H, et al. Is exclusive breastfeeding and its duration related to cardio respiratory fitness in childhood?. Journal of Maternal-Fetal and Neonatal Medicine. 2016. 29(3):461-465.	Intervention/exposure, Outcome
481	van Beijsterveldt I, de Fluiter KS, Breij LM, van der Steen M, Hokken-Koelega ACS. Fat mass and fat-free mass track from infancy to childhood: New insights in body composition programming in early life. Obesity (Silver Spring). 2021. 29(11):1899-906.	Intervention/exposure
482	van der Veek SMC, de Graaf C, de Vries JHM, et al. Baby's first bites: a randomized controlled trial to assess the effects of vegetable-exposure and sensitive feeding on vegetable acceptance, eating behavior and weight gain in infants and toddlers. BMC Pediatr. 2019. 19(1):266.	Study design, Outcome
483	van Gijssel RM, Braun KV, Kiefte-de Jong JC, Jaddoe VW, Franco OH, Voortman T. Associations between Dietary Fiber Intake in Infancy and Cardiometabolic Health at School Age: The Generation R Study. Nutrients. 2016. 8(9):531.	Intervention/exposure
484	van Gijssel RMA, Braun KVE, Kiefte-de Jong JC, Jaddoe VWV, Franco OH, Voortman T. Associations between dietary fiber intake in infancy and cardiometabolic health at school age: The generation R study. Nutrients. 2016. 8(9):531.	Intervention/exposure
485	van Staveren WA, Dhuyvetter JH, Bons A, Zeelen M, Hautvast JG. Food consumption and height/weight status of Dutch preschool children on alternative diets. J Am Diet Assoc. 1985. 85(12):1579-84.	Intervention/exposure
486	van Vliet MS, Schultink JM, Jager G, et al. The Baby's First Bites RCT: Evaluating a Vegetable-Exposure and a Sensitive-Feeding Intervention in Terms of Child Health Outcomes and Maternal Feeding Behavior During Toddlerhood. J Nutr. 2022. 152(2):386-98.	Intervention/exposure
487	Vandenplas Y, Dupont C, Eigenmann P, et al. Growth in Infants with Cow's Milk Protein Allergy Fed an Amino Acid-Based Formula. Pediatr Gastroenterol Hepatol Nutr. 2021. 24(4):392-402.	Study design, Intervention/exposure
488	Vanderhout SM, Keown-Stoneman CDG, Birken CS, Connor DL, Thorpe KE, Maguire JL. Cow’s milk fat and child adiposity: a prospective cohort study. Int J Obes. 2021. 45(12):2623-2628.	Age at intervention/exposure
489	Vandyousefi S, Whaley SE, Widen EM, et al. Association of breastfeeding and early exposure to sugar-sweetened beverages with obesity prevalence in offspring born to mothers with and without gestational diabetes mellitus. Pediatr Obes. 2019. 14(12):e12569.	Study design
490	Vard B, Adham A, Riahi R, et al. Association of early life factors with dyslipidemia in children and adolescents: The CASPIAN-V study. Health Promot Perspect. 2020. 10(4):349-358.	Study design
491	Vehapoglu A, Goknar N, Turel O, Torun E, Ozgurhan G. Risk factors for childhood obesity: Do the birth weight, type of delivery, and mother's overweight have an implication on current weight status?. World J Pediatr. 2017. 13(5):457-464.	Study design
492	Ventura AK, Li R, Xu X. Associations between Bottle-Feeding during Infancy and Obesity at Age 6 Years Are Mediated by Greater Infancy Weight Gain. Child Obes. 2020. 16(5):316. doi:10.1089/chi.2019.0299.	Intervention/exposure
493	Ventura AK, Whaley SE. Strategies to promote responsive bottle-feeding in WIC predict less frequent use of food to soothe and healthier weight status for infants with negative temperaments. Pediatr Obes. 2022. 17(8):e12908. doi:10.1111/ijpo.12908.	Intervention/exposure
494	Ventura AK. Developmental Trajectories of Bottle-Feeding During Infancy and Their Association with Weight Gain. J Dev Behav Pediatr. 2017. 38(2):109-119.	Intervention/exposure, Outcome
495	Verbestel V, De Coen V, Van Winckel M, Huybrechts I, Maes L, De Bourdeaudhuij I. Prevention of overweight in children younger than 2 years old: a pilot cluster-randomized controlled trial. Public Health Nutr. 2014. 17(6):1384-1392.	Intervention/exposure
496	Viner RM, Costa S, Johnson W. Patterns of BMI development between 10 and 42 years of age and their determinants in the 1970 British Cohort Study. J Epidemiol Community Health. 2019. 73(1):79-85.	Intervention/exposure
497	Virudachalam S, Gruver RS, Gerdes M, et al. Mothers' and clinicians' priorities for obesity prevention among black, high-risk infants. Am J Prev Med. 2016. 51(1):46-53.	Study design, Intervention/exposure
498	Visioli F, Poli A. Limitations in study of sugar-sweetened beverages. J Am Diet Assoc. 2008. 108(1):34-35.	Study design

	Citation	Rationale
499	Vlasblom E, van Grieken A, Beltman M, L'Hoir MP, Raat H, Boere-Boonekamp MM. Parenting support to prevent overweight during regular well-child visits in 0-3 year old children (BBOFT+ program), a cluster randomized trial on the effectiveness on child BMI and health behaviors and parenting. PLoS One. 2020. 15(8):e0237564.	Intervention/exposure
500	Vobecky JS, Vobecky J, Shapcott D, Demers PP. Nutrient intake patterns and nutritional status with regard to relative weight in early infancy. Am J Clin Nutr. 1983. 38(5):730-738.	Intervention/exposure
501	Vogelezang S, Santos S, van der Beek EM, et al. Infant breastfeeding and childhood general, visceral, liver, and pericardial fat measures assessed by magnetic resonance imaging. Am J Clin Nutr. 2018. 108(4):722-729.	Intervention/exposure
502	Voortman T, Braun KVE, Kiefte-De Jong JC, Jaddoe VWV, Franco OH, Van Den Hooven EH. Protein intake in early childhood and body composition at the age of 6 years: The Generation R Study. Int J Obes. 2016. 40(6):1018-1025.	Intervention/exposure
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	Citation	Rationale
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