

Beef and Beef's Nutrients During Adolescence

Essential Nutrients for Adolescents

BEEF INTAKE HELPS MEET NUTRITIONAL DEMANDS OF ADOLESCENCE

Flavorful and versatile, beef is a popular food that provides essential nutrients for health. In fact, beef's unique nutrient package contains high-quality protein and bioavailable essential nutrients making it well-suited to meet increased nutrient needs of adolescents during this stage of rapid growth and development.

According to a recent NHANES analysis, adolescent beef consumers had a higher propensity for meeting nutrient requirements for **iron, folate, riboflavin, thiamin**, vitamins **B₁₂** and **B₆**, **zinc, calcium, copper, niacin** and **phosphorus**, contributing significantly to nutrient adequacy during this life stage.⁴

Increased nutrient adequacy is particularly notable for female adolescent beef consumers who are exceptionally vulnerable to nutrient inadequacy.⁴

BEEF'S UNIQUE NUTRIENT MATRIX: CRITICAL NUTRIENTS FOR GROWTH AND DEVELOPMENT DURING ADOLESCENCE

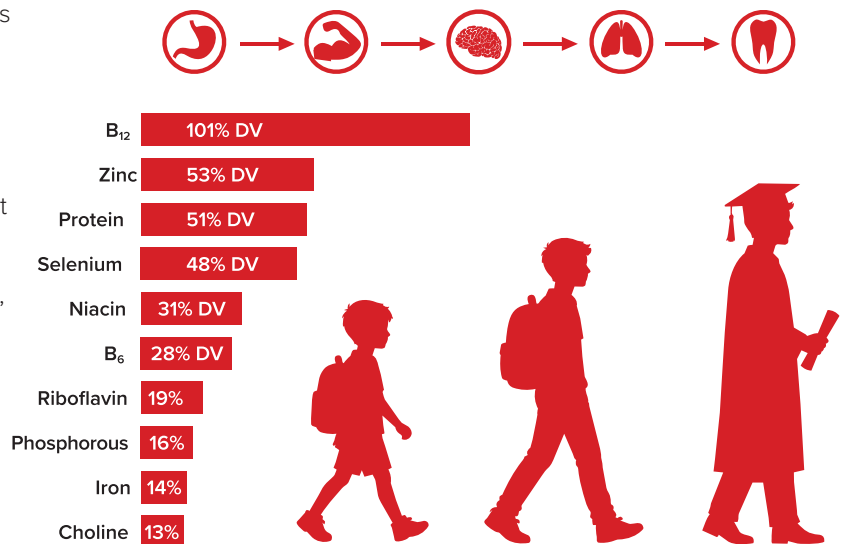
For healthy growth and development, a balanced healthful dietary pattern contributes to short- and long-term good health. Beef and other animal-source foods provide essential nutrients to adolescent diets. Key nutrients in beef for healthy growth and development during adolescence include Protein, Iron, Zinc, Vitamin B₁₂, Vitamin B₆, Riboflavin, Niacin, Choline, Phosphorus and Potassium.⁸

Protein

Dietary protein is a key nutrient for growth and development as it supplies amino acids necessary for processes such as tissue growth, energy production, immune function and nutrient absorption.⁹ In the U.S., dietary protein intake generally meets the Recommended Dietary Allowance (RDA) except for adolescent females age 14-18 years.³ It is reported that 7% of adolescent females age 9-13 years are below the RDA, while 23% of adolescent females age 14-18 years fall short. For their male counterpart, 2% of adolescent males age 9-13 years are below the RDA and 11% of adolescent males age 14-18 years are below the RDA.¹⁰

While the dietary recommendations were established based on preventing deficiency, there are no guidelines for an "optimal" protein intake in the pediatric population for promoting healthy growth and development. The Acceptable Macronutrient Distribution Range (AMDR) for protein is 10-30% of total calories for adolescents 9 to 18 years of age.¹² Approximately 2% and 1% of adolescent females age 9-13

BEEF HELPS FILL CRITICAL NUTRIENT GAPS



One serving of cooked beef provides high-quality protein and nine other essential nutrients that support optimal growth and cognitive development, helping to fuel good health.

years and 14-18 years, respectively, consume protein below the AMDR (i.e., less than 10% of total energy intake), while 1% of adolescent males age 9-18 years are below the AMDR for protein intake.¹⁰ No adolescent age groups were reported to consume protein above the AMDR.¹⁰ Additionally, evidence-based reviews designed to establish dietary reference values for healthy children, adolescents and teens have considered the potential for adverse outcomes related to higher protein intake, and these studies consistently found insufficient evidence to establish an upper limit for protein intake.^{12,13} Given these findings, there appear to be no adverse effects for increased protein intakes, even intake above the RDA but within the AMDR, for adolescents.

Beef is an excellent source of high-quality protein. One 3-ounce cooked serving provides about 51% of the Daily Value for protein.^{8,14} Beef is one of the top three food sources for protein in children and adolescents.¹⁵ Research has demonstrated that animal-based protein is more bioavailable than protein from plant food sources.¹⁶ With protein acknowledged to be a nutrient of public health challenge for adolescent girls, a nutrient-dense source of protein like beef is a food to encourage, as it provides additional key nutrients like iron as a part of a balanced diet for this population.

Iron

Iron plays a significant role in many functions because it helps the blood carry oxygen to the lungs, muscles, and all parts of our bodies. Because of this role, iron is also involved in brain function and helps keep the immune system strong. During adolescence, there are increased needs for iron in both males and females to sustain the rapid growth and development including enlarging muscle mass, expansion of blood volume and increase in hemoglobin concentration.¹⁷ The recommended intake of iron during the years 9-13, among both boys and girls, is about 8 milligrams of iron daily, while the recommendation jumps to 15 milligrams of iron daily for girls ages 14-18 years, and 11 milligrams daily for boys ages 14-18 years. The higher levels of iron overall are noted due to rapidly increased growth and development occurring during this life stage — in adolescent girls even higher requirements relate to menarche, menstruation and menstrual blood loss.¹⁷

Iron deficiency can impact physical growth, endurance and cognitive performance, and can also lead to depressed immune function in adolescents.^{17,18} Iron deficiency is especially problematic among adolescent girls and women of reproductive age, given that approximately 20% of this population subgroup is at risk of inadequate dietary iron based on biomarker data.¹⁹ In a recent analysis of U.S. females ages 12-21 years, iron deficiency affected almost 40%, and iron deficiency anemia affected 6%.²⁰

Physically active adolescents are further at increased risk of iron deficiency due to iron losses through sweat, urine, foot-strike hemolysis, and inflammatory responses. In an assessment of youth athletes (8-16 years), poor iron status was prevalent, with anemia reported in 46% of the males and 53% of the females.²¹

Beef is a good source of iron with one 3-ounce cooked serving providing about 14% of the Daily Value.^{8,14} Beef is one of the top five food sources for iron in children and adolescents.¹⁵ Additionally, beef is a source for heme iron, which is more easily absorbed or bioavailable in the body compared to non-heme iron found in plant foods and is critical to reversing iron deficiency.^{3,22,23}

Iron is identified as a nutrient of public health concern for adolescent females. Dietary guidance recommends that women and adolescent girls consume foods containing heme iron, such as lean meats including beef, poultry and seafood, which is more readily absorbed by the body, to help improve iron status.¹⁹ It is estimated that 420,000 fewer adolescent females would fall below the Estimated Average Requirement (EAR) for iron if they incorporated an average of 1.7 ounces of beef into their dietary pattern.⁴ Similarly, 160,000 fewer adolescent males would fall below the EAR for iron if they consumed 2.0 ounces of beef per day.⁴

Zinc

Zinc is essential for growth and sexual maturation.¹⁷ Zinc deficiency can delay growth and development as well as impair brain function by affecting attention, learning, memory, and motor development and may contribute to possible development of neuropsychological diseases.^{17,24,25}

Beef is an excellent source of zinc, with a 3-ounce cooked serving providing about 53% of the Daily Value.^{8,14} Beef is the top food source for zinc in children and adolescents.¹⁵

It is estimated that 1.4 million fewer adolescent females and 890,000 fewer adolescent males would fall below EAR for zinc by incorporating 1.7 and 2 ounces of beef per day into their dietary patterns, respectively.⁴

B-Vitamins: B₁₂, B₆, Niacin and Riboflavin

B vitamins like vitamins B₁₂, B₆, and niacin are critical for various important functions for body growth and maintenance, including supporting brain function and energy metabolism.

Beef is an excellent source of vitamins B₆, B₁₂, and niacin (B₃), with one 3-ounce cooked serving providing about 28%, 101%, and 31%, respectively, of the Daily Value.^{8,14} Additionally, beef is a good source of riboflavin (B₂), and a 3-ounce serving provides about 19% of the Daily Value.^{8,14} Beef is in the top 5 food sources for niacin, B₆ and B₁₂ in children and adolescents,¹⁵ and it is important to note that vitamin B₆ and B₁₂ are identified as nutrients of public health challenge for female adolescents. Animal-source foods, such as beef, are the only food sources of vitamin B₁₂. By incorporating an average of 1.7-2 ounces of beef in their daily dietary pattern, it is estimated that 600,000 fewer adolescent females and 200,000 adolescent males would fall below EAR for vitamin B₁₂, respectively.⁴

Choline

Choline is an essential nutrient in brain development, cell signaling, nerve impulse transmission, and lipid transport and metabolism.

Beef is a good source of choline; with one 3-ounce cooked serving providing about 13% of the Daily Value.^{8,14}

The adequate intake (AI) for choline is 375 mg/d for adolescents age 9-13 years, 400mg/d for females 14-18 years and 550mg/d for males 14-18 years.²⁶ In general, choline intake is suboptimal across the population with no exception for adolescents, with 14% and < 3% of males and females aged 9–13 years, respectively, meeting the AI. Similarly, 5% and < 3% of males and females age 14-18 years, respectively, meet the AI for choline.²⁶ Animal-source products typically contain higher levels of choline than most plant foods.

Phosphorus

Phosphorus helps build bones and teeth and is needed for the body to make protein for the growth, maintenance, and repair of cells and tissues.

Beef is a good source of phosphorus, with one 3-ounce cooked serving providing about 16% of the Daily Value. Beef is in the top five food sources for phosphorus in children and adolescents.^{8,14,15} It is estimated that 730,000 fewer adolescent females would fall below EAR for phosphorus if they incorporated an average of 1.7 ounces of beef into their dietary pattern.⁴ Similarly, it is estimated that 440,000 fewer male adolescents would fall below the EAR for phosphorus by incorporating an average of 2.0 ounces of beef into their dietary pattern.⁴ With phosphorus acknowledged as a nutrient of public health challenge for both female and male adolescents, food sources like beef can play an important role toward achieving improved nutrient adequacy in this age group.

Potassium

Potassium is involved in muscle contractions, heart function and water balance.

One 3-ounce cooked serving of beef provides about 6% of the Daily Value and is one of the top 10 food sources of potassium in children and adolescents.^{8,14,15} With potassium identified as a nutrient of public health concern for all Americans, food sources of potassium are important to identify and encourage as part of healthy dietary patterns.

SPOTLIGHT ON BEEF BURGERS AND SANDWICHES

On any given day, 23.2% of youth ages 2-18 years consumed a beef sandwich. Total beef sandwiches (burger and non-burger; including all beef and non-beef sandwich components) contributed 35% of protein intake, 33% of vitamin B₁₂, 27% of iron, 25% of choline, 25% of phosphorus and 21% of vitamin B₆ while contributing to 5.9% of total energy intake for this age group.¹

BEEF CONSUMPTION AMONG ADOLESCENTS

Beef consumption in adolescents has slowly declined between 2001–2018.² Approximately half of children and adolescents (2-18 years of age) are reported to consume beef on any given day, and among beef consumers in this age range, the usual intake of total beef was 2.2 ounces per day, which is within the DGA recommendation for Meat, Poultry, and Eggs subgroup.² Of the beef types analyzed as a part of this research, processed beef was the least consumed type of beef among beef consumers.² One quarter of the children and adolescent beef consumers (2-18 years) in this study reported consuming ground beef on any given day.

A recent study found that adolescent beef consumers had better nutrient adequacy (i.e., fewer adolescent beef consumers fell below the EAR) for numerous nutrients compared to those in the same age group who did not consume beef, particularly for nutrients inherently found in beef, including iron, niacin, phosphorus, riboflavin, vitamin B₁₂, vitamin B₆, and zinc.²¹ Female adolescents who consumed beef had an average total beef intake of 1.7 ounces per day. When compared to adolescent female non-beef consumers, the beef consumers had numerically higher intakes of 19 out of the 20 vitamins and minerals reported in the study. Of these, statistically higher intakes were reported for 13 of the reported nutrients (i.e., calcium, folate, iron, niacin, phosphorus, potassium, riboflavin, selenium, sodium, thiamin, total choline, vitamin B₁₂, and zinc).

Male adolescent (14-18 years) beef consumers had a 24% greater beef intake when compared to females, with intake of 2.0 ounces per day.⁴ Compared to adolescent male non-beef consumers, all 20 vitamins and minerals reported in the study were numerically higher, representing greater nutrient adequacy of the beef consumers, with 11 nutrients statistically higher (i.e., calcium, iron, niacin, phosphorus, potassium, selenium, sodium, thiamin, total choline, vitamin B₁₂, and zinc) for the beef eaters.⁴

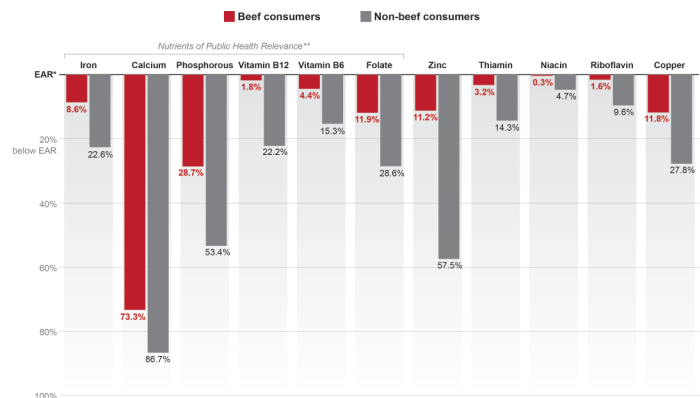
POTENTIAL IMPACT OF REDUCING/ EXCLUDING BEEF FROM THE DIET

There is strong evidence supporting the inclusion of animal-source foods, such as beef, in healthy dietary patterns to provide essential nutrients such as high-quality protein, iron, choline, vitamins B₆ and B₁₂, and zinc, some of which are not always easily obtained with plant-based vegetarian and vegan diets. Additionally, plant protein foods often contain less bioavailable forms of these needed nutrients or require significantly more calories to get the same amount of nutrients.^{27,28} Over one-third of protein consumed in the average adolescent diet is derived from lower-quality protein sources such as grains, legumes, nuts and seeds.²⁹ A systematic review of children and adolescents following vegetarian and vegan or omnivore (meat-containing) diets concluded that the vegetarian and vegan children and adolescents were at risk for inadequate vitamin B₁₂, iron, and zinc intakes.³⁰

Compared to all other age groups, adolescents have the largest discrepancy between recommended and current nutrient intakes.³ Poor nutrient intake during adolescence can

Adolescent Females (14-18 years) Who Eat Beef Are More Likely to Achieve Nutrient Adequacy Than Beef Non-Eaters

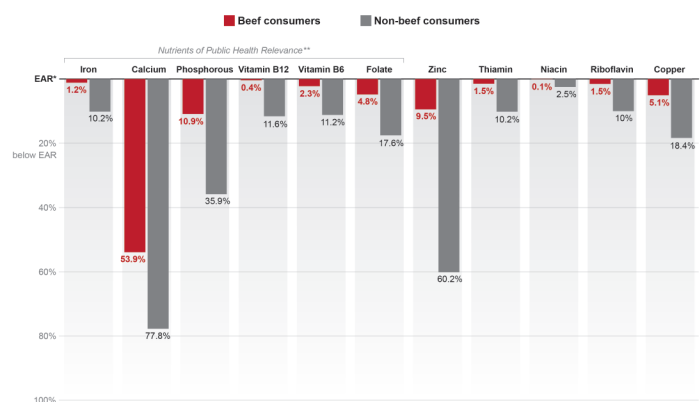
Based on the percentage of female beef eaters and beef non-eaters who fall BELOW the Estimated Average Requirement (EAR)



*Estimated Average Requirement is the level of daily intake for a specific nutrient that meets the nutritional requirements of 50% of all people without health conditions. EAR is typically used to assess the nutrient intakes of populations to help in planning nutritionally adequate diets.
 **Bailey R, et al. A Proposed Framework for Identifying Nutrients and Food Components of Public Health Relevance in the Dietary Guidelines for Americans. <https://www.sciencedirect.com/science/article/pii/S0022316622001535>

Adolescent Males (14-18 years) Who Eat Beef Are More Likely to Achieve Nutrient Adequacy Than Beef Non-Eaters

Based on the percentage of male beef eaters and beef non-eaters who fall BELOW the Estimated Average Requirement (EAR)



*Estimated Average Requirement is the level of daily intake for a specific nutrient that meets the nutritional requirements of 50% of all people without health conditions. EAR is typically used to assess the nutrient intakes of populations to help in planning nutritionally adequate diets.
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lead to significant challenges in growth, overall development, and learning, such as delayed physical development, poor academic performance, and depressed immune function. In addition, health-promoting dietary habits and lifestyle behaviors are established in adolescence, having both short- and long-term health consequences. The inclusion of beef and other nutrient-dense animal-source foods in a healthful dietary pattern can help improve nutrient adequacy among adolescents. Emerging research indicates beef intake can help improve diet quality in adolescents, can help promote satiety and is associated with increased mental well-being. Future research is necessary to ensure adolescents not only have the resources, education, and support to choose healthful, nutrient-dense foods and dietary patterns but also are equipped with behavioral strategies that help promote healthful habits and behaviors throughout the life span.

References

- Murphy MM, Anderson MM, Bi X. Analysis of nutrient contribution of beef sandwiches in the United States (NHANES 20132016). *Front Nutr*, 10 June 2024 (11). <https://doi.org/10.3389/fnut.2024.1355490>.
- Lau CS, Fulgoni VL, 3rd, Van Elswyk ME, McNeill SH. Trends in Beef Intake in the United States: Analysis of the National Health and Nutrition Examination Survey, 2001-2018. *Nutrients* 2023; 15(11): 2475.
- U.S. Department of Agriculture and U.S. Department of Health and Human Services. 2020. Dietary Guidelines for Americans, 2020-2025. 9th Edition. <https://www.dietaryguidelines.gov/>.
- Fulgoni K, Fulgoni VL. Beef Intake Is Associated with Higher Nutrient Intake and Nutrient Adequacy in U.S. Adolescents, NHANES 2001-2018. *Nutrients* 2023; 15(23): 4996.
- Black LI, Terlizzi EP, Vahratian A. 2022. Organized sports participation among children aged 6–17 ayears: United States, 2020. NCHS data brief ; no. 441 <https://dx.doi.org/10.15620/cdc.119026>.
- Smith JJ, Eather N, Morgan PJ, Plotnikoff RC, Faigenbaum AD, Lubans DR. The health benefits of muscular fitness for children and adolescents: a systematic review and meta-analysis. *Sports Med* 2014; 44(9): 1209-23.
- Raiten DJ, Allen LH, Slavin JL, Mitloehner FM, Thoma GJ, Haggerty PA, Finley JW. Understanding the Intersection of Climate/ Environmental Change, Health, Agriculture, and Improved Nutrition: A Case Study on Micronutrient Nutrition and Animal Source Foods. *Curr Dev Nutr* 2020; 4(7): nzaa087.
- U.S. Department of Agriculture FoodData Central. 2019. Available at fdc.nal.usda.gov (Beef composite, cooked – NDB Number 13364).
- Joint FAO/WHO/UNU. 2007. Expert Consultation on Protein and Amino Acid Requirements in Human Nutrition (WHO Technical Report Series 935).
- Berryman CE, Lieberman HR, Fulgoni, VL 3rd, Pasiakos SM. Protein intake trends and conformity with the Dietary Reference Intakes in the United States: analysis of the National Health and Nutrition Examination Survey, 2001-2014. *Am J Clin Nutr* 2018; 108(2): 405-13.
- Garcia-Iborra M, Castanys-Munoz E, Oliveros E, Ramirez M. Optimal Protein Intake in Healthy Children and Adolescents: Evaluating Current Evidence. *Nutrients* 2023; 15(7).
- Institute of Medicine, 2005. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. The National Academies Press, Washington, DC. <https://doi.org/doi:10.17226/10490>.
- European Food Safety Authority (EFSA). Scientific Opinion on Dietary Reference Values for Protein. *EFSA Journal* 2012; 10(2): 2557.
- U.S. Food and Drug Administration. Daily Value on the New Nutrition and Supplement Facts Labels. <https://www.fda.gov/food/new-nutrition-facts-label/daily-value-new-nutrition-and-supplement-facts-labels>.
- Keast DR, Fulgoni VL, 3rd, Nicklas TA, O'Neil CE. Food sources of energy and nutrients among children in the United States: National Health and Nutrition Examination Survey 2003-2006. *Nutrients* 2013; 5(1): 283-301.
- Phillips SM, Fulgoni, VL 3rd, Heaney RP, Nicklas TA, Slavin JL, Weaver CM. Commonly consumed protein foods contribute to nutrient intake, diet quality, and nutrient adequacy. *Am J Clin Nutr* 2015; 101(6): 1346S-52S.
- American Academy of Pediatrics Committee on Nutrition, 2019. Pediatric Nutrition, 8th Ed. Kleinman RE & Greer FR (Ed.) American Academy of Pediatrics, Itasca, IL.
- Norris SA, Frongillo EA, Black MM, Dong Y, Fall C, Lampl M, Liese AD, Naguib M, Prentice A, Rochat T, Stephensen CB, Tinago CB, Ward KA, Wrottesley SV, Patton GC. Nutrition in adolescent growth and development. *Lancet* 2022; 399(10320): 172-84.
- Dietary Guidelines Advisory Committee. Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services. <https://www.dietaryguidelines.gov/2020advisory-committee-report>.
- Weyand AC, Chaitoff A, Freed GL, Sholzberg M, Choi SW, McGann PT. Prevalence of Iron Deficiency and Iron-Deficiency Anemia in US Females Aged 12-21 Years, 2003-2020. *JAMA* 2023; 329(24): 2191-93.
- Shoemaker ME, Gillen ZM, McKay BD, Koehler K, Cramer JT. High Prevalence of Poor Iron Status Among 8- to 16-Year-Old Youth Athletes: Interactions Among Biomarkers of Iron, Dietary Intakes, and Biological Maturity. *J Am Coll Nutr* 2020; 39(2): 155-62.
- Institute of Medicine, 2001. Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. The National Academies Press, Washington, DC. <https://doi.org/doi:10.17226/10026>.
- Piskin E, Cianciosi D, Gulec S, Tomas M, Capanoglu E. Iron Absorption: Factors, Limitations, and Improvement Methods. *ACS Omega* 2022; 7(24): 20441-56.
- Black MM. The evidence linking zinc deficiency with children's cognitive and motor functioning. *J Nutr* 2003; 133(5 Suppl 1): 1473S-6S.
- Nyaradi A, Li J, Hickling S, Foster J, Oddy WH. The role of nutrition in children's neurocognitive development, from pregnancy through childhood. *Front Hum Neurosci* 2013; 7: 97.
- Wallace TC, Blusztajn JK, Caudill MA, Klatt KC, Natker E, Zeisel SH, Zelman KM. Choline: The Underconsumed and Underappreciated Essential Nutrient. *Nutr Today* 2018; 53(6): 240-53.
- Petersen KS, Flock MR, Richter CK, Mukherjee R, Slavin JL, Kris-Etherton PM. Healthy Dietary Patterns for Preventing Cardiometabolic Disease: The Role of Plant-Based Foods and Animal Products. *Curr Dev Nutr* 2017; 1(12): cdn.117.001289.
- Wolfe RR, Baum JI, Starck C, Moughan PJ. Factors contributing to the selection of dietary protein food sources. *Clin Nutr* 2018; 37(1): 130-38.
- Hoy MK, Clemens JC, Moshfegh AJ. 2021. Protein Intake of Adolescents in the U.S.: What We Eat in America, NHANES 20152016. Food Surveys Research Group Dietary Data Brief no. 30.
- Neufingerl N, Eilander A. Nutrient Intake and Status in Children and Adolescents Consuming Plant-Based Diets Compared to Meat-Eaters: A Systematic Review. *Nutrients* 2023; 15(20): 4341.

