Federal Data Analysis Report for the 2025 Dietary Guidelines Advisory Committee: Nutritional Biomarker Outcomes

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Introduction

The 2025 Dietary Guidelines Advisory Committee (Committee) used data analysis to describe the current health status and dietary intakes of individuals in the United States. The federal data analysis team and interagency partners supported the work of the Committee by analyzing data on specific topics and questions. The federal team and partners included expert scientists with advanced degrees in nutrition, statistics, and epidemiology from the following Departments and agencies:

United States Department of Health and Human Services (HHS)

- Office of Disease Prevention and Health Promotion, Office of the Assistant Secretary for Health
- National Cancer Institute, National Institutes of Health
- National Center for Health Statistics, Centers for Disease Control and Prevention

United States Department of Agriculture (USDA)

- Center for Nutrition Policy and Promotion, Food and Nutrition Service, Food, Nutrition, and Consumer Services
- Food Surveys Research Group, Beltsville Human Nutrition Research Center, Agricultural Research Service, Research, Education, and Economics

The Federal Data Analysis Reports provide federal staff-led summaries for the full collection of data analysis results that were cited in the Federal Data Analysis Plan or published in the Federal Data Analysis Supplements.[1-41] This report includes results for nutritional biomarker outcomes, which contributed to the body of evidence for 1 of the 4 data analysis scientific questions:

- Which nutrients and/or dietary components present a substantial public health concern because of underconsumption or overconsumption?

The 2025 Committee's Scientific Report synthesizes the data analysis results and presents conclusion statements that describe the state of the science based on the evidence considered for each data analysis question.[42] Neither the Federal Data Analysis Reports nor the Committee's Scientific Report should be interpreted as dietary guidance.

A brief overview of the data analysis methodology for the scientific question addressed in this report, along with summaries of the evidence, are described in the following sections.

Methodology

A collection of federal data sources, including the What We Eat in America (WWEIA), National Health and Nutrition Examination Survey (NHANES), informed the Committee's data analysis work. The Federal Data Analysis Plan describes the data analysis process, strategy, sources, and analyses used to support the Committee in answering the prioritized scientific questions.[1] The Federal Data Analysis Plan also provides a summary of and cites the methodology for each data source, including data collection, preparation, and analysis.

The Federal Data Analysis Reports provided a comprehensive summary of results for the topics examined in the data analysis questions.[43-47] Data for dietary intakes and chronic health conditions were analyzed for a variety of sociodemographic groups. Prioritized sociodemographic variables included age/life stage, sex, race

and/or ethnicity, poverty to income ratio, household food security category, current household participation in the Supplemental Nutrition Assistance Program (SNAP), and current child participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). When available, additional sociodemographic variables were examined in published analyses: detailed race and/or ethnicity, education, family income, birth in or outside of the United States, health insurance status, disability status, geographic/metropolitan location, body mass index (BMI) status, and diabetes status.

Data points that may be unreliable— such as those with a small sample size, wide confidence interval (CI) and/or relative CI, large standard error, or large coefficient of variation— were excluded from the reports; however, these data points can be viewed in the original publications for most analyses. Analyses that included statistical testing were prioritized when possible—but were often not available—to identify differences between sociodemographic groups, including for the analyses in this report. When statistical testing was completed, significant differences were reported.

Questions and Key Definitions

This report describes data analysis results for nutritional biomarker outcomes, which contributes to the evidence for 1 data analysis question. The methodology and key definitions for that question are presented below.

1. Which Nutrients and/or Dietary Components Present a Substantial Health Concern Because of Underconsumption or Overconsumption?

This question applied a 3-pronged framework to systematically identify nutrients and dietary components that are underconsumed or overconsumed and may present a public health concern for the population ages 6 months and older. Described in detail elsewhere, the 3-pronged framework was developed by a previous Committee and supported by the National Academies of Sciences, Engineering, and Medicine (NASEM).[48,49] To answer this question, the Committee reviewed evidence from several data sources relevant to 1 or more prongs:

1. Dietary intake data (usual nutrient intakes and total usual nutrient intakes), using self-reported 24-hour recall from What We Eat in America (WWEIA), NHANES;
2. Biological and clinical indicators (e.g., biomarkers), using laboratory and health examination data from NHANES; and
3. Clinical health consequences measured directly or indirectly through validated measures (e.g., health condition prevalence), using various data sources and collection methods including NHANES, National Health Information Survey (NHIS), Surveillance, Epidemiology, and End Results (SEER), and National Vital Statistics System (NVSS).

Dietary intake data provided comparisons of nutrient intakes relative to recommended amounts, based on the *Dietary Guidelines for Americans, 2020-2025* and National Academies of Sciences, Engineering, and Medicine's (NASEM) Dietary Reference Intakes (DRIs), including Estimated Average Requirements (EAR), Adequate Intakes (AI), Chronic Disease Risk Reduction Intakes (CDRR), Tolerable Upper Intake Levels (UL), Acceptable Macronutrient Distribution Ranges (AMDR), and Estimated Energy Requirements (EER).[50-57] Biological and clinical indicators provided laboratory data (e.g., vitamin D) in comparison to levels for deficiency, excess, or health risk. Data for nutrient intakes and clinical health outcomes are available in separate Data Analysis Reports.[44,45]

In this report, nutritional biomarker data for individuals ages 1 year and older are obtained from NHANES, using the 2017-2018 data cycle or 2017-March 2020 data release. Data are collected via laboratory tests in mobile exam centers. The specific analyses, including the ages and life stages examined, are described and defined in **Table 1**.

Table 1. Nutritional Biomarkers and Cutoffs Examined for the U.S. Population Using the National Health and Nutrition Examination Survey (NHANES)

Biomarker	Nutrient	Ages Examined	Cutoff(s)	Data Years Used
Inflammation-adjusted ferritin at risk of iron overload[a]	Iron	Children ages 1-5 years Females ages 12-49 years (childbearing age)	>150 µg/L	NHANES 2017-March 2020
Inflammation-adjusted ferritin for iron deficiency[a]	Iron	Children ages 1-5 years Females ages 12-49 years (childbearing age)	<12 µg/L for ages 1-5 years <15 µg/L for females ages 12-49 years	NHANES 2017-March 2020
High serum soluble transferrin receptor concentration (indicator of iron deficiency)	Iron	Ages 1-5 years Females ages 12-49 years (childbearing age)	>4.4 mg/L[58]	NHANES 2017-March 2020
Low folate red blood cell concentration (indicator of body folate stores and long-term nutritional status)	Folate	Ages 1+ years Pregnant or lactating females ages 20-44 years	<95 ng/mL[58]	NHANES 2017-March 2020
Low serum folate concentration (indicator of recent intake)	Folate	Ages 1+ years Pregnant or lactating females ages 20-44 years	<2 ng/mL[58]	NHANES 2017-March 2020
Serum vitamin D concentration at risk of deficiency[b]	Vitamin D	Ages 1+ years Pregnant or lactating females ages 20-44 years	Serum 25-hydroxyvitamin D <30 nmol/L[58]	NHANES 2017-2018[c]
Serum vitamin A deficiency	Vitamin A	Ages 6-19 years Females ages 20-59 years	Serum vitamin A <20 µg/dL[58]	NHANES 2017-2018[c]
Serum vitamin C deficiency	Vitamin C	Ages 6+ years	Serum vitamin C <11.4 µmol/L[58]	NHANES 2017-2018[c]
Serum vitamin E deficiency	Vitamin E	Ages 6+ years	Serum vitamin E <500 µg/dL[58]	NHANES 2017-2018[c]

[a] Estimates are based on serum ferritin concentrations that are adjusted for high sensitivity c-reactive protein (hs-CRP) levels using the SAS macro developed by Geng et al.[59-61]

[b] Estimates are season-adjusted, which means they are adjusted for the 6-month time period when the examination was performed: November 1 through April 30 or May 1 through October 31.

[c] Laboratory tests for this biomarker were not conducted for the 2019-2020 cycle.

In addition to reviewing the available data, the Committee also considered systematic review and food pattern modeling evidence for the nutrients and dietary components examined by this and previous Committees as well as the nutrients and food components identified as a public health concern in the 2020 Committee's report. For infants and young children ages 6 through 23 months, nationally representative data are limited; thus, the 3-pronged framework for nutrients and dietary components of public health concern was supplemented with expert opinion from the Committee and guidance from the NASEM report on the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).[62]

Summary of the Evidence: Nutritional Biomarker Outcomes

Iron

Inflammation-Adjusted Ferritin Concentration for Iron Deficiency

Age and sex[2]

- Among children ages 1-5 years, the prevalence of inflammation-adjusted serum ferritin deficiency (<12 µg/L) is 7.0 percent.
- Among females, the prevalence of inflammation-adjusted serum ferritin deficiency (<15 µg/L) is 24.0 percent for ages 12-19 years and 22.6 percent for ages 20-49 years.

Life stage[2]

- Among pregnant or lactating females ages 20-44 years, the prevalence estimate for inflammation-adjusted serum ferritin deficiency does not meet the NCHS Data Presentation Standards for Proportions due to CI width >5 and relative CI width >130 percent.

Inflammation-Adjusted Ferritin Concentration at Risk of Iron Overload

Sex and age[2]

- Among females, the prevalence of inflammation-adjusted serum ferritin (>150 µg/L) at risk of iron overload in individuals ages 12-19 years is 0.1 percent and in individuals 20-49 years is 2.3 percent.

Life stage[2]

- Among pregnant or lactating females ages 20-44 years, the estimate for high inflammation-adjusted serum ferritin does not meet the NCHS Data Presentation Standards for Proportions due to CI width >5 and relative CI width >130 percent.

High Serum Soluble Transferrin Receptor Concentration

Age and sex[2]

- Among children ages 1-5 years, the prevalence of high serum soluble transferrin receptor concentration (>4.4 mg/L) is 17.1 percent.
- The prevalence of high serum soluble transferrin receptor concentration is 12.5 percent among females ages 12-19 years and 12.4 percent among females ages 20-49 years.

Life stage[2]

- Among pregnant or lactating females ages 20-44 years, the prevalence of high serum soluble transferrin receptor concentration is 13.1 percent.

Folate

Low Folate (Red Blood Cell) Concentration

Age[2]

- The prevalence of low folate (RBC) concentration (<95 ng/mL) is 0 percent for ages 1-5 years, 6-11 years, 12-19 years, and 40-59 years. The prevalence is <0.1 percent among ages 20-39 years and ages 60 years and older.

Sex[2]

- Among ages 1 year and older, the prevalence of low folate (RBC) concentration is <0.1 percent among males and females.

Life stage[2]

- The prevalence of low folate (RBC) concentration is 0 percent among pregnant or lactating females ages 20-44 years.

Low Serum Folate Concentration

Age[2]

- The prevalence of low serum folate concentration (<2 ng/mL) is 0 percent for ages 1-5 years, 6-11 years, 12-19 years, and 20-39 years; 0.2 percent for ages 40-59 years; and <0.1 percent for ages 60 years and older.

Sex[2]

- For individuals ages 1 year and older, the prevalence of low serum folate concentration is 0.1 percent among males and <0.1 percent among females.

Life stage[2]

- For pregnant or lactating females ages 20-44 years, the prevalence of low serum folate concentration is 0 percent.

Vitamin D

Age[2]

- The prevalence of vitamin D concentrations at risk of deficiency (serum 25-hydroxyvitamin D <30 nmol/L) ranges from 1.2 percent to 7.3 percent. The prevalence is 1.3 percent for ages 1-5 years, 1.2 percent for ages 6-11 years, 6.8 percent for ages 12-19 years, 7.3 percent for ages 20-39 years, 5.1 percent for ages 40-59 years, and 2.4 percent for ages 60 years and older.

Sex and age[2]

- The prevalence of vitamin D concentrations at risk of deficiency ranges from 0.6 percent for males ages 6-11 years to 8.0 percent for females ages 12-19 years. There is variation between males and females, respectively, at ages 1-5 years (2.0 percent vs. 0.7 percent), ages 6-11 years (0.6 percent vs. 1.8 percent), ages 12-19 years (5.6 percent vs. 8.0 percent), ages 20-39 years (6.9 percent vs. 7.6 percent), ages 40-59 years (4.8 percent vs. 5.3 percent), and ages 60 years and older (1.9 percent vs. 2.9 percent).

Life stage[2]

- Among pregnant or lactating females ages 20-44 years, the estimate for vitamin D concentration at risk of deficiency does not meet the NCHS Data Presentation Standards for Proportions due to CI width >5 and relative CI width >130 percent.

Vitamin A

Age[2]

- The prevalence of serum vitamin A deficiency (<20 µg/dL) is 0.9 percent in children ages 6-11 years and 0.3 percent in adolescents ages 12-19 years.
- In females ages 20-59 years, the prevalence of serum vitamin A deficiency is 0.2 percent.

Vitamin C

Age[2]

- The prevalence of serum vitamin C deficiency (<11.4 µmol/L) is 0.5 percent in children ages 6-11 years, 6.2 percent in adults ages 20-39 years, 7.0 percent in adults ages 40-59 years, and 7.2 percent in older adults ages 60 years and older.
- The estimate for ages 12-19 years does not meet the NCHS Data Presentation Standards for Proportions due to CI width >5 and relative CI width >130 percent.

Sex and age[2]

- The prevalence of serum vitamin C deficiency varies from 0.5 percent among females ages 6-11 years to 8.4 percent among males ages 60 years and older. Prevalence varies between males and females, respectively, at ages 20-39 years (7.2 percent vs. 5.2 percent), ages 40-59 years (7.5 percent vs. 6.5 percent), and ages 60 years and older (8.4 percent vs. 6.1 percent).

Vitamin E

Age[2]

- The prevalence of serum vitamin E deficiency (<500 µg/dL) is 0.2 percent for ages 6-11 years, 0.7 percent for ages 12-19 years, 0 percent for ages 20-39 years, 0.1 percent for ages 40-59 years, and 0.1 percent for ages 60 years and older.

Sex and age[2]

- The prevalence of serum vitamin E deficiency (<500 µg/dL) in males compared to females is:
  - Ages 6-11 years: 0 percent vs. 0.4 percent
  - Ages 12-19 years: 1.1 percent vs. 0.3 percent
  - Ages 40-59 years: <0.1 percent vs. 0.2 percent
  - Ages 60 years and older: 0.1 percent vs. 0.1 percent

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Appendix: Abbreviations

Table 2. List of Abbreviations

Abbreviation	Full name
AI	Adequate Intake
AMDR	Acceptable Macronutrient Distribution Range
ARS	Agricultural Research Service
CDC	Centers for Disease Control and Prevention
CDRR	Chronic Disease Risk Reduction Intake
CNPP	Center for Nutrition Policy and Promotion
DRI	Dietary Reference Intakes
EAR	Estimated Average Requirement
EER	Estimated Energy Requirement
FNDDS	Food and Nutrient Database for Dietary Studies
FNS	Food and Nutrition Service
HHS	United States Department of Health and Human Services
IHS	Indian Health Service
NASEM	National Academies of Sciences, Engineering, and Medicine
NCI	National Cancer Institute
NCHS	National Center for Health Statistics
NEAB	Nutrition and Economic Analysis Branch
NGAD	Nutrition Guidance and Analysis Division
NHANES	National Health and Nutrition Examination Survey
NHIS	National Health Interview Survey
NIH	National Institutes of Health
NVSS	National Vital Statistics System
OASH	Office of the Assistant Secretary for Health
ODPHP	Office of Disease Prevention and Health Promotion
RBC	red blood cell

Abbreviation	Full name
RDA	Recommended Dietary Allowance
SEER	Surveillance, Epidemiology, and End Results
UL	Tolerable Upper Intake Level
USDA	United States Department of Agriculture
WIC	Special Supplemental Nutrition Program for Women, Infants, and Children
WWEIA	What We Eat in America