What We Eat in America Dietary Data, NHANES: August 2021-August 2023 24-Hour Dietary Recall Interview Mode Change

Anne M. Williams, Ana Terry, Lara J. Akinbami, Nicholas Ansai, Cynthia L. Ogden

Division of Health and Nutrition Examination Surveys
National Center for Health Statistics
Hyattsville, Maryland

Centers for Disease Control and Prevention
U.S. Department of Health and Human Services

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Contents

Executive Summary

In the National Health and Nutrition Examination Survey (NHANES) August 2021-August 2023 cycle, the administration mode of the Day 1 24-hour dietary recall interview (hereafter "Day 1 interview") was changed. To reduce in-person contact between interviewers and participants during the COVID-19 pandemic, this interview was done over the phone whereas in past cycles, it was done in person during the mobile exam center (MEC) visit. As a result, the Day 1 interview became an additional stage of the survey conducted by phone following the MEC visit. Response rates for this new stage that account for nonresponse to the household screening interview, home interview, MEC exam, and Day 1 interview are now provided on the NHANES webpage. The Day 2 interview has always been conducted by phone. To assess the potential impact of the Day 1 mode change, response rates, number of days between Day 1 and Day 2 interviews, sample sizes, number of foods reported, and mean nutrient intake were compared between August 2021-August 2023 and past cycles. Results from these assessments and analytic guidance include:

- Response rates for Day 1 and Day 2 interviews were lower during August 2021-August 2023 than for past cycles.
- Sample sizes for the dietary interviews during August 2021-August 2023 were smaller than in past cycles. Consequently, estimates may have lower precision and there may be less statistical power to discern differences between groups.
- The mean number of days between Day 1 and Day 2 interviews was slightly higher during August 2021-August 2023 than for past cycles.
- The mean number of foods reported during the Day 1 interview during August 2021-August 2023 was slightly lower than for past cycles.
- Differences were seen for some mean nutrient intake and nutrient distributions between August 2021-August 2023 and past cycles. These may be due to changes in dietary intake in the population, the mode change, lower response rates, or any combination thereof. Analysts should consider and acknowledge the possibility that the mode change may impact findings.
- As for all cycles, dietary interview weights account for nonresponse to the 24-hour dietary interviews and should be used for most analyses of dietary interview data. Analysts are encouraged to review the NHANES tutorial to help them evaluate which survey weights are most appropriate.

For details about the sample design, weighting methods, and analytic guidelines, please refer to the brief overview that accompanied the initial release of the August 2021-August 2023 public use data.

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I. Background

The National Health and Nutrition Examination Survey (NHANES) uses questionnaires and objective health measures to collect nationally representative data on health and dietary intake using a multi-stage design. Survey operations were adapted to minimize in person contact between participants and staff during the COVID-19 pandemic for August 2021-August 2023 data collection. In past cycles, the first 24-hour dietary recall interview (hereafter Day 1 interview) was collected in-person during the MEC exam, while the second 24-hour recall interview (hereafter Day 2 interview) was collected over the phone. Only participants who completed the Day 1 interview were eligible for the Day 2 interview. For the August 2021-August 2023 cycle, NHANES changed the mode of administration for the Day 1 interview to be over the phone. This phone interview was scheduled during the MEC exam.

II. Objectives

Based on the condensed timeline to get NHANES back in the field as quickly as possible after the pause in data collection in March 2020, there was not time to formally pilot or test the impact of the mode change of the Day 1 interview. Therefore, NHANES undertook a series of post-data collection investigations to assess the potential impact of the mode change. We analyzed survey operations outcomes (response rates, number of days between Day 1 and Day 2 interviews and sample sizes) and nutritional intake estimates (number of foods, macronutrient and micronutrient intake) and compared these to past 2-year cycles (2011-2012, 2013-2014, 2015-2016 and 2017-2018).

III. Analyses (Methods and Results)

A. Methods

A.1. Operational outcomes

We performed unweighted analyses for operational outcomes. Statistical testing was not performed, and descriptive comparisons are presented. Operations-related analyses included data for NHANES participants who completed Day 1 or both Day 1 and Day 2 interviews and had responses that were deemed reliable.

Analyses of operational outcomes included:
- Response rates
- Number of days between dietary interviews
- Sample sizes

Dietary interview response rates for August 2021-August 2023 are available online for the first time (NHANES August 2021 - August 2023 Response Rates) and for past cycles, restricted access response rate data were used. Data for the number of days between the two dietary interviews also are not publicly available and thus these analyses used restricted access data. All sample sizes are available online in the documentation for each survey cycle.

A.2. Nutritional estimates

Analysts frequently use one day of dietary interview data for assessment of nutritional intake on a given day in a population. Therefore, we assessed mean nutrient intake and nutrient distributions on a given day over time using Day 1 interview data. We also compared differences in mean nutrient intake between Day 1 and Day 2 across time. Weighted estimates were calculated using Day 1 dietary weights when only Day 1 data were included, while estimates that included Day 2 data (e.g. differences between Day 1 and Day 2) were calculated using Day 2 dietary weights.
Analyses of nutritional estimates included participants ages 1 year and older who had complete, reliable dietary interview data for Day 1, did not fast, and did not consume breastmilk. For analyses of differences between Day 1 and Day 2 participants had complete, reliable data for both days, and did not fast or consume breastmilk either day.

Analyses of nutritional estimates included:
- Mean number of foods reported per day
- Percentage of energy from each macronutrient (protein, fats, carbohydrates)
- Absolute intake of selected micronutrients (iron, calcium, vitamin A) in grams or micrograms per 1,000 kilocalories

Estimating macro- and micronutrient densities adjusts for expected differences in intake by sex and age. Nutrient density distributions were visualized using the SGPLOT procedure in SAS with the density option to produce smoothed weighted histograms, and the data were summarized using the SURVEYMEANS procedure in SAS which accounts for primary sampling unit, strata, and dietary weight.

No statistical testing was performed to compare distributions between survey cycles. We assessed linear trends in mean estimates over time using SUDAAN and report the pairwise contrast between the most recent 2-year survey cycle (2017-2018) and the cycle where the mode change occurred (August 2021- August 2023).

Next, we calculated differences in intake between the Day 1 and Day 2 interviews at the participant level for each cycle, and then the SURVEYMEANS procedure in SAS was used to calculate mean weighted estimates. Differences between survey cycles are qualitatively described and no statistical testing was performed.

Because of differences in the number of foods consumed within the age group of youth 1-19 years, the number of total foods reported were presented only for adults (20 and older) and results are stratified by sex. For other outcomes, results are stratified by both sex and age (1-19 years, 20 and older).
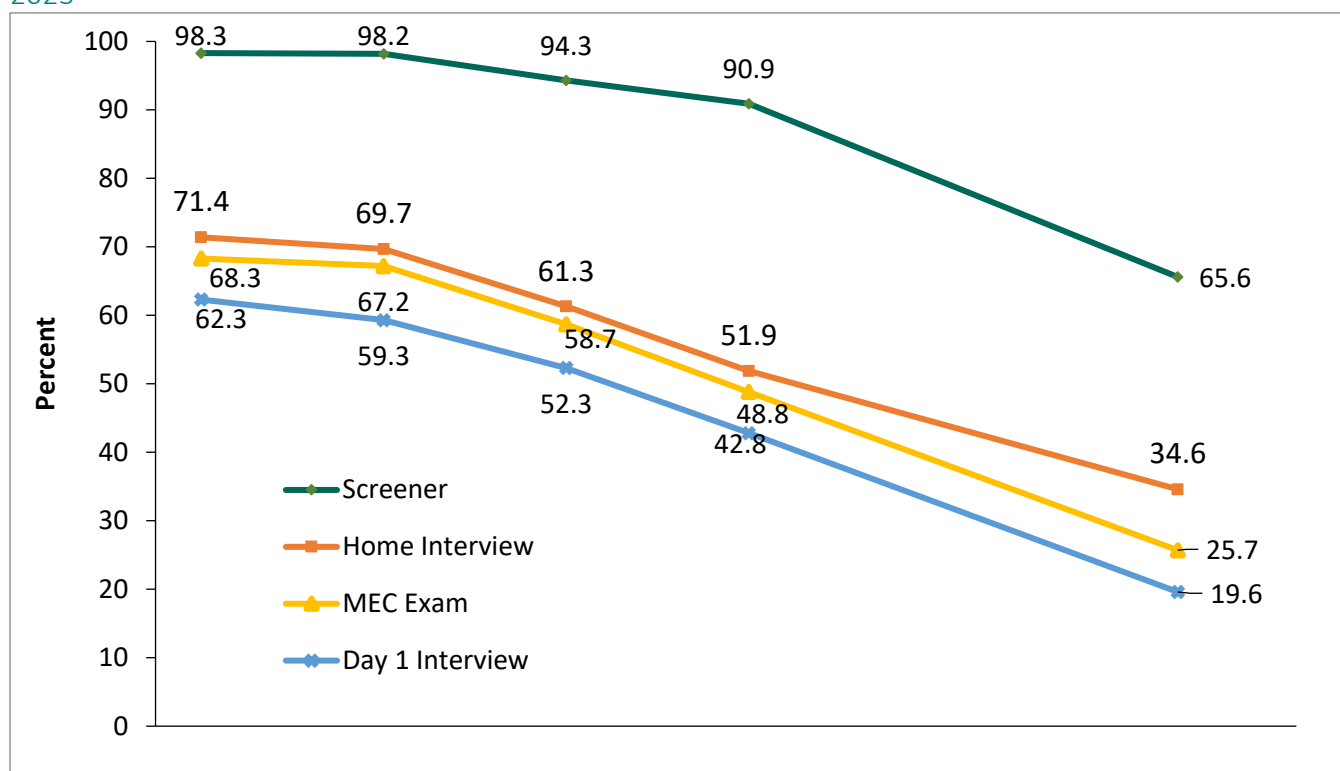
B. Results

B.1. Operational outcomes

B.1.1. Response rates

Response rates in August 2021-August 2023 were lower than in past cycles for NHANES at all stages, including for the MEC exam (**Figure 1**). The August 2021-August 2023 Day 1 interview unconditional response rate was 19.6%. In past cycles the unconditional response rate for the Day 1 interview ranged from 62.3% (2011-2012) to 42.8% (2017-2018). Part of the difference in Day 1 response rates between August 2021-August 2023 and past cycles is due to the mode change because participants needed to complete a phone interview after the MEC exam which added a stage for nonresponse. The response rate for the Day 1 interview conditioned on having a health examination in the MEC was 76.2% during August 2021-August 2023 whereas in past cycles, 87.8%-91.2% of MEC exam participants completed the Day 1 interview at the MEC.

Figure 1 – Unconditional survey response rates for survey stages, 2011-2012 to August 2021-August 2023

Source: National Health and Nutrition Examination Survey

Due to the additional nonresponse resulting from the added survey stage for the Day 1 interview and the lower response rate for the MEC exam compared to past cycles, the sample sizes for the August 2021-August 2023 Day 1 and Day 2 interviews were also lower (**Table 1**).

B.1.2. Sample sizes

Table 1 – Dietary interview sample size, ages 1 year and older, by day of interview, 2011-2012 to August 2021-August 2023

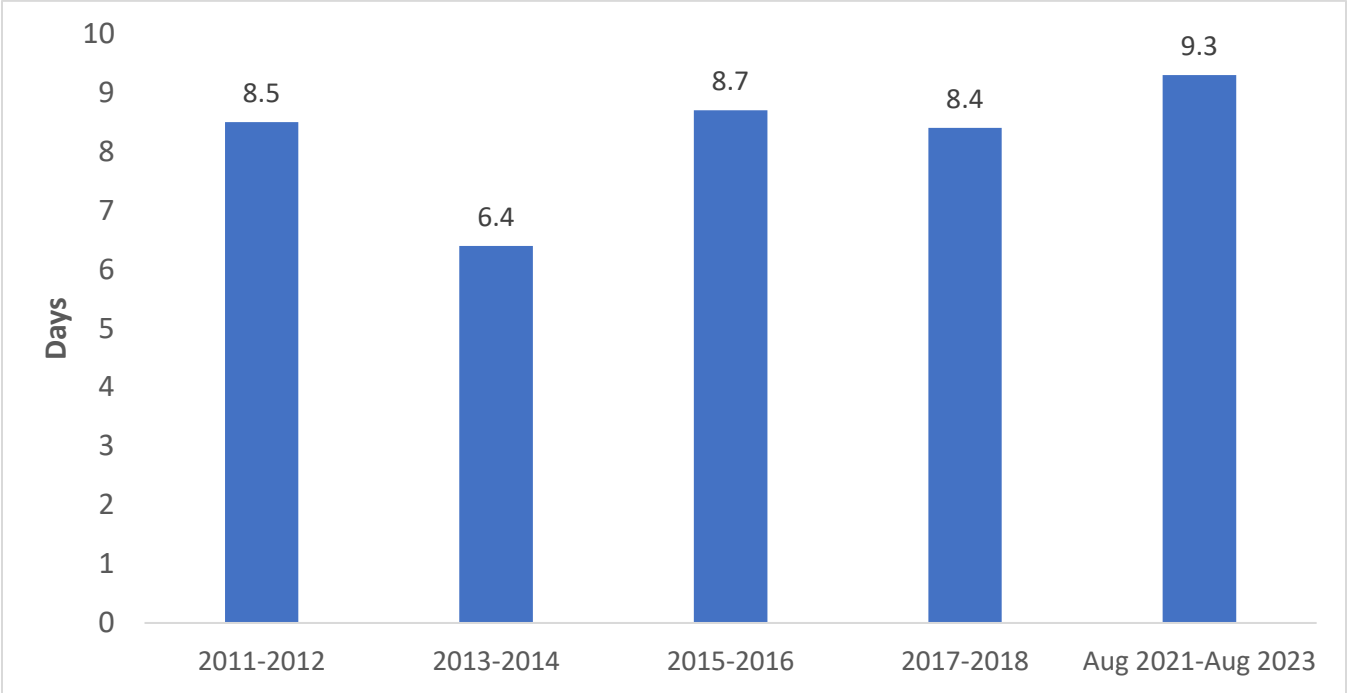|	2011-2012	2013-2014	2015-2016	2017-2018	Aug 2021-Aug 2023
Day 1	8,388	8,531	8,326	7,483	6,687
Days 1 and 2	7,479	7,442	6,858	6,488	5,822

NOTES: Includes participants with complete, reliable data that were not receiving breastmilk and who were not fasting. Unweighted.
SOURCE: National Health and Nutrition Examination Survey

B.1.3. Days between Day 1 and Day 2 interviews

The mean number of days between Day 1 and Day 2 interviews was higher during August 2021-August 2023 (9.3 days) than for past cycles (Figure 2). For previous cycles, the mean number of days between Day 1 and Day 2 ranged from 6.4 in 2013-2014 to 8.7 in 2015-2016.

Figure 2 – Mean number of days between Day 1 and Day 2 dietary interview by survey cycle

NOTES: Includes NHANES 2-year survey cycles 2011-2012 through August 2021-August 2023.
SOURCE: National Health and Nutrition Examination Survey

B.2. Nutritional estimates

B.2.1. Trends over time on a given day

Overall, the weighted mean total number of foods reported on a given day for adults ranged from 15.1 (August 2021-August 2023) to 16.5 (2013-2014, **Table 2**). The mean total number of foods reported declined over time (linear trend p<0.0001) and the differences between 2017-2018 and August 2021-August 2023 was significant overall, and among both males and females (p<0.001 for all groups).

Table 2 – Mean number of foods (standard error) reported on a given day, ages 20 and older, by sex, U.S. 2011-2012 to August 2021-August 2023

	2011-2012	2013-2014	2015-2016	2017-2018	Aug 2021-Aug 2023	Linear trend p-value [3]	T-test p-value [4]
Overall	16.1 (0.2)	16.5 (0.2)	15.7 (0.2)	16.0 (0.2)	15.1 (0.2)	<0.0001	<0.001
Males	16.0 (0.2)	16.3 (0.3)	15.5 (0.3)	15.9 (0.3)	14.9 (0.3)	0.0001	<0.001
Females	16.1 (0.2)	16.7 (0.2)	15.9 (0.3)	16.1 (0.2)	15.2 (0.2)	<0.001	<0.001

NOTES: Weighted estimates. Based on Day 1 interview. Linear trend p-value reflects 2011–2012 to Aug 2021–Aug 2023.
T-test p-value reflects 2017-2018 vs. Aug 2021-Aug 2023.
Source: National Health and Nutrition Examination Survey

B.2.2. Macronutrients

Table 3 shows weighted estimates for the percent of energy intake from macronutrients on a given day by survey cycle. Among both age groups and both sexes, the mean percent of energy from carbohydrates decreased between 2011-2012 and August 2021-August 2023. The pairwise comparison

between 2017-2018 and August 2021-2023 was significant for adults of both sexes but not for youth 1-19 years. The mean percent of energy from fats increased significantly over this period for all groups, and differences between 2017-2018 and August 2021-August 2023 were significant for adults of both sexes, but not youth. Finally, the mean percent of energy from protein did not follow a distinct pattern across time; there were significant decreases among female youth and adult males over time, but there were no significant changes between 2017-2018 and August 2021-August 2023 for any group.

Table 3 – Mean percent of energy intake (standard error) for macronutrients reported on a given day, by sex and age, US, 2011-2012 to August 2021-August 2023

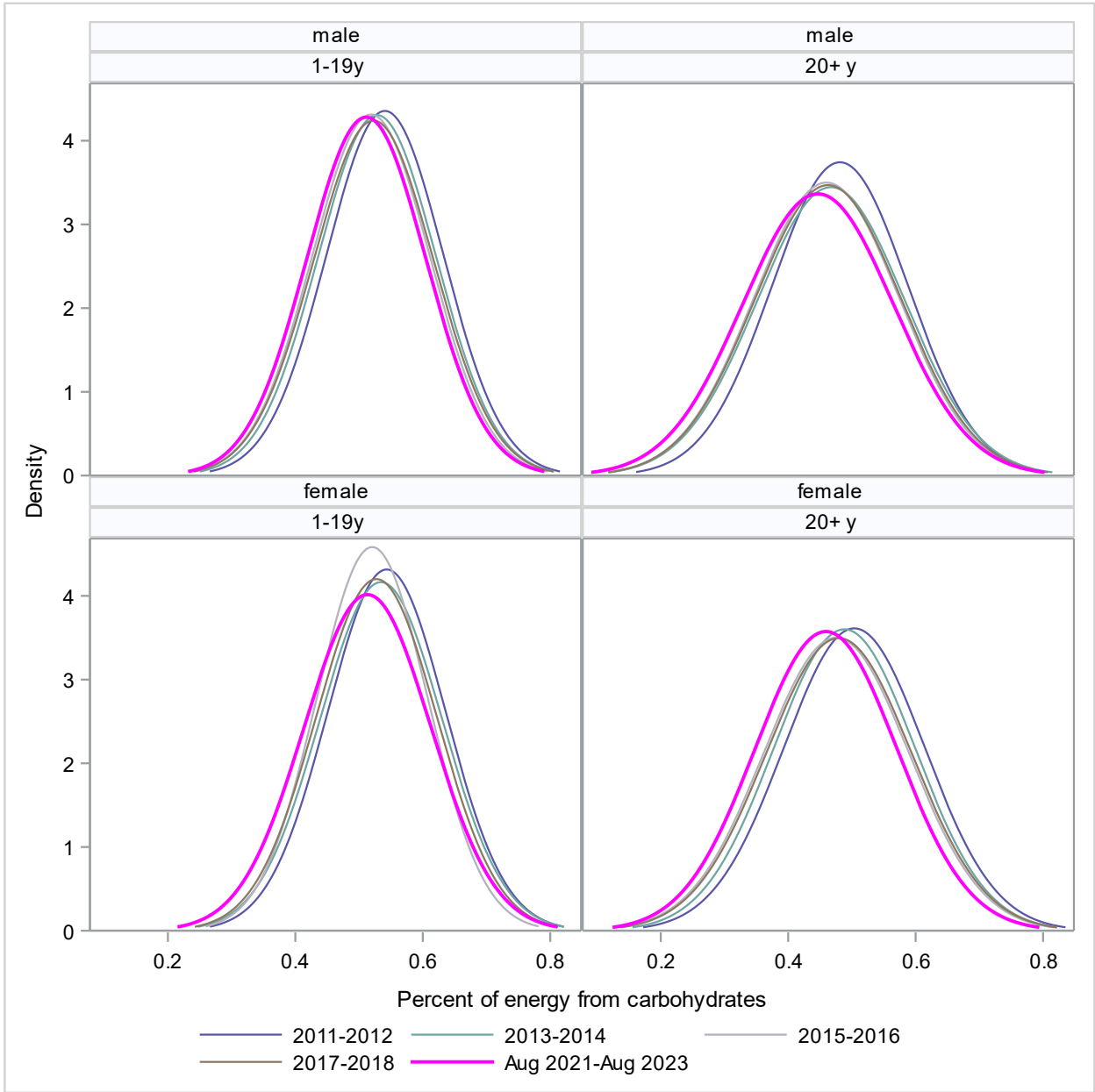|	2011-2012	2013-2014	2015-2016	2017-2018	Aug 2021-Aug 2023	Linear trend p-value	T-test p-value
Males 1-19							
Carbohydrates	54.0 (0.3)	52.8 (0.4)	51.9 (0.5)	51.5 (0.3)	51.1 (0.3)	<0.0001	0.30
Fats	32.4 (0.3)	33.1 (0.3)	34.4 (0.3)	35.0 (0.3)	35.1 (0.3)	<0.0001	0.44
Protein	14.6 (0.2)	15.1 (0.2)	14.8 (0.2)	14.6 (0.2)	14.2 (0.1)	0.08	0.11
Females, 1-19							
Carbohydrates	54.3 (0.4)	53.4 (0.4)	52.1 (0.5)	52.5 (0.5)	51.3 (0.2)	0.0006	0.15
Fats	32.7 (0.3)	33.1 (0.3)	34.8 (0.4)	34.9 (0.3)	35.6 (0.2)	<0.0001	0.27
Protein	14.1 (0.2)	14.6 (0.2)	14.4 (0.2)	13.9 (0.2)	13.6 (0.1)	0.001	0.45
Males, 20 +							
Carbohydrates	48.1 (0.3)	46.7 (0.4)	46.0 (0.3)	45.9 (0.3)	44.7 (0.3)	<0.0001	0.03
Fats	33.3 (0.3)	34.0 (0.2)	35.2 (0.3)	36.0 (0.3)	37.0 (0.2)	<0.0001	0.05
Protein	15.9 (0.1)	16.4 (0.3)	16.2 (0.3)	15.7 (0.2)	15.7 (0.1)	0.01	0.78
Females, 20 +							
Carbohydrates	50.4 (0.4)	48.8 (0.4)	47.5 (0.5)	47.3 (0.5)	45.9 (0.2)	<0.0001	0.02
Fats	33.0 (0.3)	34.4 (0.3)	35.8 (0.4)	36.4 (0.3)	37.8 (0.2)	<0.0001	0.002
Protein	15.3 (0.2)	15.8 (0.2)	15.9 (0.2)	15.5 (0.2)	15.3 (0.1)	0.53	0.51

NOTES: Weighted estimates. Based on Day 1 interview. Linear trend p-value reflects 2011–2012 to Aug 2021–Aug 2023.
T-test p-value reflects 2017-2018 vs. Aug 2021-Aug 2023.
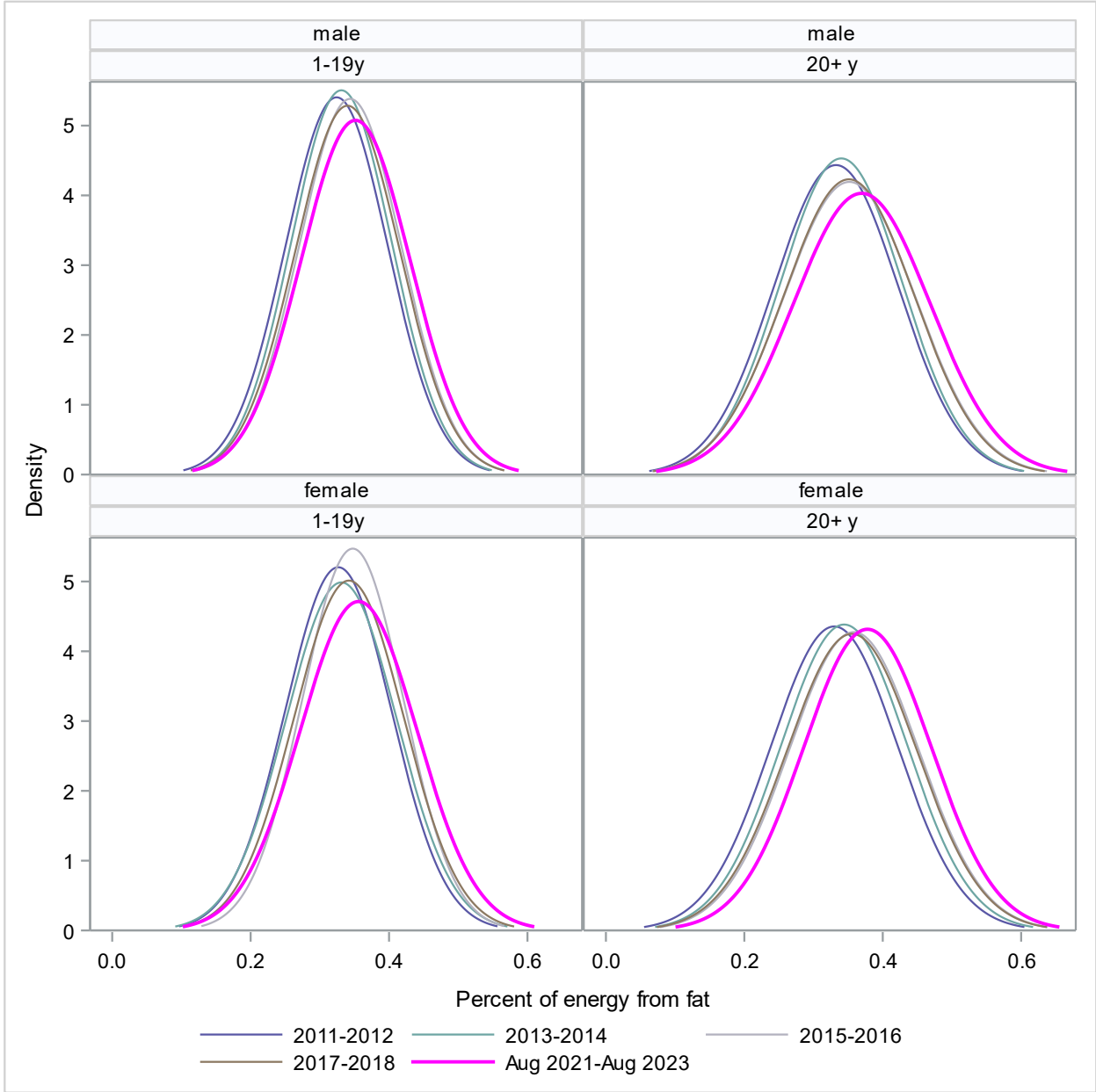Source: National Health and Nutrition Examination Survey

The weighted density plots for energy from carbohydrates on a given day across survey cycles generally show a left shift (towards a lower amount) over time (**Figure 3)**. In contrast, distributions for energy from fats shifted to the right over time (towards a higher amount) **(Figure 4)**. There were negligible differences in the distribution of energy from protein across survey cycles although the distribution during August 2021-August 2023 appeared to be narrower than for past cycles for each subgroup (**Figure 5)**. The patterns over time in the density plots are consistent with the results for mean intake of macronutrients shown in **Tables 3**.

Figure 3 – Percent of energy intake from carbohydrates on a given day by sex and age, US 2011-2012 to August 2021-August 2023
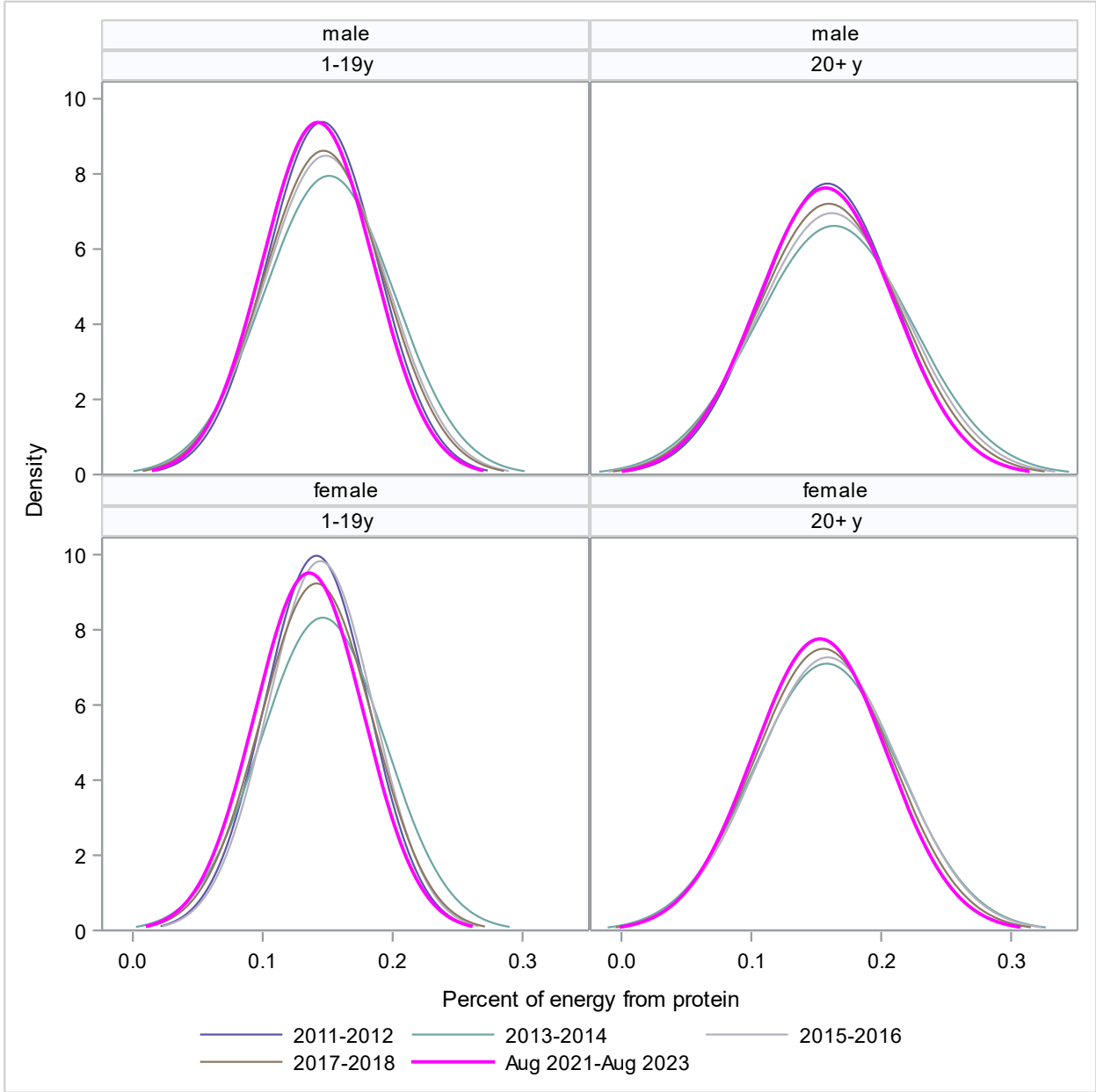

Notes: Weighted density plot. Based on Day 1 interview.
Source: National Health and Nutrition Examination Survey

Figure 4 – Percent of energy intake from fats on a given day by sex and age, US 2011-2012 to August 2021-August 2023

Notes: Weighted density plot. Based on Day 1 interview.
Source: National Health and Nutrition Examination Survey

Figure 5 – Percent of energy intake from protein[1] on a given day[2] by sex and age, US 2011-2012 to August 2021-August 2023

Notes: Weighted density plot. Based on Day 1 interview.
Source: National Health and Nutrition Examination Survey

B.2.3. Micronutrients

Table 4 shows intake per 1000 kcal on a given day for selected micronutrients. Mean iron intake significantly declined over time and between 2017-2018 and August 2021-August 2023 for all groups. Mean vitamin A intake significantly declined over time and between 2017-2018 and August 2021-August 2023 for male and female youth but not for adults. Mean calcium intake declined over time for male and female youth but not for adults. Differences between 2017-2018 and August 2021-August 2023 were significant for female youth.

Table 4 – Mean intake of select micronutrients (standard error) per 1,000 calories on a given day, by sex and age, US 2011-2012 to August 2021-August 2023

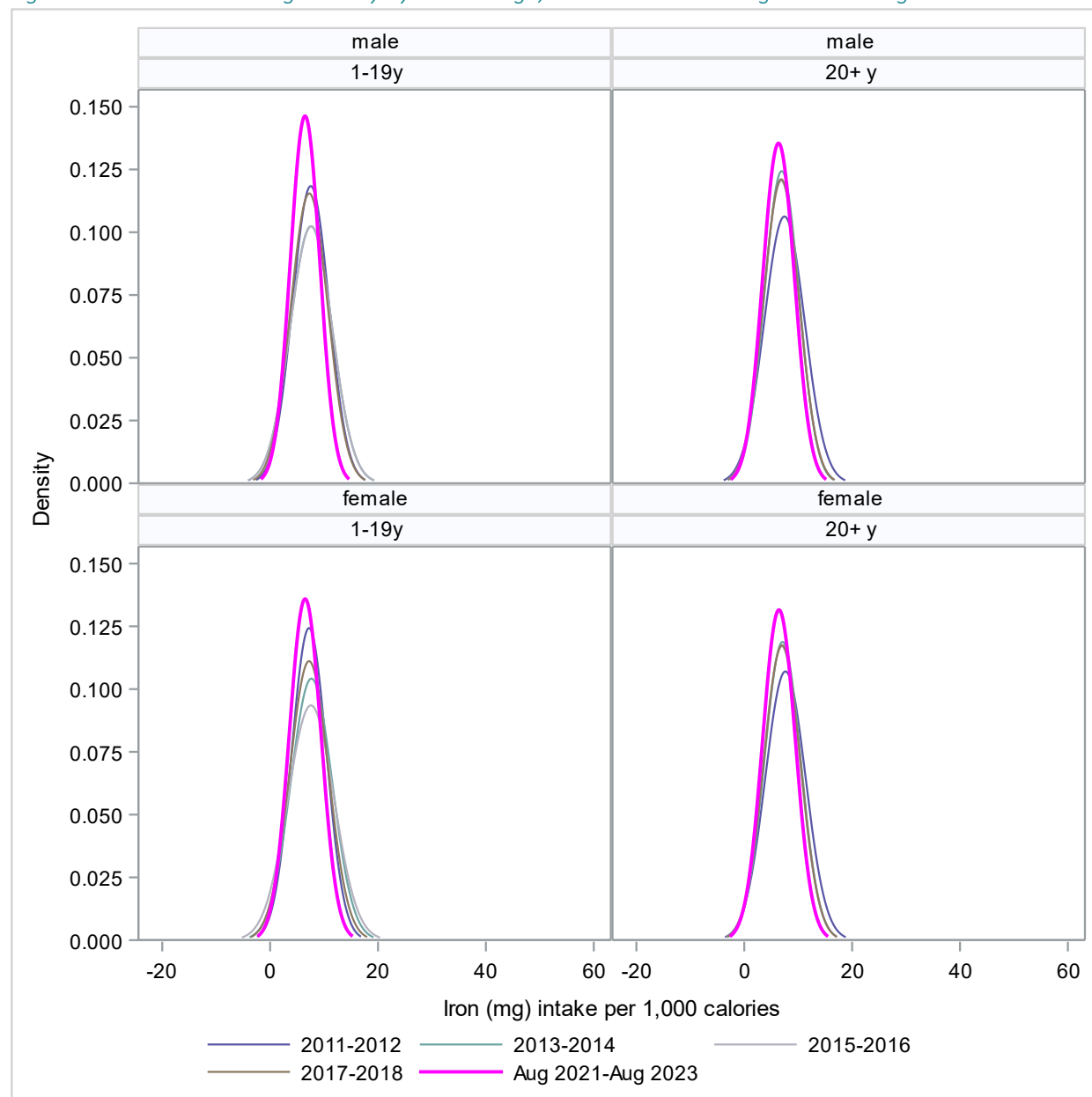|	2011-2012	2013-2014	2015-2016	2017-2018	Aug 2021-Aug 2023	Linear trend p-value	T-test p-value
Males, 1-19							
Iron (mg/1,000 kcal)	7.5 (0.1)	7.5 (0.2)	7.6 (0.1)	7.1 (0.1)	6.5 (0.1)	<0.0001	0.001
Vitamin A (µg/1,000 kcal)	326.6 (9.7)	334.0 (9.8)	334.1 (9.2)	317.8 (8.4)	271.3 (5.2)	<0.0001	0.0001
Calcium (mg 1,000 kcal)	579.0 (12.7)	574.8 (10.7)	560.5 (9.9)	545.2 (9.1)	520.1 (10.1)	0.001	0.07
Females, 1-19							
Iron (mg/1,000 kcal)	7.2 (0.1)	7.6 (0.1)	7.6 (0.3)	7.2 (0.2)	6.5 (0.1)	<0.0001	0.001
Vitamin A (µg/1,000 kcal)	314.3 (6.4)	358.8 (20.7)	332.7 (10.0)	330.6 (10.5)	277.7 (9.1)	0.002	0.002
Calcium (mg/1,000 kcal)	572.0 (11.8)	576.5 (15.6)	544.1 (11.5)	544.5 (7.4)	503.7 (6.8)	<0.0001	0.001
Males, 20 +							
Iron (mg/1,000 kcal)	7.3 (0.1)	6.9 (0.1)	6.8 (0.1)	6.7 (0.1)	6.3 (0.1)	<0.0001	0.0003
Vitamin A (µg/1,000 kcal)	311.2 (32.6)	289.9 (7.6)	289.5 (11.8)	289.3 (8.0)	269.3 (6.0)	0.21	0.05
Calcium (mg/1,000 kcal)	445.2 (6.3)	446.8 (6.7)	444.9 (5.7)	490.7 (30.6)	431.7 (6.1)	0.64	0.06
Females, 20 +							
Iron (mg/1,000 kcal)	7.6 (0.1)	7.1 (0.1)	6.9 (0.1)	6.9 (0.1)	6.4 (0.1)	<0.0001	0.0006
Vitamin A (µg/1,000 kcal)	343.9 (14.5)	338.7 (11.8)	347.4 (9.7)	349.0 (12.5)	328.2 (9.7)	0.59	0.19
Calcium (mg/1,000 kcal)	487.3 (8.2)	488.7 (6.0)	490.6 (10.1)	489.0 (9.7)	478.2 (4.3)	0.41	0.32

Notes: Weighted estimates. Based on Day 1 interview. Linear trend p-value reflects 2011–2012 to Aug 2021–Aug 2023.
T-test p-value reflects 2017-2018 vs. Aug 2021-Aug 2023.
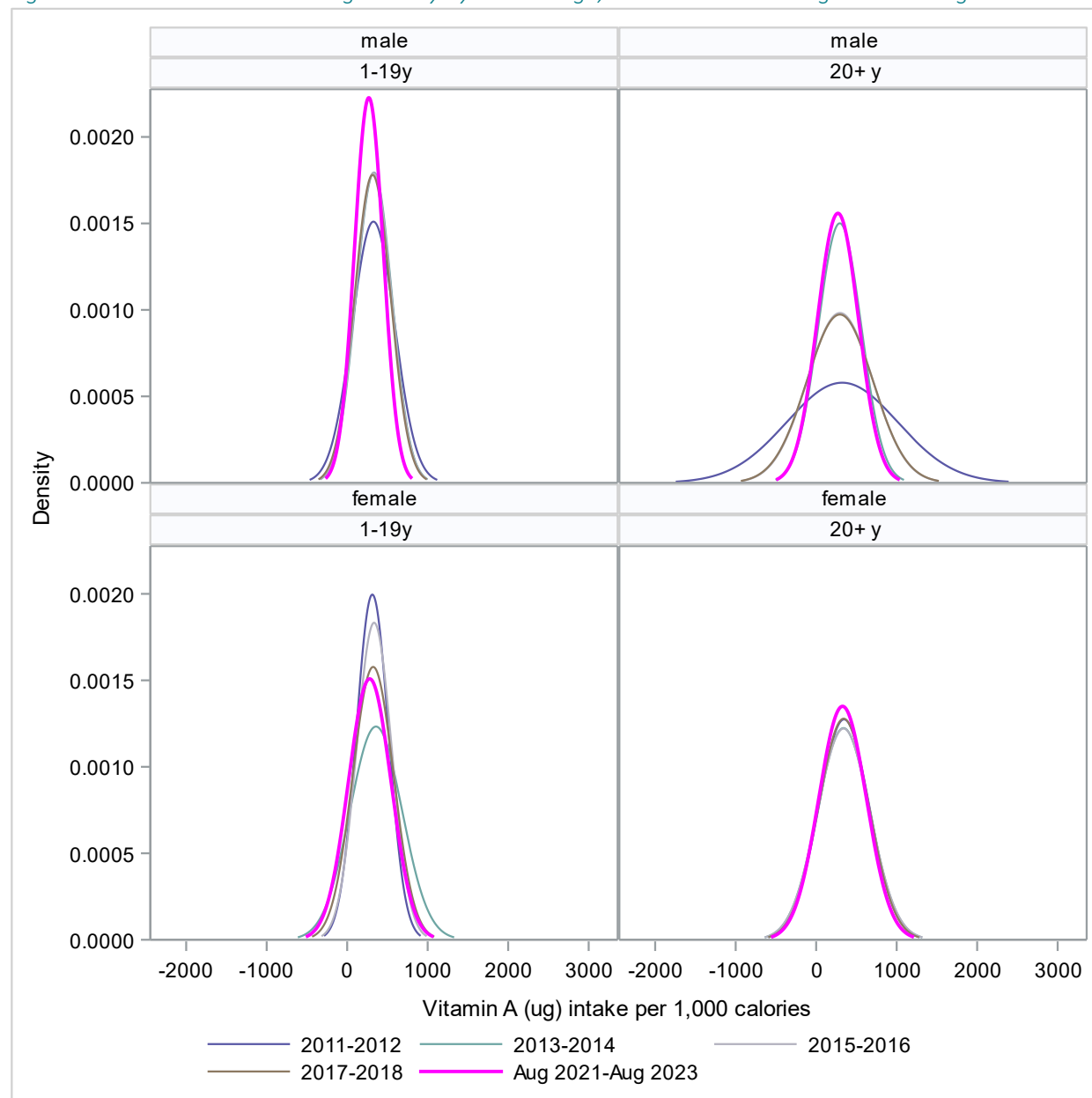Source: National Health and Nutrition Examination Survey

Patterns in weighted density plots for intake on a given day for iron, vitamin A and calcium varied. The distribution of iron intake was narrower in August 2021-August 2023 with a shift to the left compared to past cycles for all subgroups (**Figure 6**). The distribution of vitamin A intake during August 2021-August 2023 appeared narrower than in past cycles for males and females 1-19 years and particularly for adult males. However, for adult females there was little difference between cycles (**Figure 7**). For calcium intake, the most notable difference was a wider distribution for adult men during 2017-2018 compared to past cycles whereas for other groups, distributions were similar across cycles (**Figure 8**).

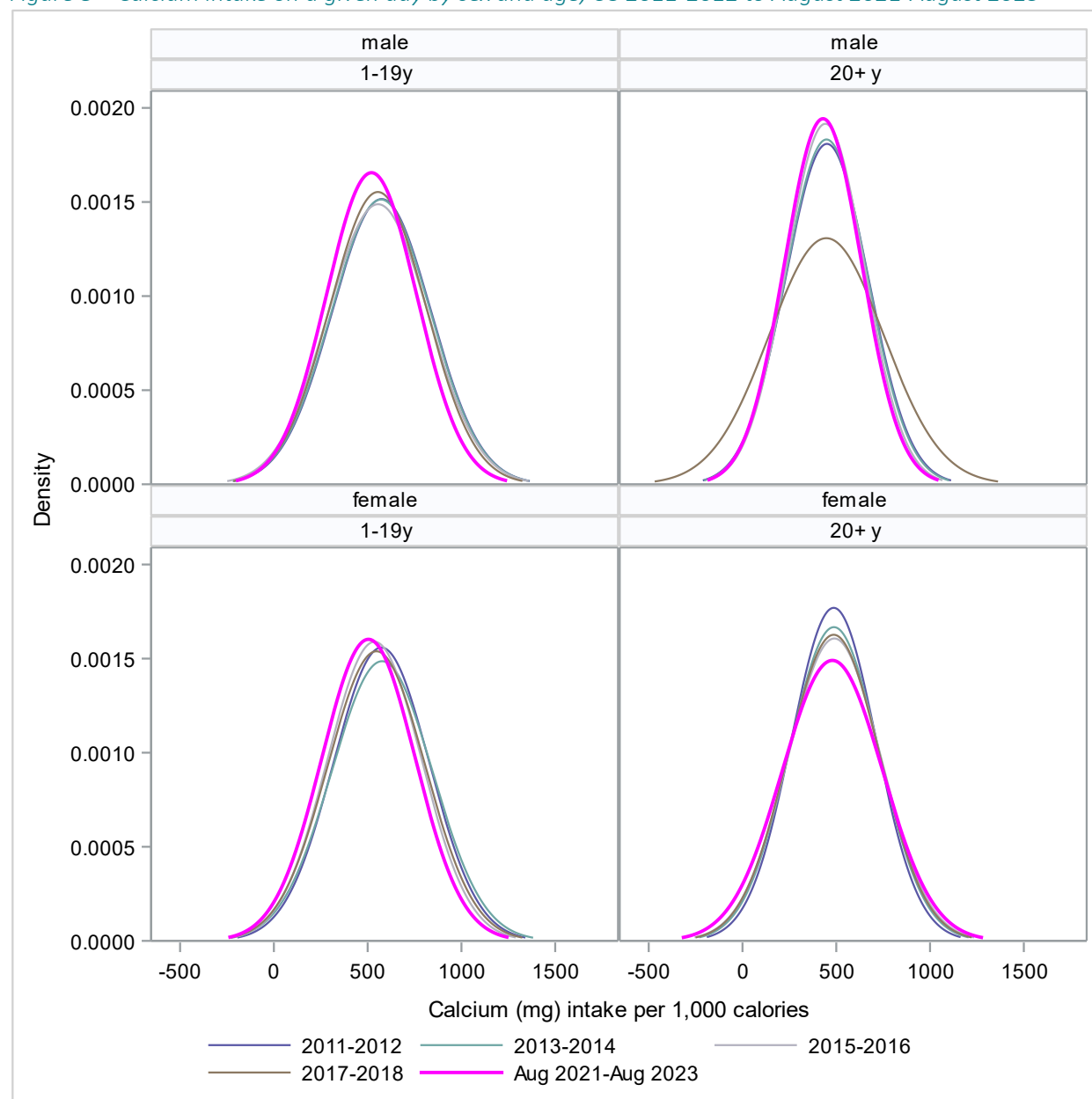*Figure 6 – Iron intake on a given day by sex and age, US 2011-2012 to August 2021-August 2023*

Notes: Weighted density plot; iron intake expressed as a proportion of total calories. Based on Day 1 dietary interview.
Source: National Health and Nutrition Examination Survey

Figure 7 – Vitamin A intake on a given day by sex and age, US 2011-2012 to August 2021-August 2023

Notes: Weighted density plot; vitamin A intake expressed as a proportion of total calories. Based on Day 1 dietary interview.
Source: National Health and Nutrition Examination Survey

Figure 8 – Calcium intake on a given day by sex and age, US 2011-2012 to August 2021-August 2023
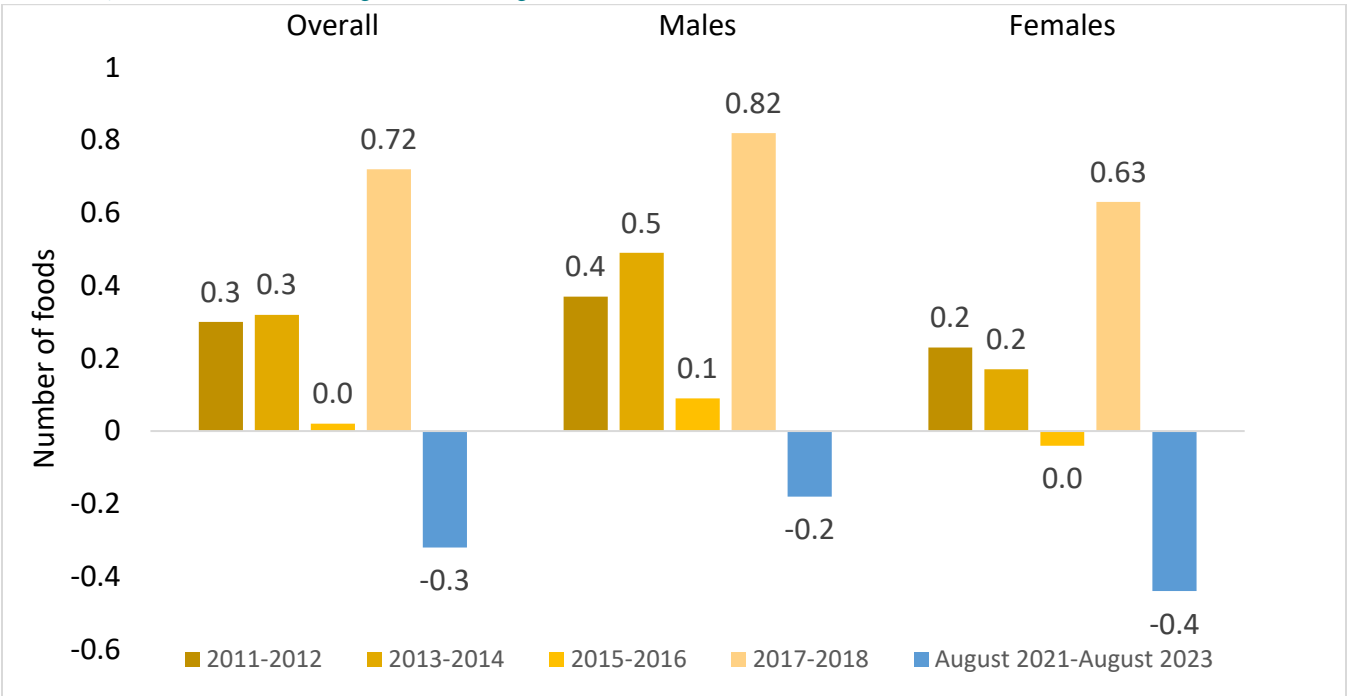

Notes: Weighted density plot; calcium intake expressed as a proportion of total calories. Based on Day 1 dietary interview.
Source: National Health and Nutrition Examination Survey

B.2.4. Differences in total foods reported, and macronutrient and micronutrient intake between Day 1 and Day 2 interviews over time

Comparison of the differences between Day 1 and Day 2 dietary interviews between August 2021-August 2023 to those of past cycles may provide some insight into the impact of the mode change for the Day 1 interview from in-person to phone. Among adults, the mean absolute differences in the number of foods reported on Day 1 and Day 2 of the interviews were less than one food in all cycles (**Figure 9**). However, during August 2021-August 2023, the difference was negative while in past cycles it was positive. Unlike during past cycles, more foods were reported during Day 2 than Day 1 interviews during August 2021-August 2023. Patterns for males and females were similar.

Figure 9 – Mean difference between Day 1 and Day 2 in the number of total foods reported by sex, adults age 20 and older, US 2011-2012 to August 2021-August 2023
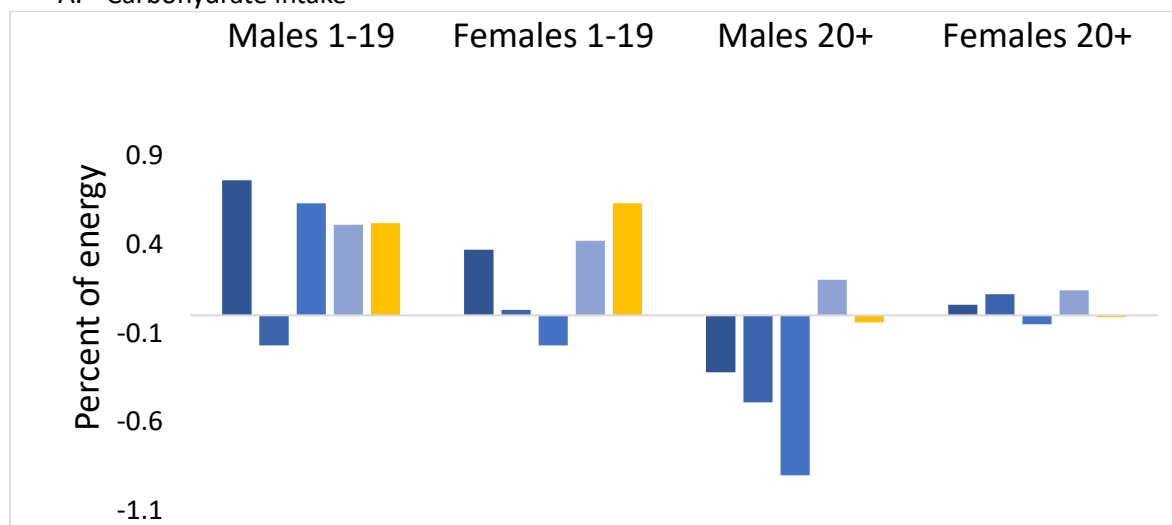

Source: National Health and Nutrition Examination Survey

The mean differences between Day 1 and Day 2 percent of energy from carbohydrates, fats, and protein are shown in **Figure 10**. In some cases, such as carbohydrate and protein intake for adults, the differences are smaller for August 2021-August 2023 than past cycles. Although there is variation over time, between subgroups and between macronutrients**.**

Figure 10 – Mean differences between Day 1 and Day 2 in macronutrient intake by sex and age, US 2011-2012 to August 2021-August 2023
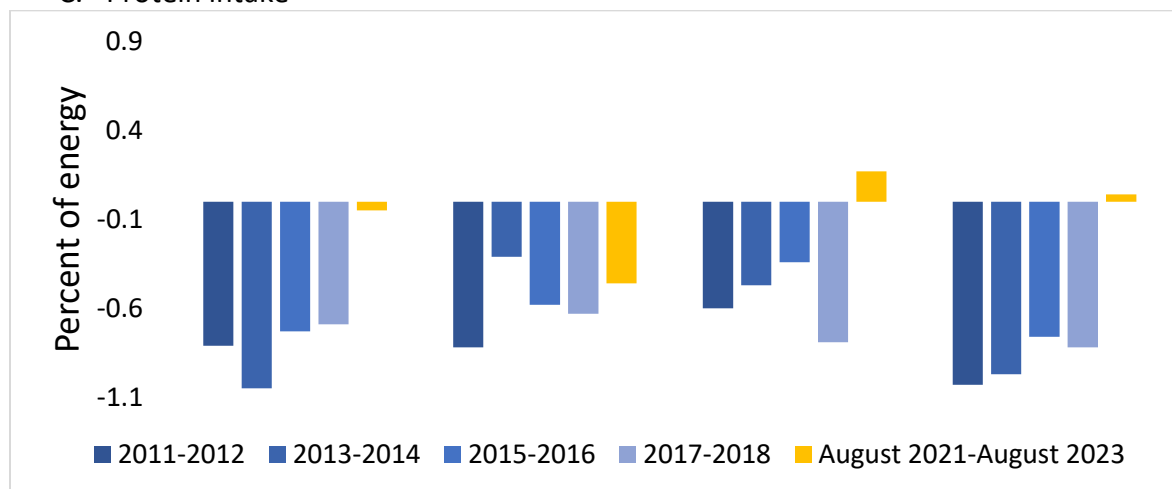
A. Carbohydrate intake

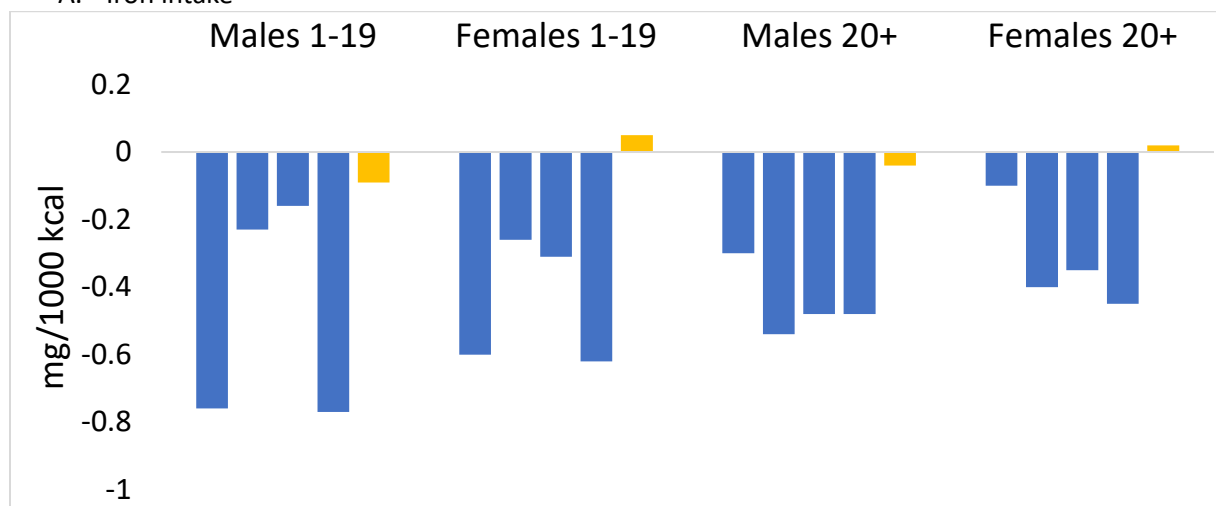
B. Fat intake

C. Protein intake

Source: National Health and Nutrition Examination Survey

The differences between Day 1 and Day 2 of mean micronutrient intake (iron, vitamin A, and calcium) per 1,000 calories varied across survey cycles (**Figure 11).** Differences in mean iron intake during August 2021-August 2023 were smaller than for past cycles. For only male youth and adult females, vitamin A intake differences were also smaller during August 2021-August 2023 compared to past cycles. Differences in mean calcium intake also appeared smaller during August 2021-August 2023 than in most past cycles.

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Figure 11 – Mean differences between Day 1 and Day 2 in select micronutrient intake by sex and age, US 2011-2012 to August 2021-August 2023
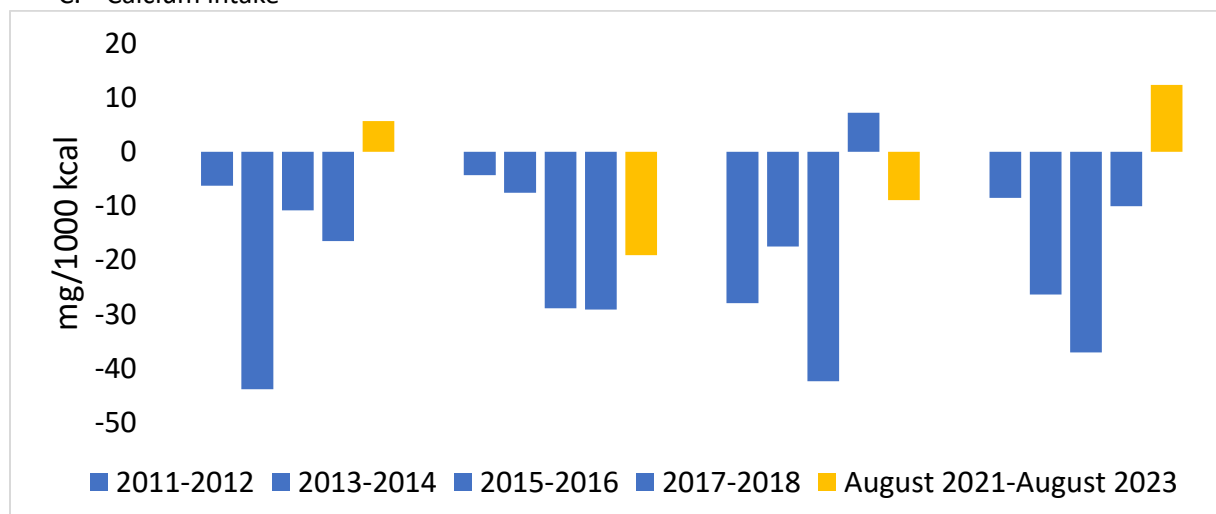
A. Iron intake

B. Vitamin A intake

C. Calcium intake

■ 2011-2012   ■ 2013-2014   ■ 2015-2016   ■ 2017-2018   ■ August 2021-August 2023

Source: National Health and Nutrition Examination Survey

IV. Discussion

Changes in the Day 1 interview mode from in-person to phone during August 2021-August 2023 could have potentially impacted dietary intake estimates. To mitigate any impact, the mode change in the August 2021-August 2023 cycle was accompanied by measures to maintain data quality. During the in-person interview in past cycles, 3-D measuring guides were used to estimate the amount of foods and drinks consumed. A Food Model Booklet, measuring cups, measuring spoons, household spoons, and a ruler were given to the participant to estimate portion sizes during the second dietary interview. In August 2021-August 2023, the Food Model Booklet and measuring guides were provided for the participant to use during the two telephone interviews. Some predictable operational impacts were observed. Compared to past cycles, response rates and sample sizes were lower. While approximately 90% of MEC visit participants responded to the in-person Day 1 interview in past cycles, in August 2021-August 2023 76.2% of MEC visit participants responded to the additional stage of the phone Day 1 interview. There were also lower response rates to earlier stages of NHANES (home interview and MEC exam) compared to past cycles. Non-response bias analyses did not find evidence of a biased sample overall for the August 2021-August 2023 cycle (1). However, due to lower sample sizes for this cycle, statistical power to compare groups may be reduced compared to past cycles.

There are differences in dietary intake estimates between August 2021-August 2023 and past cycles. The mean number of foods reported in the Day 1 interview in August 2021-August 2023 was slightly lower, and Day 1—Day 2 differences in number of foods reported was in the opposite direction of those for past cycles. It has been documented that compared to biomarkers self-reported dietary intake underestimates energy intake (2). The consistent pattern in past cycles where the number of foods is lower on Day 2 (phone) compared to Day 1 (in person) could suggest that phone interviews are more prone to underestimation of intake than in-person interviews. The opposite pattern during August 2021-August 2023 suggests that the mode change may have increased underreporting on Day 1 compared to past cycles.

The impact of the mode change on other dietary intake estimates is more difficult to discern, perhaps in part because of the adjustment for calorie intake. There were inverse linear trends observed across cycles: the mean proportion of energy from fats increased while the mean proportion of energy from carbohydrates decreased. For some micronutrients and subgroups, there was evidence of lower micronutrient intake over time, most consistently for iron. Some of these changes may reflect population-level trends in dietary or supplement intake. Yet, without a cross over study, it is not possible to discern whether differences between August 2021-August 2023 and past cycles were due to a secular change in population-level intake, the mode change, changing nutrient content of foods consumed, other survey design changes, nonresponse bias due to lower response rates, or a combination of these and other factors. It is also possible that the COVID-19 pandemic impacted dietary intake but the evidence of dietary changes during the pandemic has been mixed (3).

V. Conclusions

In summary, data users are encouraged to consider possible impacts of the mode change for the Day 1 interview on dietary intake estimates from the August 2021-August 2023 cycle. These include lower response rates, smaller sample sizes, and a lower number of mean foods reported on Day 1 compared to past cycles.

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VI. References

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