Blood Methylmercury and Fish Consumption Among People of Childbearing Age in the General U.S. Population

NHANES 1999-March 2020

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Executive Summary

In the United States, exposure to methylmercury (MeHg) in humans occurs largely through the consumption of fish (National Research Council, 2000; Rice *et al.*, 2000). Blood concentrations of MeHg in women of childbearing age are of particular interest because exposure to MeHg *in utero* is associated with adverse health effects, e.g., neuro-developmental deficits such as IQ and motor function deficits in children (Mergler *et al.*, 2007; National Research Council, 2000).

This report documents an analysis of fish consumption and blood mercury concentrations in women aged 16-49 years in the United States using data collected by the National Health and Nutrition Examination Survey (NHANES) from 1999 through March 2020 (10 survey releases). NHANES is a continuous survey designed to collect data on the health and nutritional status of the U.S. population. The NHANES reports data on chemicals, or their metabolites as measured in blood and urine samples collected from a statistically representative sample of the U.S. population. CDC releases NHANES data every two years.

In this study, we applied fish tissue mercury concentrations to fish species reported being consumed by the study participants, and estimated the usual intake of mercury through fish consumption (United States Environmental Protection Agency, 2014). We imputed blood MeHg from blood total and blood inorganic mercury data and investigated the trend of blood MeHg concentration over time by demographic characteristics. Additionally, we looked the association between blood mercury concentration and demographic characteristics and the association between blood mercury concentration and estimated usual intake of mercury. We also looked for trends in frequency of fish consumption as well as the association of fish consumption and mercury intake with demographic characteristics. Finally, we looked for geographic differences in blood mercury.

Key Findings

Trends in MeHg concentrations in blood: There are statistically significant decreasing trends in blood MeHg concentrations over time (higher in 1999-2000 and lowest in 2017-March 2020) and by demographic characteristics (such as education, income, race/ethnicity, and age over the study period).

- The geometric mean blood MeHg concentration in 1999-2000 survey release is 1.94 times higher than the geometric mean in 2017-March 2020 survey release, representing a 48 percent decrease between NHANES 1999-2000 (the earliest set of data analyzed) and 2017-March 2020 (the most recent dataset).
- The percentage of women of childbearing age with blood MeHg concentrations over 5.8 µg/L in 1999-2000 is about 3.5 times the concentration found in 2001-March 2020, representing a 71 percent decrease. There is a statistically significant difference between the survey releases for the percent with blood MeHg concentrations over 5.8 µg/L (Rao-Scott Chi-square $p<0.001$). No significant difference ($p=0.12$) is found between the survey releases after removing survey release 1999-2000.
- The geometric mean blood MeHg concentration in women who reported their race as "Other Race – Including Multi-Racial" (which includes Asian, Native American, Pacific and Caribbean Islander, Alaska Native, multiracial, and unknown race) in 1999-2004 is 1.82 times higher than the geometric mean in 2017-March 2020 data, representing a 45 percent decrease between NHANES 1999-2004 and 2017-March 2020.
- Higher blood MeHg concentrations are observed with increasing age, ratio of family income to poverty, education level, and among participants who reported their race as "Other Race – Including Multi-Racial."

Predictors of MeHg concentrations in blood: Transformed usual intake (TUI) is a significant predictor ($p<0.0001$) of blood MeHg concentrations. The rate of increase in blood MeHg concentration due to TUI varied by education, race/ethnicity, and log-transformed body weight. Other significant predictors of blood MeHg concentrations are NHANES survey release, education, race/ethnicity, log-transformed hematocrit concentration, and log-transformed bodyweight. Household income is a marginally significant predictor of blood MeHg concentrations ($p=0.054$).

Trends in fish consumption by demographic characteristics and geography: Blood MeHg concentrations are positively associated with the reported frequency of fish consumption over the previous 30 days. While significant differences in reported frequency of fish consumption are found across the six NHANES survey releases from 1999-2010 in a previous study (United States Environmental Protection Agency, 2013), there are no statistically significant differences in reported frequency of fish consumption across the more recent NHANES survey releases in the current study (2013 to March 2020).

There are statistically significant differences in blood MeHg concentrations geographically, with higher levels among residents of coastal counties compared to residents of non-coastal counties. The residents of the Northeast region have the highest levels of the four regions, followed by the West, South, and the Midwest.

Overarching Interpretation

There is a decreasing trend in the geometric mean of blood MeHg concentrations. While the estimated amounts of total fish eaten over the previous 30 days in NHANES 2013-March 2020 are at the higher end of estimated amounts for NHANES 1999-2010, the estimated mercury intake from total fish consumption over the previous 30 days in NHANES 2013-March 2020 are lower than estimated intakes for NHANES 1999-2010. This suggests that women of childbearing age are potentially choosing to eat fish that tend to have lower mercury concentrations leading to lower estimates of mercury intake per unit body weight.

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List of Abbreviations

CDC	Centers for Disease Control and Prevention
DK	Don't know
DL	Detection limit
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FNDDS	Food and Nutrient Database for Dietary Studies
IHg	Inorganic mercury
MeHg	Methylmercury
NCHS	National Center for Health Studies
NCI	National Cancer Institute
NHANES	National Health and Nutrition Examination Survey
RR	Relative Ratio
THg	Total mercury
TUI	Transformed usual intake
USDA	United States Department of Agriculture

BACKGROUND AND PURPOSE 1

In the United States, exposure to methylmercury (MeHg) in humans occurs largely through the consumption of fish (National Research Council, 2000; Rice et al., 2000). Mercury released into the environment is converted to MeHg in sediments and in the water column and bioaccumulates through aquatic food webs. This bioaccumulation leads to increased levels of MeHg in larger, older, predatory fish; concentrations in fish tissue may exceed a million-fold the concentrations in water (National Research Council, 2000). Fish and shellfish tissue contaminated by MeHg can put human health at risk. Blood total mercury (THg) concentrations reflect exposure to organic mercury, predominantly MeHg, from consumption of fish (Björnberg et al., 2003; Sanzo et al., 2001; Svensson et al., 1992). MeHg exposure in utero is associated with adverse health effects, e.g., neurodevelopmental deficits such as IQ and motor function deficits in children (Mergler et al., 2007; National Research Council, 2000).

In October 2021, the EPA and FDA issued *Advice about Eating Fish and Shellfish* (EPA_FDA, 2021), which updated the consumer advice on mercury in fish originally issued in 2001. This update was due, in part, to research over the past decade that has indicated that fish consumption during pregnancy may be beneficial for the growth and brain development of the fetus and young children (Bramante et al., 2018; Golding et al., 2016; Stratakis et al., 2020; Taylor et al., 2016). The advice provides recommendations for pregnant and breastfeeding women, women of childbearing age, and young children, and includes a chart with fish species considered “Best Choices,” “Good Choices,” and “Choices to Avoid,” with recommended servings per week.

In the *FY 2022-2026 EPA Strategic Plan*, the EPA has committed in Goal 5 to “Ensure Clean and Safe Water for All Communities” and specifically under Objective 5.2 to “Protect and Restore Waterbodies and Watersheds, to address sources of water pollution and ensure water quality standards are protective of health and needs of all people and ecosystems.” The EPA has identified several strategies it will undertake to help protect public health and ensure clean and safe waters that include developing nationally recommended water quality criteria and addressing contaminants that endanger human health. The EPA’s approach to making fish safe to eat, which is a human health benefit, has been to:

- Work collaboratively with air agencies to maintain and improve the nation’s air quality.
- Encourage development of statewide mercury reduction strategies.

- Reduce air deposition of mercury.
- Improve public information and notification of fish contamination risks.

The Agency can assess progress towards this goal through the measurement of blood mercury concentrations among women of childbearing age as reported by the Centers for Disease Control and Prevention's (CDC) National Health and Nutrition Examination Survey (NHANES). NHANES is a continuous survey designed to collect data on the health and nutritional status of the U.S. population. The NHANES reports data on chemicals, or their metabolites as measured in blood and urine samples collected from a statistically representative sample of the U.S. population. CDC releases NHANES data every two years and reports environmental exposure results for every NHANES release in the National Report on Human Exposure to Environmental Chemicals (Center for Disease Control and Prevention, 2021a, b).

A 2013 study on blood mercury trends in women of childbearing age from NHANES 1999-2010 (Birch et al., 2014; United States Environmental Protection Agency, 2013) found blood mercury concentrations in NHANES survey release 1999-2000 to be statistically significantly higher than the mean of the subsequent 10 releases (2001-2010) for both blood THg and blood MeHg. The EPA reference dose (RfD) for MeHg is 0.1 µg/kg-day (United States Environmental Protection Agency, 2001). This is equivalent to a blood mercury concentration of 5.8 µg/L. An RfD is an estimate of the maximum daily intake that is not likely to cause harmful effects across a lifetime. From 2008 to 2018, the EPA used the percent of women of childbearing age that have blood mercury concentrations over 5.8 µg/L as one measure of the progress towards making fish and shellfish safer to eat. In the study of NHANES 1999-2010, the percentage of women of childbearing age with blood MeHg >5.8 µg/L was significantly higher in survey release 1999-2000. The study also found a significant quadratic trend[1] in blood MeHg concentration since 1999-2000. This quadratic trend indicates decreasing blood MeHg concentrations between NHANES survey release 2001-2002 and 2003-2004, followed by relatively small changes and a slight increase in the survey release 2009-2010. There was a significant relationship between mercury intake from fish consumption and blood MeHg, although mercury intake did not fully explain the differences observed across the survey releases.

A 2009 study (Mahaffey et al., 2009) that investigated regional and coastal differences in NHANES 1999-2004 blood mercury data found that elevated blood mercury occurred more

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[1] A non-linear trend described by a second-order polynomial function.

commonly in women living in coastal areas of the United States and that exposure varied regionally with those residing in the Northeast having the highest blood mercury concentrations followed by the South, West, and Midwest.

This study focuses on NHANES 1999-March 2020 data with the goal to investigate national trends in blood mercury concentrations and fish consumption among women of 16-49 years of age. The specific objectives are to assess:

1. Trends in blood mercury concentrations over time and by demographic characteristics.
2. Association between blood mercury concentration and demographic characteristics.
3. Association between estimated usual intake of mercury and blood mercury concentration.
4. Trends in frequency and amounts of fish consumed and the association of fish consumption and mercury intake with demographic characteristics.
5. Geographic distribution of blood MeHg.

DATA AND METHODS 2

2.1 NHANES and Methods Overview

NHANES is designed to assess the health and nutritional status of adults and children in the United States. It is conducted by the National Center for Health Statistics (Center for Disease Control and Prevention, 2013), part of the CDC that is responsible for producing vital and health statistics for the United States. NHANES collects health-related data from a nationally representative sample of about 5,000 non-institutionalized individuals located in 15 counties in the United States each year and releases the data on two-year cycles. The survey includes interview and examination components. The interview includes demographic, socioeconomic, dietary, and health-related questions. The examination consists of medical, dental, and physiological measurements and laboratory tests of blood and urine. Data from both components of all NHANES releases 1999-March 2020 were used to investigate the trend of blood mercury concentration across NHANES releases by demographic categories. This analysis focused on data from the three most recent NHANES survey releases (2013-2014, 2015-2016, and 2017-March 2020[2]) to assess fish consumption and compare results with the NHANES 1999-2010 study on trends in fish consumption (Birch et al., 2014; United States Environmental Protection Agency, 2013).

2.2 NHANES Data

The required NHANES data files and variables were identified and downloaded from the NHANES website. These files were merged to create a dataset customized to the needs of this project. For each NHANES survey release, the study data include:

- **Demographics:** Characteristics previously shown to be related to blood mercury and/or fish consumption (gender, age, race/ethnicity, education, and annual income), and sampling weights, pseudo-stratum, and pseudo-primary sampling unit (PSU) variables. The pseudo-stratum and pseudo-PSU variables provide information on how participants were selected and are needed to calculate standard errors and p-values. They are modified from the actual NHANES strata and PSUs for disclosure control and are thus prefixed "pseudo."
- **Survey weights:** Appropriate survey weights of each NHANES release are selected for this analysis (Table 1).

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[2] Due to the COVID-19 pandemic, field operation and data collection for NHANES 2019-2020 were suspended in March 2020. The 2019 March 2020 data were combined with the full data set from NHANES 2017-2018 to create a nationally representative 2017-March 2020 data file.

Table 1. Survey weights and adjustment factor for combining multiple NHANES cycles

Survey release	Survey weight	Adjusted weight factor
1999-2000	WtMec4Yr*2	2/21.2
2001-2002	WtMec4Yr*2	2/21.2
2003-2004	WtMEC2Yr	2/21.2
2005-2006	WtMEC2Yr	2/21.2
2007-2008	WtMEC2Yr	2/21.2
2009-2010	WtMEC2Yr	2/21.2
2011-2012	WtMEC2Yr	2/21.2
2013-2014	WTSH2YR	2/21.2
2015-2016	WTSH2YR	2/21.2
2017-March 2020	WTMECPRP	3.2/21.2

Data processing and analyses were performed using the Statistical Analysis System (SAS) version 9.4 (SAS Institute, 2016). In general, two-year Mobile Examination Center (MEC) exam weights (WTMEC2YR) were used for this analysis. The two-year MEC exam weights for NHANES 1999-2000 and 2001-2002 were based on a different population and hence not comparable. An adjusted four-year MEC survey weight (WTMEC4YR) was created to account for the two different reference populations (Johnson et al., 2013).

In the NHANES 2013-2014 and 2015-2016, blood mercury was analyzed in one-half of the 12 years and older population.[3] Special sample weights (WTSH2YR) were created for the subsample to account for the additional probability of selection into the subsample, as well as the additional nonresponse to the lab tests results.

- MEC exam weights (WTMECPRP) created for combined NHANES 2017-2018 and 2019-March 2020 data were used for NHANES 2017-March 2020 data.
- In addition, the NHANES 2017-March 2020 data covered 3.2 years compared with 2 years for other NHANES data files. Because the period differs from earlier cycles, the survey weights were adjusted when 2017-March 2020 data files were combined with other two-year cycles (Akinbami et al., 2022). In this study, data from NHANES cycles from 1999-2000 through 2017-March 2020 covered 21.2 years of data collection. For each two-year cycle, the adjusted factor was 2/21.2. And the survey weights for 2017-March 2020 data were adjusted using a factor of 3.2/21.2.
- **Laboratory results:**
  - Blood total mercury (THg) and inorganic mercury (IHg) concentrations.
  - Hematocrit values, related to blood mercury in that mercury binds to the red blood cells.
- **Body measures:** Body weight is related to fish consumption and blood mercury.
- **Dietary intake, 24-hour recall:** Data necessary to estimate usual intake of fish (food codes, meal name, amount eaten; one record per food item eaten). Usual fish intake is

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[3] NHANES collected data for individuals aged 12 and older. This study uses a subset of the data for women aged 16 to 49.

the long-term average intake of raw finfish and shellfish (from marine, estuarine, and fresh waters).

- **Dietary intake, 30 day frequency of consumption:** Data used to estimate usual intake of fish (number of times participants reported consuming fish in previous 30 days, calculated from reports for the following species as collected by NHANES – clams, crabs, crayfish, lobster, mussels, oysters, scallops, shrimp, other shellfish, other unknown shellfish, breaded fish products, tuna, bass, catfish, cod, flatfish, haddock, mackerel, perch, pike, pollock, porgy, salmon, sardines, sea bass, shark, swordfish, trout, walleye, other fish, and other unknown fish).

2.2.1 Blood Mercury Data

The laboratory data files from all survey releases contain measurements of THg and IHg in blood. Laboratory methods are available on the NHANES website. Table 2 presents the total sample size (N) by survey release, along with the detection limit (DL), the percentage of concentrations observed below the DL, and the standard error of the percentage for blood THg and IHg.

Table 2. Sample size and weighted percent of results below the limit of detection, by survey release

Survey release	***THg***				***IHg***			
	N	**DL[a]**	**Weighted percent <DL[a]**	**SE**	**N**	**DL[a]**	**Weighted percent <DL[a]**	**SE**
All Years	15,236		14.0	0.5	15,175		79.6	0.7
1999-2000	1,632	0.137	5.5	0.6	1,630	0.446	97.7	0.5
2001-2002	1,799	0.137	3.5	0.6	1,777	0.446	93.4	1.2
2003-2004	1,615	0.20[b]	7.6	1.3	1,595	0.446	70.2	1.9
2005-2006	1,788	0.33[b]	15.8	1.2	1,782	0.446	64.9	3.0
2007-2008	1,486	[c]	16.7	1.6	1,484	0.446	69.4	2.3
2009-2010	1,780	0.33	15.0	1.9	1,778	0.35	84.3	1.3
2011-2012	1,428	0.16	5.2	1.1	1,425	0.27	75.0	2.3
2013-2014	814	0.28	19.8	2.1	814	0.27	79.4	2.3
2015-2016	740	0.28	17.2	1.6	739	0.27	84.0	2.4
2017-2020	2,154	0.28	25.9	2.0	2,151	0.21	78.9	1.4

[a] Detection limit. Laboratory Method procedure documents by NHANES releases are available on the NHANES website (https://wwwn.cdc.gov/nchs/nhanes/default.aspx).

[b] From Calwell, K.L, et al., 2009

[c] Not specified (3*std of >20 runs of blood blank)

2.2.2 Dietary Recall Data

NHANES conducts two 24-hour dietary recalls with participants. The first is an in-person interview and occurs during the examination and the second is a telephone interview 3 to 10 days later. Participants report every food and drink item they consumed in the 24 hours before the interview, including the amount. The food items are coded using U.S. Department of Agriculture (USDA) food codes from the Food and Nutrient Database for Dietary Studies (FNDDS). The FNDDS files are available from the Agriculture Research Service of the USDA (FNDDS DOWNLOAD DATABASES: USDA ARS). The recipes for the food codes were searched to find all food codes that contain finfish or shellfish, including mixed dishes. All records in the 24-hour data file for women aged 16-49 years that were for fish-containing food codes were extracted. The recipe file and 24-hour recall data were merged to calculate quantity of raw fish consumed per recipe. A detailed description of how the fish-containing records were extracted can be found in the 2014 U.S. EPA report, *Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010)* (United States Environmental Protection Agency, 2014).

Additionally, participants are asked to report the number of times they consumed various types of finfish and shellfish over the past 30 days. Responses to these questions are combined to derive a variable that provides the number of times each respondent consumes any seafood in the past 30 days (frequency of seafood consumption).

2.3 Fish Tissue Mercury Data

To estimate mercury intake, data on mercury concentrations in fish tissue are needed. Mercury concentration in fish varies greatly among species and within species, with older and larger fish having higher concentrations (United States Environmental Protection Agency, 1997). We updated our database of fish tissue mercury concentrations used in the report *Trends in Blood Mercury Concentrations and Fish Consumption Among U.S. Women of Childbearing Age NHANES, 1999-2010* (United States Environmental Protection Agency, 2013) with data through 2020. This addition included data from the peer reviewed articles (Imanse *et al.*, 2022; Janssen *et al.*, 2021; Janssen *et al.*, 2019; Malinowski, 2019; Melnyk *et al.*, 2021; Sackett *et al.*, 2017; Taylor and Calabrese, 2018; Whitney, 2021; Wolff *et al.*, 2016). Fish tissue mercury concentrations for fish caught between 2011 and 2020 were also extracted from the following databases and reports provided by federal and state governments:

- 2013-2014 National Rivers and Streams Assessment Fish Tissue Study (United States Environmental Protection Agency, 2023).

- Assessment of mercury sources in Alaskan lake food webs: U.S. Geological Survey data release (Lepak, 2022).
- Total Mercury Concentrations in Smallmouth Bass from Chesapeake Bay Tributaries, USA Dataset, 2013-2017 (Willacker, 2020).
- Fish mercury concentration data and ancillary data for streams and rivers across New York States (United States), 1969-2016, including environmental characteristics of selected locations sampled during 2007-16 (Murray, 2020).
- Hg Concentrations of Fish Tissue Samples in the Vicinity of Yellow Pine, Idaho (McGee, 2020).
- Mercury Contaminant Levels in Louisiana Biota (Louisiana Department of Environmental Quality, 2016-2020).
- Selenium and mercury in the Kootenai River, Montana and Idaho, 2018-2019: U.S. Geological Survey data release (Mebane, 2019).
- Status and trends of mercury in fish tissue in New Hampshire waterbodies, 1992-2016 (New Hampshire Department of Environmental Services, 2018).
- Measuring Mercury Trends in Freshwater Fish in Washington State (Washington State Department of Ecology, 2011-2016).
- 2015 Great Lakes Human Health Fish Fillet Tissue Study (United States Environmental Protection Agency, 2015).

Additional data included fish tissue mercury concentrations for the following species that were used for the fish tissue mercury database developed for this analysis: bass, perch, mackerel, carp, catfish, haddock, trout, rockfish, flatfish, sea bass, herring, pompano, pike, salmon, porgy, and whitefish.

To estimate the geometric mean mercury concentration for each fish species, we used the SAS MIXED procedure and modeled the log-transformed fish tissue mercury concentration by fish species, treating the data source as a random effect. Some of the data sources reported average concentrations for multiple fish samples and some sources reported mercury concentrations for each individual fish sampled. In order to account for this in the model, we included a weighting factor. The weighting factor allowed the model to account for different variances due to both data source and number of individual fish samples contributing to each reported value, which modeled the error variance as a power function of the number of samples averaged to obtain the reported value. The predicted values were converted to geometric mean fish mercury concentrations. The average mercury concentration weighted by 30-day consumption frequency was used for fish not specified in the dietary recall food recipe code. To the extent it could be tested, there were no consistent time trend in the fish mercury concentration data in the sources that we used. Table A.1 provides the microgram (μg) of mercury per gram of fish by species group used in the analysis.

2.4 Statistical Methods

The relationship between blood mercury concentrations, mercury intake, time, and demographic characteristics were assessed using:

1. Summary statistics based on the imputed concentrations of blood MeHg and the percentage of participants with blood THg and blood MeHg concentrations over 5.8 µg/L.
2. Comparison of imputed concentration of blood MeHg over time by demographic characteristics.
3. Estimation of usual intake of fish (Tooze *et al.*, 2010; Tooze *et al.*, 2006; United States Environmental Protection Agency, 2014).
4. Regression calibration and linear regression modeling to predict imputed blood MeHg concentration from age, race, education, income, usual intake of mercury, and log-transformed hematocrit concentration (Kipnis *et al.*, 2009).
5. Regression modeling to predict amount of fish consumption.
6. Logistic regression to predict the probability of reporting any fish consumption in the previous 30 days.
7. Regression modeling to predict mercury intake.

For the analysis, we imputed blood MeHg concentration from blood total and inorganic measurements. Blood THg and IHg measurements below the DL were also imputed. Details of the estimation of usual intake of mercury and the methodology to model MeHg concentrations are described in Section 2.4.1. Details of the imputation methodology are discussed in Section 2.4.2.

A box plot and table of blood MeHg concentrations were generated to provide sample sizes, geometric means, 95 percent confidence intervals of geometric means, and percentiles (25th, 75th, and 90th) by survey release. Geometric means of blood MeHg concentrations and their standard errors were generated by age group, race/ethnicity, income, and education. A test with p value less than 0.05 is considered significant. These data were generated by averaging the 20 imputed values for each individual, then calculating the statistics from those values utilizing a SAS software survey procedure to incorporate the uncertainty due to the survey sample design. Data from all NHANES survey releases were used to investigate the trend of blood MeHg concentration over time (i.e., 1999-2004, 2005-2010, 2011-2016, and 2017-March 2020) (Table 4).

The frequency distribution of fish consumption, estimated 30-day fish consumption amount, estimated 30-day mercury intake, and the estimated 30-day mercury intake per unit body weight were calculated. Detailed tables of these distributions were generated to provide sample sizes, arithmetic means, percentiles (25th, 50th, 75th, 90th, and 95th) and their 95 percent confidence intervals, by survey releases, race/ethnicity, age, income, and education. These tables are in the Appendix (Tables A.4a, A.5 to A.8). Plots and analytic extracts based on these tables are presented in the report.

Data processing and analyses were performed using SAS software, 9.4 (SAS Institute, 2016) and following the NHANES Analytical Guidelines posted on the NHANES website (Akinbami *et al.*, 2022). All analyses were weighted using the statistical weights recommended in the guidelines as detailed in Section 2.2, and the sampling design variables were used in calculating the variance of the estimates.

Age was categorized into four groups: 16-19, 20-29, 30-39, and 40-49 years. Race/ethnicity groups recorded in NHANES consistently across the 10 survey periods include Mexican American, Other Hispanic, Non-Hispanic White, Non-Hispanic Black, and “Other Race.” “Other Race” consists of Asian, Native American, Pacific and Caribbean Islander, Alaska Native, multiracial, and unknown race.

Hematocrit was included in the analysis because approximately 80 percent of MeHg binds to red blood cells (Clarkson and Magos, 2006; Rothenberg *et al.*, 2015). This variable was log-transformed for modeling.

Some demographic information (e.g., family and household income; education for youth 6-19 years) were modified or not included in the 2017–March 2020 public-use data file release due to potential disclosure risks (Akinbami *et al.*, 2022).

Family and household income is not included in the 2017–March 2020 release. The ratio of family income to the federal poverty level is included as for previous cycles. The seven income categories used for the analysis are based on this ratio: less than one times the ratio, one to less than two times the ratio, two to less than three times the ratio, three to less than four times the ratio, four to less than five times the ratio, greater than or equal to five times the ratio, and missing values.

Education level for adults aged 20 and over in the 2017-March 2020 release is included. Education is categorized as less than, equal to, or greater than the median education level for the participant’s age for all previous NHANES cycles, and adults aged 20 and over for NHANES 2017-March 2020. Education level for children and youth of 6–19 years was not included in the 2017–March 2020 release and thus for this study, participants aged 16-19 years are categorized as an unknown education group.

2.4.1 Usual Intake of Fish and Mercury

The National Cancer Institute (NCI) provides SAS macros (titled MIXTRAN and INDIVINT) to calculate the distribution of usual intake of dietary components (such as fish and mercury from fish) and for calculating the expected mean of transformed usual intake (TUI) that can be used for calculating the relationship between usual intake and another dependent variable, such as blood mercury concentrations. Using fish consumption as an example, the MIXTRAN macro fits the following models in order to predict the distribution of usual intake across the population:

- A logistic mixed model for predicting the probability of consuming fish in any 24-hour dietary recall.
- A linear mixed model to predict the reported amount of fish consumed in dietary recalls where fish consumption is reported. The fish consumption is modeled on a transformed scale using a Box-Cox transformation.
- The usual intake is the product of the probability of fish consumption and the amount consumed.

The output from the MIXTRAN macro can be used as input to the INDIVINT macro to calculate the expected mean fish consumption for each individual or equivalently the regression calibration estimate of fish consumption that can then be used to predict blood mercury concentration in a linear regression model.

The NCI macros have some limitations when applied to the NHANES fish consumption data, including:

- With many predictors, the MIXTRAN macro may take a long time to converge to the final parameter estimates or may fail to converge.
- When assuming the random effects in the logistic and linear mixed models are correlated, MIXTRAN may fail to converge when using the NHANES survey weights.
- With the NHANES data, the MIXTRAN macro needs to be run multiple times, once for each replicate weight created to calculate variance of the parameter estimates.

Due to these limitations, Westat created a modification to the NCI method, hereafter referred to as the EPA method. The EPA method has the following steps:

1. Fit the weighted logistic model using the SAS SURVEYLOGISTIC procedure, saving the logit transformed predicted probability of fish consumption (call this LogitXBeta).
2. To estimate the variance components, fit a logistic mixed model similar to that used by MIXTRAN except the only predictor is LogitXBeta and the intercept is set to zero.
3. Determine a Box-Cox transformation that makes the reported distribution of amount consumed roughly normally distributed.

4. Fit a weighted linear model to predict the amount of fish consumed, when consumed, saving the predicted amount.
5. To estimate the variance components, fit a linear mixed model similar to that used by MIXTRAN, except the only predictor is the predicted amount from the previous regression and the intercept and slope are set to one and zero, respectively.
6. Assuming random effects from the logistic and linear models are independent, the output from previous modeling steps are used as inputs to the NCI INDIVINT macro to calculate the regression calibration estimate for transformed usual fish consumption. See the discussion below regarding selection of the transformation to use.
7. Finally, the regression calibration estimate of usual fish consumption is used to predict blood mercury concentration using weighted regression.

The steps above were repeated for each replicate weight.

Regression calibration assumes that a linear model is used to predict the dependent variable (blood mercury concentration) from the transformed usual intake. The INDIVINT macro assumes a Box-Cox transformation of usual intake is used and requires that a Box-Cox lambda parameter be specified. Several values of lambda were tried to identify a lambda for which the relationship between the regression calibration estimates of usual intake were most linearly related to blood THg measurements. A Box-Cox lambda of 0.70 was selected and used for all analyses. Because a value of 0.70 might not be optimal for all analyses, the final regression model allowed for the slope above and below the median usual intake to differ. In all cases the slope difference was not statistically significant. To accommodate this modification, non-linear regression was used to fit the final model.

2.4.2 Imputation

The MeHg concentration was calculated from the difference between the THg measurements and the IHg measurement. However, due to measurement errors, that difference can be negative. In addition, a few of the THg concentrations were less than the DL and not otherwise specified and many of the IHg measurements were below the DL.

Predictors were selected by stepwise selection using SAS GLMSELSECT to predict the log-transformed blood THg concentration from calculated TUI and selected main effects. Significant ($p<0.05$) main effects and interactions of (TUI) and main effects were identified. The selected predictors were then tested for significance using SAS SURVEYREG. The final set of main effect variables were race/ethnicity, income, education, NHANES survey release, centered age in decade, centered log-transformed body weight, centered log-transformed hematocrit, and TUI. The final set of two-way interactions were interactions of TUI with centered log-transformed body weight, centered log-transformed hematocrit, race/ethnicity, and education.

The following procedure was used to impute the missing concentrations for the non-detects and adjust for the negative values. A Bayesian model was used to:

- Impute the THg values less than the DL as a function of the regression calibration estimate of usual intake (using the NHANES analysis weight) and other predictors.
- Impute the IHg values less than the DL as a function of the regression calibration estimate of usual intake (using the NHANES analysis weight), the THg measurement (detected or imputed) and other predictors.
- Calculate the preliminary organic mercury concentration as the difference between the total and inorganic mercury concentrations (using detected or imputed values).
- Adjust the differences to be greater than zero such that the log-transformed differences have a roughly normal distribution.

The following transformation was used to adjust the smallest differences upward to make all values greater than zero.

$$Organic\ Hg = \frac{Difference + \sqrt{Difference^2 + 0.04}}{2}$$

Twenty imputed datasets were created for the analysis. For each replicate weight, the final regression model (Step 7 in the EPA Method) was fit separately for each of the 20 imputed datasets.

2.5 Estimation of 30-Day Fish Consumption and Mercury Intake

In order to investigate the relationship between fish consumption and mercury intake with demographic characteristics, estimates of the amount of fish consumed over 30 days were calculated based on the NHANES 24-hour dietary recall data and the 30-day frequency of fish consumption data. The 24-hour data provided the amount of meal consumed at one time. Information on the amount and species of fish ingredients provided in the 24-hour recall can be obtained by linking the FNDDS database with food code. Many participants who reported consuming fish during the previous 30 days did not consume fish in the past 24-hours, so a corresponding amount and species of fish consumed in a meal were not available. Therefore, a statistical model was used to estimate the amount of fish they consumed in a meal to calculate their estimated 30-day consumption. We followed the method described in the report *Trends in Blood Mercury Concentrations and Fish Consumption Among U.S. Women of Childbearing Age NHANES, 1999-2010* (United States Environmental Protection Agency,

2013) to estimate the amount of 30-day consumption of fish. The predicted grams of fish consumed in a meal for each species from the model were multiplied by the reported frequency of consumption of corresponding species to get the amount of 30-day consumption for each fish species. The sum of the 31 species-specific fish consumption amounts of each participant was the estimated 30-day consumption of fish for each women aged 16-49 years. The estimated mercury intake was calculated as the product of species-specific fish tissue mercury concentration and the estimated amount of fish consumed at one time for each species. The participant level 30-day mercury intake was calculated as the sum of mercury intake by fish species.

Mercury intake per body weight can be explained as the product of four components:
1) frequency of fish consumption; 2) weighted average meal size, weighted by frequency of consumption; 3) weighted average fish tissue mercury concentration, weighted by the quantity of fish consumed; and 4) inverse body weight (United States Environmental Protection Agency, 2013).

Logistic regression was used to model the probability of consuming fish in a 30-day period. For participants who reported consuming fish, regression analysis was used to investigate the association between these four components and demographic characteristics (education, race/ethnicity, income, and age group).

RESULTS 3

3.1 Blood MeHg Summary Statistics

This section presents the summary statistics based on the imputed concentrations of blood MeHg by selected subpopulations.

3.1.1 Time Trends in Blood Mercury Concentrations

Figure 1 presents the distribution of blood MeHg concentration by NHANES survey release using boxplots. The geometric mean blood MeHg concentration is highest in survey release 1999-2000 then declines to the lowest in 2017-March 2020. The geometric mean blood MeHg in the 2005-2006 release slightly higher than that in the 2003-2004 and 2007-2008 releases, and the geometric mean blood MeHg in the 2009-2010 release slightly higher than that in the 2007-2008 and 2011-2012 releases. This general declining trend in geometric means is significant ($p<0.001$) across the ten survey releases. This same general pattern over time is observed in the 25th and 90th percentiles of blood MeHg concentrations (Table 3). Detailed tabulations of the distribution of blood MeHg concentrations, including sample size, arithmetic mean, geometric mean, percentiles (25th, 50th, 75th, 90th, 95th), and their 95 percent confidence intervals, by NHANES releases, race/ethnicity, age group, income, and education are presented in Table A.2.

Figure 1. Distribution of log-transformed blood MeHg (µg/L), by NHANES survey releases, women aged 16-49 years

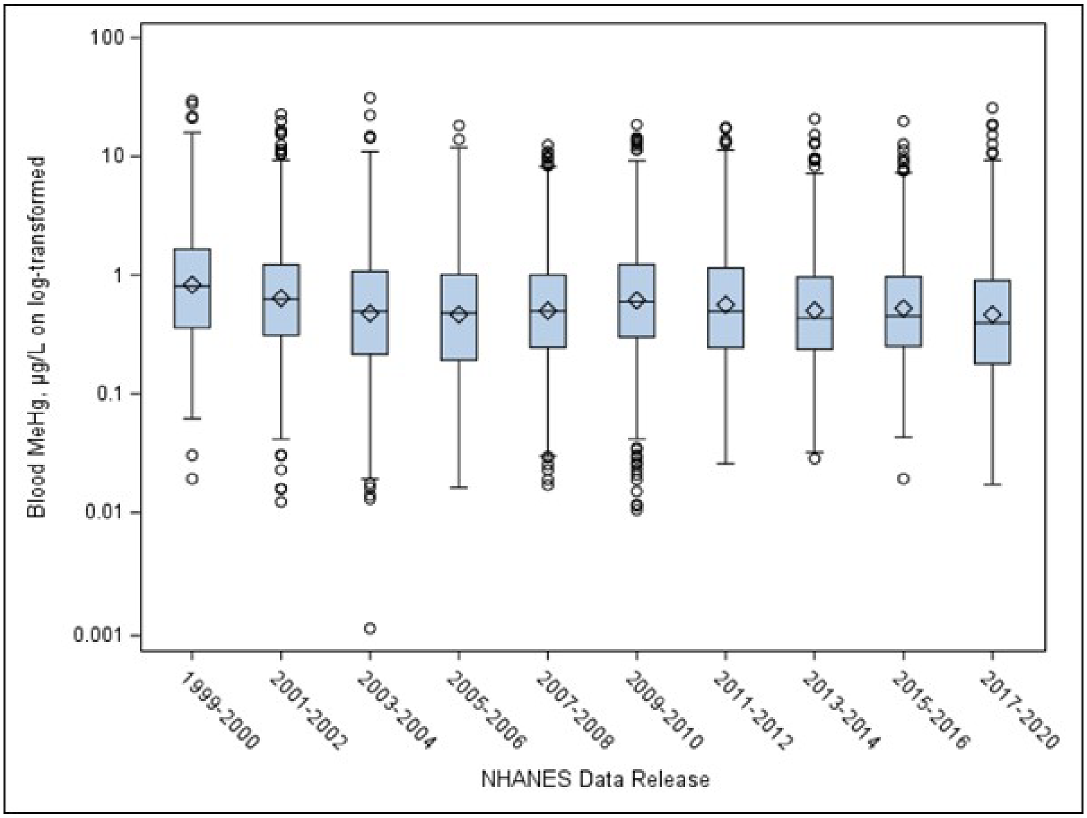


Table 3. Distribution of blood MeHg concentration (µg/L), by survey release

Survey release	**N**	***Geometric mean***	***Percentiles***		
		(95% CI)	**25th**	**75th**	**90th**
All Years	15,236	0.57 (0.55, 0.60)	0.25	1.21	2.58
1999-2000	1,632	0.93 (0.78, 1.12)	0.41	1.88	4.56
2001-2002	1,799	0.72 (0.65, 0.79)	0.34	1.46	2.92
2003-2004	1,615	0.53 (0.45, 0.61)	0.24	1.21	2.60
2005-2006	1,788	0.58 (0.51, 0.66)	0.25	1.33	2.71
2007-2008	1,486	0.52 (0.46, 0.59)	0.25	1.06	2.39
2009-2010	1,780	0.67 (0.61, 0.73)	0.31	1.38	2.73
2011-2012	1,428	0.52 (0.44, 0.60)	0.23	0.98	2.32
2013-2014	814	0.50 (0.45, 0.55)	0.23	0.94	2.21
2015-2016	740	0.50 (0.45, 0.56)	0.24	0.94	2.19
2017-2020	2,154	0.48 (0.43, 0.54)	0.18	1.01	1.99

The EPA reference dose (RfD) for MeHg is 0.1 µg/kg-day (United States Environmental Protection Agency, 2001). This is equivalent to a blood mercury concentration of 5.8 µg/L. An RfD is an estimate of the maximum daily intake that is not likely to cause harmful effects across a lifetime. The EPA uses the percent of women of childbearing age that have blood mercury concentrations over 5.8 µg/L as one measure of the progress towards making fish and shellfish safer to eat. The calculated weighted prevalence of both blood MeHg and THg concentrations over 5.8 µg/L by survey release are presented in Table 4. The percentages of women of childbearing age with blood MeHg concentrations above 5.8 µg/L in 1999-2000 is about 3.5 times that found in 2001-March 2020, representing a 71 percent decrease. There is a significant difference between the survey releases for MeHg (Rao-Scott Chi-square p<0.001). No significance difference (p=0.12) is found between the survey releases after removing the 1999-2000 survey release.

Table 4. Weighted percent of women 16 and 49 years with blood MeHg ≥5.8 µg/L and blood THg ≥5.8 µg/L, by survey release

Survey release	***N***	***Blood MeHg***		***Blood THg***	
		Weighted %	**SE**	**Weighted %**	**SE**
1999-2000	1,632	6.9	1.65	7.3	1.67
2001-2002	1,799	3.5	0.83	3.9	0.88
2003-2004	1,615	1.7	0.69	2.5	0.83
2005-2006	1,788	2.4	0.58	2.7	0.60
2007-2008	1,486	2.3	0.50	2.5	0.55
2009-2010	1,780	2.1	0.37	2.3	0.41
2011-2012	1,428	1.3	0.45	1.8	0.50
2013-2014	814	2.3	0.69	2.7	0.66
2015-2016	740	1.8	0.50	1.8	0.49
2017-2020	2,154	1.2	0.37	1.3	0.37

Note: Geometric mean and percentiles were calculated from the mean of imputed values for each respondent. Decreasing trend over time, p<0.001 for both blood MeHg and THg concentrations based on logistic regression.

3.1.2 Demographic Distributions

Table 5 presents the comparison of blood MeHg concentration over time by demographic characteristics for women 16-49. NHANES survey periods are grouped as 1999-2004, 2005-2010, 2011-2016, and 2017-March 2020. The geometric mean of blood MeHg concentrations decreases significantly over time in most demographic categories. There is a 31 percent decrease in blood MeHg concentration from 1999-2004 to 2017-March 2020. Within each time period, people of “Other Race,” 40-49 years of age, with income greater than or equal to 5 times the poverty line and education level higher than median level of the age group, have higher blood MeHg concentrations compared to the rest of the groups within each demographic characteristic.

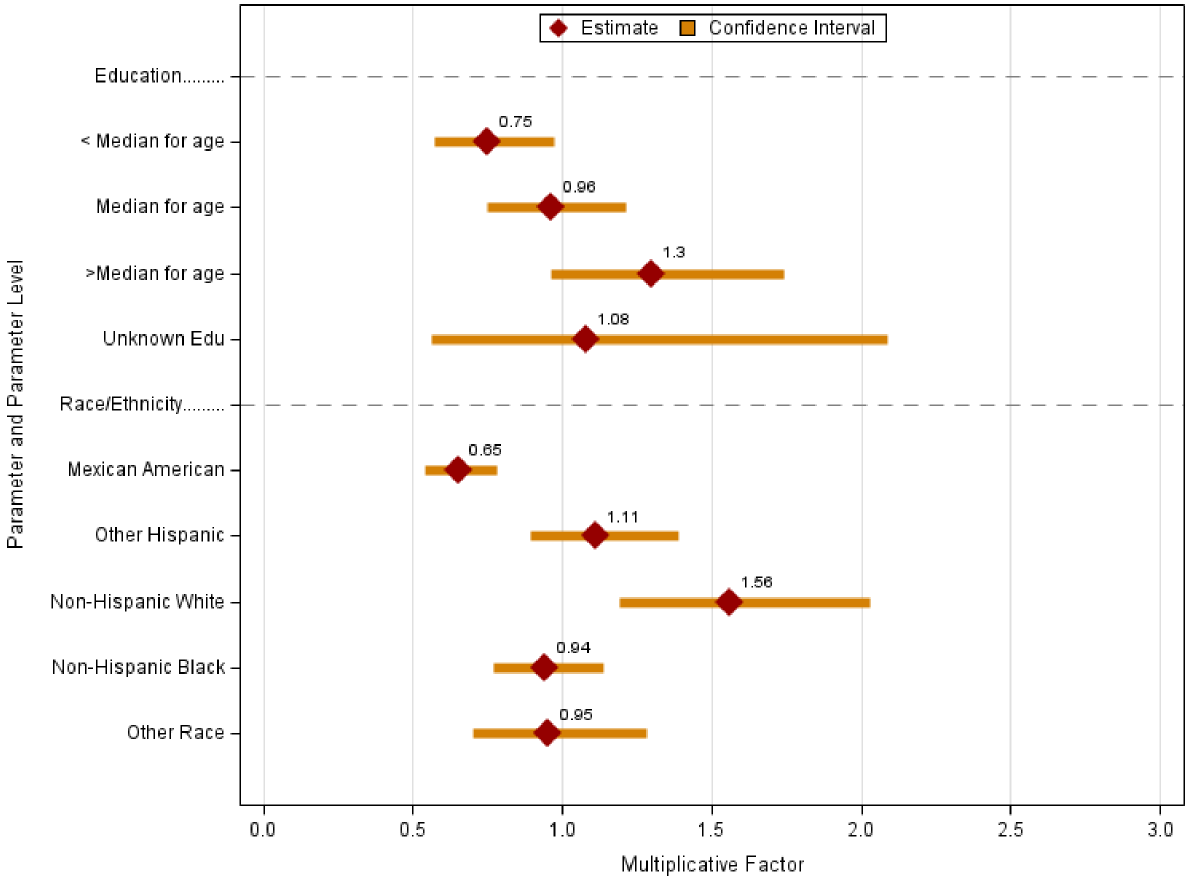
Table 5. Comparison of imputed blood MeHg concentration (µg/L) over time, by demographic characteristics, women aged 16-49 years

Blood mercury concentrations	**1999-2004**		**2005-2010**		**2011-2016**		**2017-March 2020**		**p-value**
	Geo. mean	**SE**	**Geo. mean**	**SE**	**Geo. mean**	**SE**	**Geo. mean**	**SE**	**(F test)**
OVERALL	0.70	0.03	0.59	0.02	0.51	0.02	0.48	0.03	<.0001
Race/Ethnicity									
Mexican American	0.53	0.03	0.44	0.02	0.39	0.02	0.42	0.03	0.0027
Other Hispanic	0.85	0.07	0.66	0.05	0.59	0.04	0.54	0.05	0.0320
Non-Hispanic White	0.66	0.04	0.55	0.03	0.47	0.02	0.45	0.05	0.0003
Non-Hispanic Black	0.90	0.06	0.65	0.03	0.53	0.04	0.56	0.05	<.0001
Other Race	1.17	0.13	1.25	0.12	0.89	0.07	0.64	0.05	<.0001
Age, Years									
16 to 19	*0.44*	*0.03*	*0.37*	*0.02*	*0.31*	*0.02*	*0.33*	*0.03*	*<.0001*
20 to 29	*0.60*	*0.03*	*0.52*	*0.03*	*0.47*	*0.03*	*0.49*	*0.06*	*0.0122*
30 to 39	*0.80*	*0.06*	*0.63*	*0.04*	*0.55*	*0.03*	*0.51*	*0.03*	*<.0001*
40 to 49	*0.83*	*0.05*	*0.71*	*0.03*	*0.61*	*0.03*	*0.52*	*0.04*	*<.0001*
Ratio of Family Income to Poverty Guidelines									
0 to <1x poverty line	0.54	0.03	0.44	0.03	0.39	0.02	0.41	0.04	0.0006
1x to <2x poverty	*0.58*	*0.03*	*0.48*	*0.02*	*0.40*	*0.02*	*0.38*	*0.02*	*<.0001*
2x to <3x poverty line	0.68	0.05	0.53	0.04	0.49	0.04	0.41	0.03	0.0003
3x to <4x poverty line	*0.65*	*0.06*	*0.57*	*0.04*	*0.53*	*0.05*	*0.49*	*0.06*	*0.1904*
4x to <5x poverty line	0.77	0.05	0.60	0.05	0.54	0.04	0.52	0.07	0.0077
>= 5x poverty line	*1.07*	*0.08*	*0.94*	*0.06*	*0.81*	*0.06*	*0.68*	*0.06*	*0.0012*
Missing/Refused/DK	0.78	0.09	0.63	0.07	0.60	0.04	0.54	0.07	0.2421
Education									
<Median education for age	*0.59*	*0.03*	*0.46*	*0.02*	*0.39*	*0.02*	*0.38*	*0.03*	*<.0001*
=Median education for age	*0.67*	*0.03*	*0.57*	*0.03*	*0.46*	*0.02*	*0.47*	*0.03*	*<.0001*
>Median education for age	*0.98*	*0.07*	*0.82*	*0.05*	*0.72*	*0.04*	*0.69*	*0.07*	*0.0039*

3.2 Blood MeHg Modeling

The parameter estimates and p-values from the multivariable modeling of blood MeHg concentrations are presented in Table A.3. The parameter estimate provides the direction and magnitude of the effect the predictor has on log-transformed blood MeHg concentration. Level of education (p=0.0007) and race/ethnicity (p<0.001) are significantly associated with log-transformed blood MeHg concentrations. Figure 2 shows the relative blood MeHg concentrations for different education and racial/ethnic groups represented by multiplicative difference from the overall MeHg concentration. The red diamond shows the estimate and the orange bar shows the 95 percent confidence interval of the estimate. If the 95 percent confidence interval does not cross 1, then the estimate is statistically significant at p<0.05. Blood MeHg concentration increases with education level. The difference in blood MeHg concentrations between women with education levels above the median for their age and those at the median level is more pronounced than the difference between women with education levels at the median and those below it for their age. There is significant difference (p<0.0001) in blood MeHg concentrations between the race/ethnicity groups, with non-Hispanic White women of childbearing age having the highest blood MeHg concentrations and Mexican American having the lowest.

Figure 2. Relative blood MeHg concentrations with 95 percent confidence intervals, by demographic characteristics (NHANES 2013-March 2020)

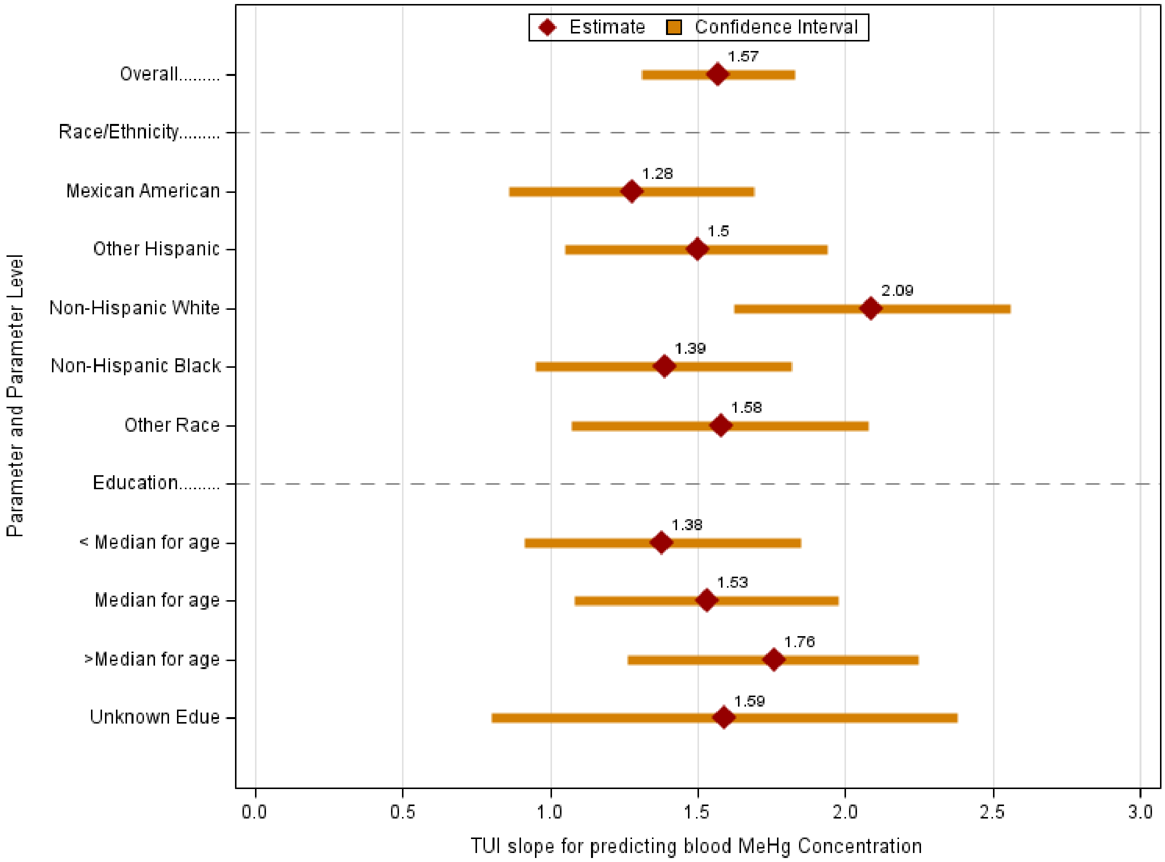


TUI of mercury (µg Hg/day) through fish consumption is one of the significant predictors of blood MeHg concentration (p<0.001), with higher consumption associated with higher blood MeHg concentration.

Figure 3 shows the slopes for the relationship between TUI of mercury through fish consumption and log-transformed MeHg overall and by demographic group. The strength of the relationship between usual intake of mercury through fish consumption and the blood MeHg concentration increases as the value of the slope factor increases. The following provides a basis for interoperating the TUI slope parameters. Consider comparing blood MeHg concentrations between subjects whose usual intake of mercury from fish consumption differs by 10 percent while holding all other factors constant. If all MeHg comes from mercury intake through fish intake, increasing usual intake of mercury through fish consumption by 10 percent should increase blood MeHg concentration by 10 percent (TUI slope =0.1). If half of the blood MeHg concentrations comes from usual intake of mercury through fish consumption and half comes from other sources, increasing usual intake of mercury through fish consumption by 10 percent should increase blood MeHg concentrations by 5 percent (TUI = 0.05). The slope relating log-transformed usual intake of mercury through fish consumption to log-transformed MeHg is an estimate of the fraction of blood MeHg concentration from usual intake of mercury through fish consumption. The slope for TUI is a close approximation to the slope of the relationship between log-transformed usual intake and log-transformed blood MeHg concentration.

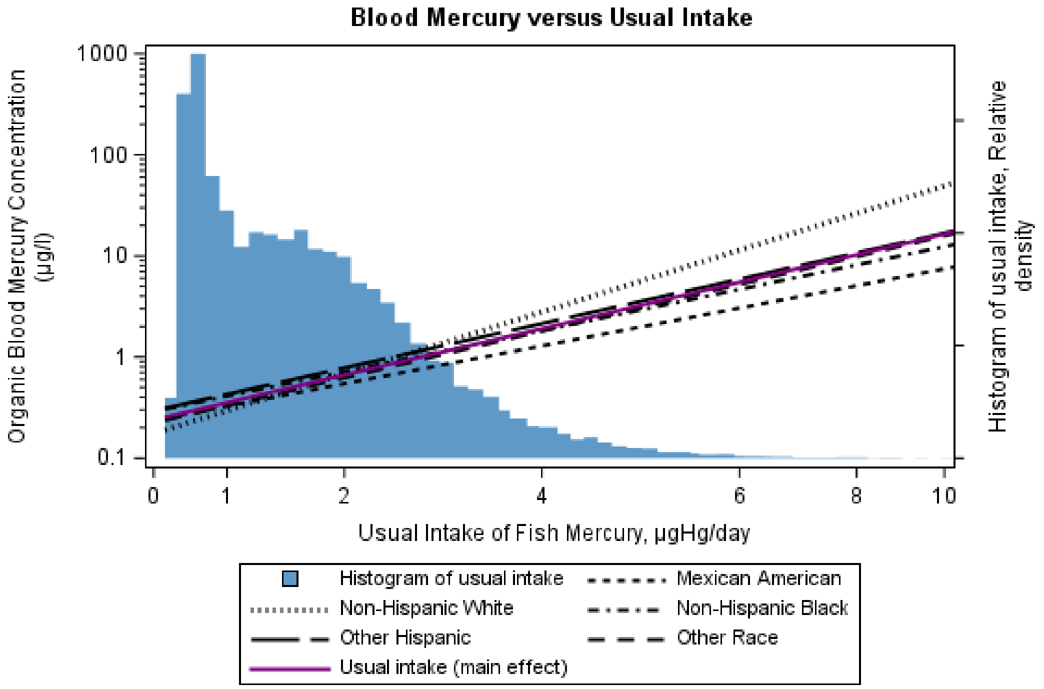
All slopes are greater than zero, indicating a positive relationship between TUI of mercury through fish consumption and blood MeHg concentration. The slope varies significantly based on level of both education (p=0.01) and race/ethnicity (p<0.001), indicating that blood MeHg concentration increases at different rates with increasing intake of fish mercury by education and race/ethnic groups. Participants whose education level is higher than the median education level of the corresponding age group have a higher slope than the rest of the education groups indicating that blood MeHg concentration increase more to a unit increase in TUI of mercury for those with greater than median level education compared to the other participants. Non-Hispanic White participants have the highest slope among all race/ethnic groups and therefore have blood MeHg concentrations that increase faster as TUI of mercury increases.

Figure 3. *Slope parameter relating transformed usual fish intake of mercury and log-transformed blood MeHg concentrations, overall and by demographic group, with 95 percent confidence intervals*



Due to the model's complexity, the slope parameters presented in Figure 3 may be difficult to interpret in terms of TUI of mercury (µg Hg/day). Figure 4 shows the predicted relationship between blood MeHg concentrations and TUI of mercury by racial/ethnic groups. For non-Hispanic White participants, blood MeHg concentrations increase at a faster rate with TUI of mercury compared to the rest of the groups. The slope is similar among participants who identify as Mexican American, other Hispanic, and non-Hispanic Black.

Figure 4. Estimated blood MeHg given usual intake of fish mercury, by race/ethnicity



Other significant predictors include NHANES survey release (p<0.001), log-transformed body weight (p=0.002) and its interaction with TUI of mercury (p<0.001), and log-transformed hematocrit concentration (p=0.005).

3.3 Trends in Fish Consumption

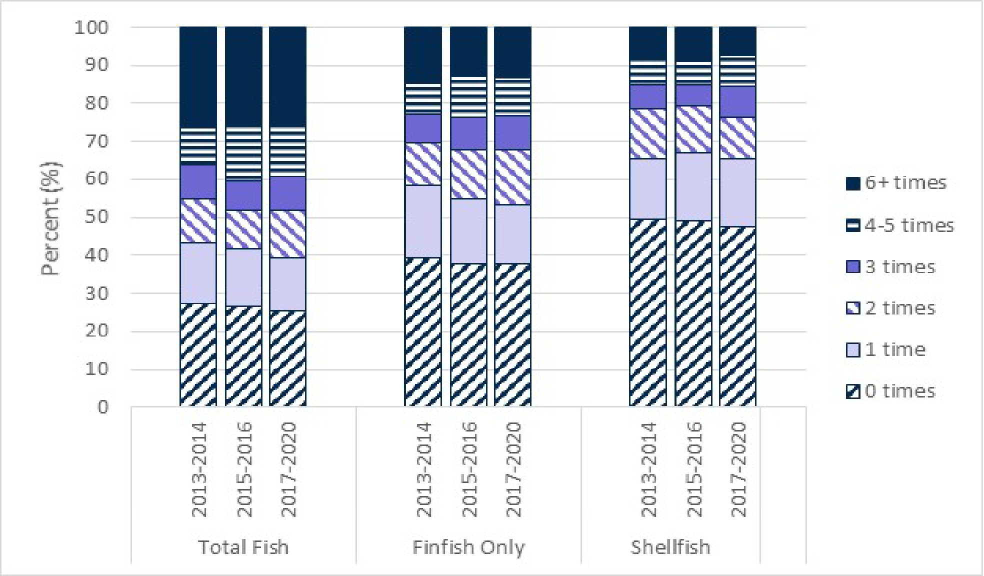
This section presents trends in fish consumption of NHANES 2013-March 2020 and compares them to trends in fish consumption of NHANES 1999-2010 (United States Environmental Protection Agency, 2013). NHANES 2011-2012 data was not included in the current study and therefore not part of this trends analysis.

3.3.1 Trends in Frequency of Consumption

Figure 5a presents the weighted percent of women aged 16-49 years in each of the six categories of reported frequency of fish consumption by NHANES survey releases (2013-March 2020). Detailed tabulations are in Table A.4a. There are no significant differences in reported frequency of consumption between survey releases (Rao-Scott chi-square p-values: p=0.66 for total fish, p=0.56 for finfish, p=0.74 for shellfish). Figure 5b displays the same distribution of NHANES 1999-2010 (United States Environmental Protection Agency, 2013). While there are statistically significant differences in consumption frequency between the survey releases 1999-2010, there is not a consistent trend over time (Rao-Scott chi-square p-values; p=0.03 for total fish, p=0.02 for finfish, and p=0.16 for shellfish). Comparing the frequency of consumption of total fish between the two studies, there are 7 percent more women reported not consuming fish in the previous 30 days in 2013-2014 than in 2009-2010, and approximate 5 percent decrease in women reported consuming fish 6 times or more from 2009-2010 (31.8%) to 2013-2014 (26.4%). This indicates a shift of consuming fish less frequently in women of childbearing age.

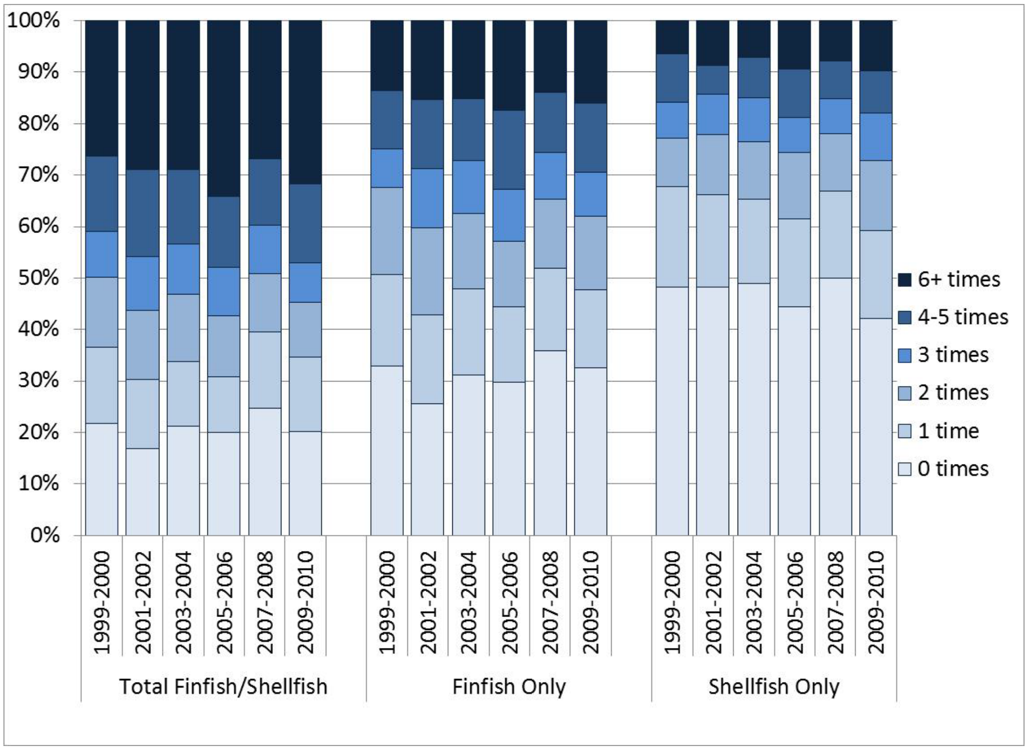
The fish consumption frequencies are similar between survey releases for each consumption category. However, there are some differences in the frequency of consumption by category of fish. For example, in NHANES 2013-2014, the percent of women who did not consume total fish (finfish and shellfish) in the previous 30 days (27%) is less than the percent of women who did not consume finfish (39%) or shellfish only (49%) in the previous 30 days. This is likely due to the fact that some women only consumed finfish or shellfish. Similarly, the percent of women who consumed fish a total of six or more times in the previous 30 days (26%) was greater than the percent of women who consumed finfish (15%) or shellfish (8%) only six or more times. This difference is a result of participants who may have consumed finfish or shellfish less than six times, but when combined, they consumed either finfish or shellfish six or more times. These findings are similar to a previous study of NHANES 1999-2010 data (United States Environmental Protection Agency, 2013).

Figure 5a. Weighted percent of participants by 30-day fish consumption frequency, by NHANES survey release (2013–March 2020), women aged 16-49 years



Note: Data for Figure 5a is in Table A.4a in Appendix A.

Figure 5b. Weighted percent of participants by 30-day fish consumption frequency, by NHANES survey release (1999-2010), women aged 16-49 years

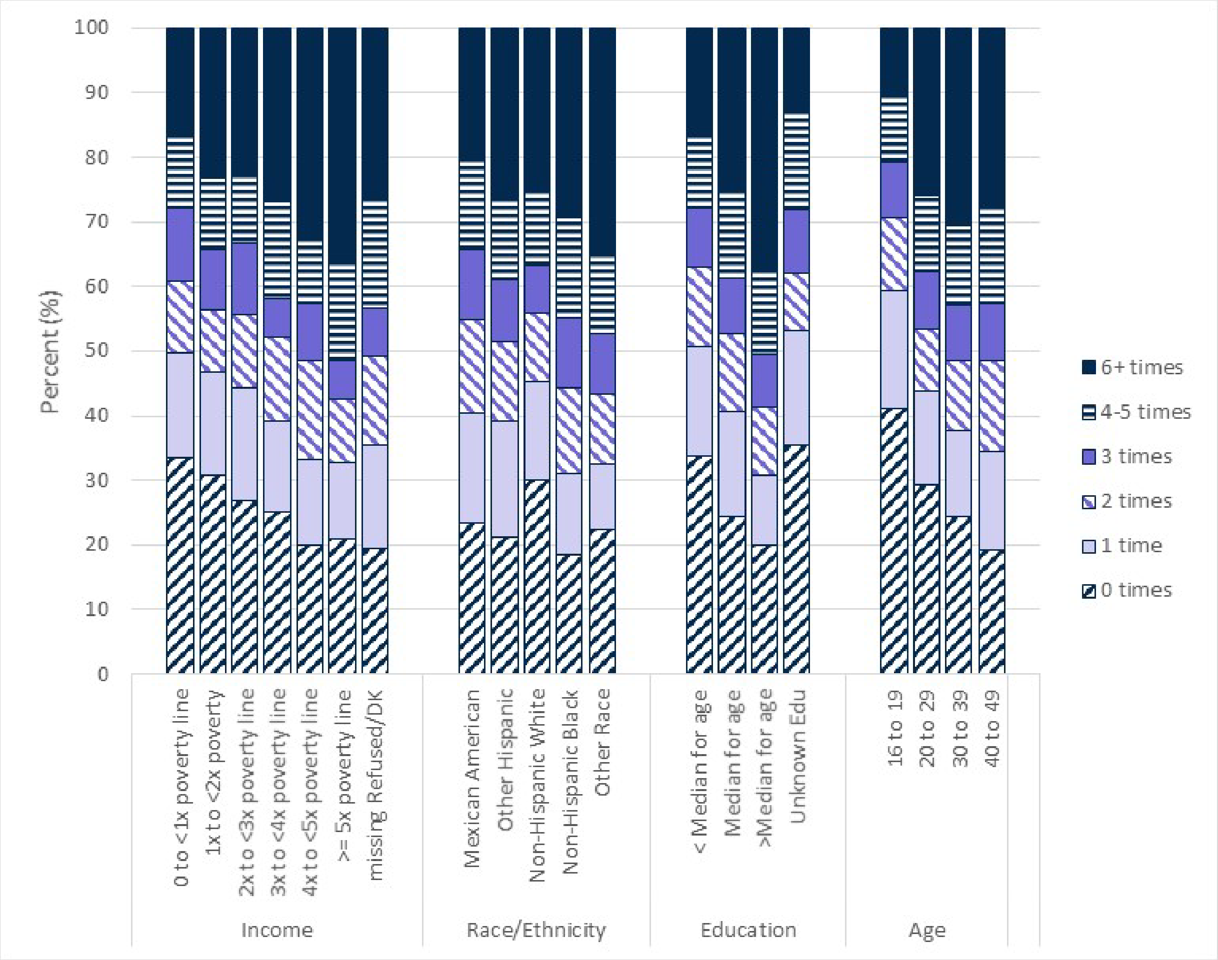


Note: Data for Figure 5b is in Table A.4b in Appendix A.

Figure 6a presents the frequency of consumption by income, race/ethnicity, education, and age of NHANES 2013-March 2020. There are significant differences in frequency of total fish consumption between income groups, race/ethnicity, age, and education (Rao-Scott Chi-Square p-values <0.0001). These demographic characteristics were included in the analysis of relationship between fish consumption and intake of mercury with demographic factors. Women with higher income tend to eat fish more frequently. Individuals of “Other Race” eat fish more frequently compared to Mexican American, non-Hispanic White, non-Hispanic Black, and other Hispanic. These findings are consistent with a previous study of NHANES 1999-2010 data (United States Environmental Protection Agency, 2013) shown in Figure 6b. Older age is associated with increased frequency of fish consumption in both studies. Women aged 30-39 years consume fish more frequently than those in other age groups of NHANES 2013-March 2020, while women of 40-49 years consume fish more frequently based on NHANES 1999-2010 (United States Environmental Protection Agency, 2013). Women with higher levels of education are associated with higher frequency of fish consumption based on NHANES 2013-March 2020.

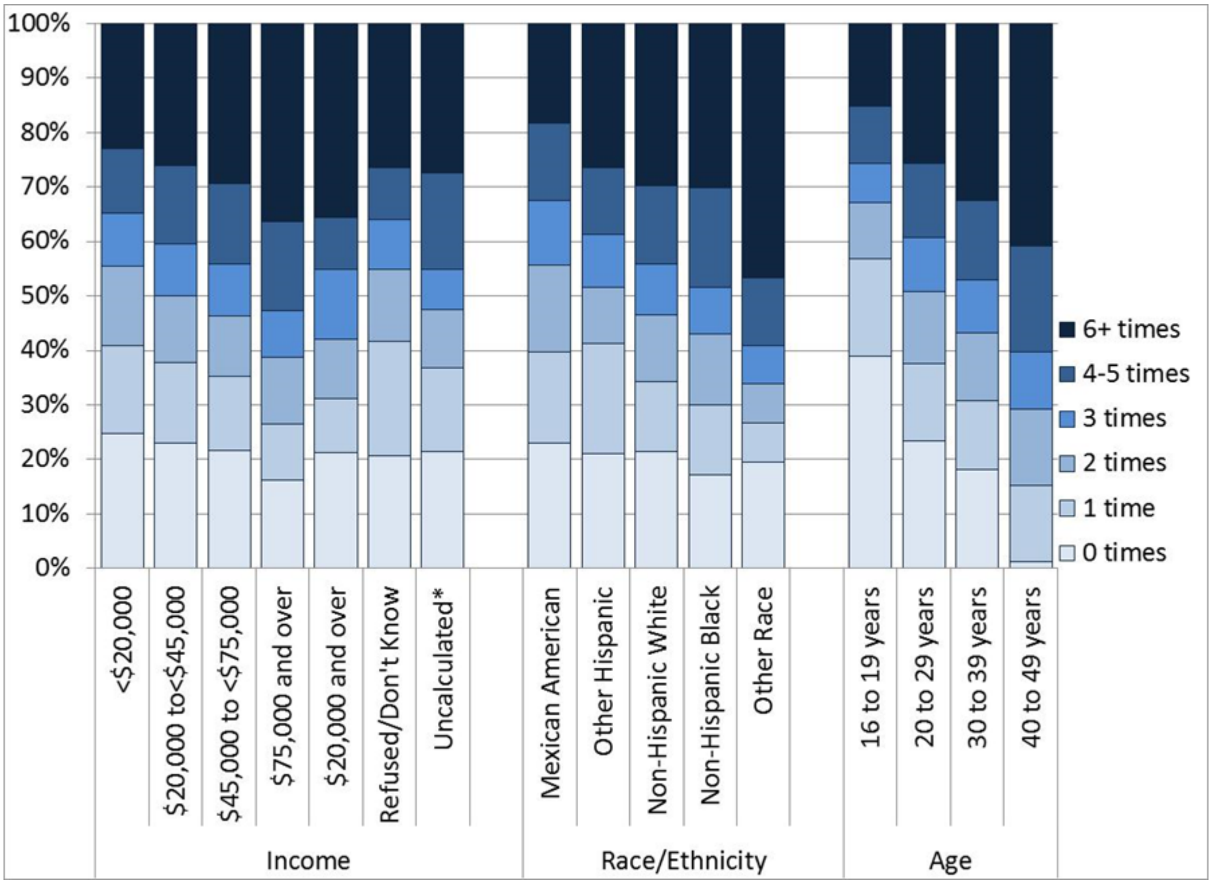
There is a trend of decreasing frequency of fish consumption among women of "Other Race," non-Hispanic White, and ages 30-39 and 40-49. For example, comparing the estimates by race/ethnicity between NHANES 1999-2010 and 2013-March 2020, the percent of women of "Other Race" who reported total fish consumption of 6 or more times decreased from 46.6 percent to 35.4 percent, and the reported frequency of not consuming fish increased from 19.5 percent to 22.3 percent. Similar patterns were also observed in Non-Hispanic White.

Figure 6a. Weighted percent of participants by 30-day total fish consumption frequency, by demographic characteristics, women aged 16-49 years, NHANES 2013-March 2020



Note: Data for Figure 6a is in Table A.4a in Appendix A.

Figure 6b. Weighted percent of participants by 30-day total fish consumption frequency, by demographic characteristics, women aged 16-49 years, NHANES 1999 – 2010



Note: Data for Figure 6b is in Table A.4b in Appendix A.

* Uncalculated indicates that the participant is residing in a multi-family dwelling and one or more of the families only reported a range for their family income, either <$20,000 or >$20,000. Thus NCHS did not calculate household income for these participants.

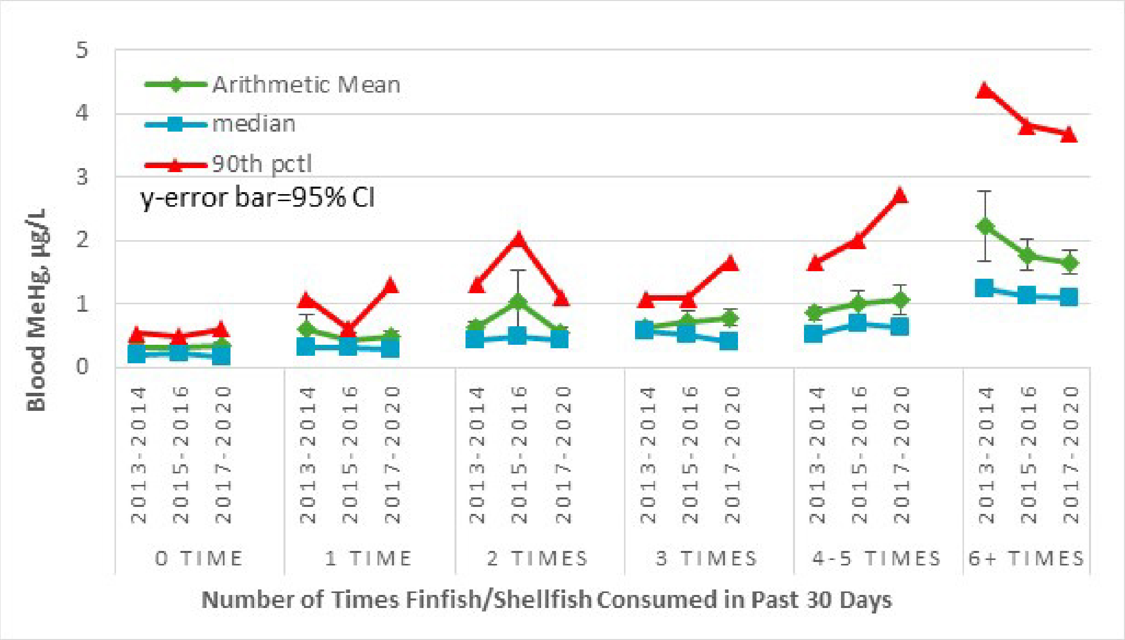
3.3.2 Trends in Estimated Amounts Consumed Over the Previous 30 days

The estimated amounts of fish consumed has remained relatively consistent over the NHANES survey releases from 2013-March 2020. Detailed tabulation of the amounts of fish consumed (in grams [g]), mercury intake (in micrograms [µg]), and mercury intake per unit body weight (µg Hg/kg bw) are tabulated in Tables A.5 through A.7 by NHANES releases, and Table A.8 by race/ethnicity, age, income, and education. While the average amounts of total fish eaten per participant and NHANES release for NHANES 2013-March 2020 (318.8-335.3 g) are at the higher end of those found in NHANES 1999-2010 (254.6-322.5 g) (United States Environmental Protection Agency, 2013), the estimated mercury intake from total fish consumption in NHANES 2013-March 2020 (22.83-25.62 µg) are lower than those of the previous survey releases (29.33-37.40 μg), indicating women probably choose to eat fish with lower mercury concentration. This leads to lower estimates of mercury intake per unit body weight in NHANES 2013-March 2020 (0.32-0.36 μg Hg/kg bw) compared to those found in NHANES 1999-2010 (0.42-0.54 μg Hg/kg bw).

3.3.3 Association Between Fish Consumption Frequency and Blood Mercury

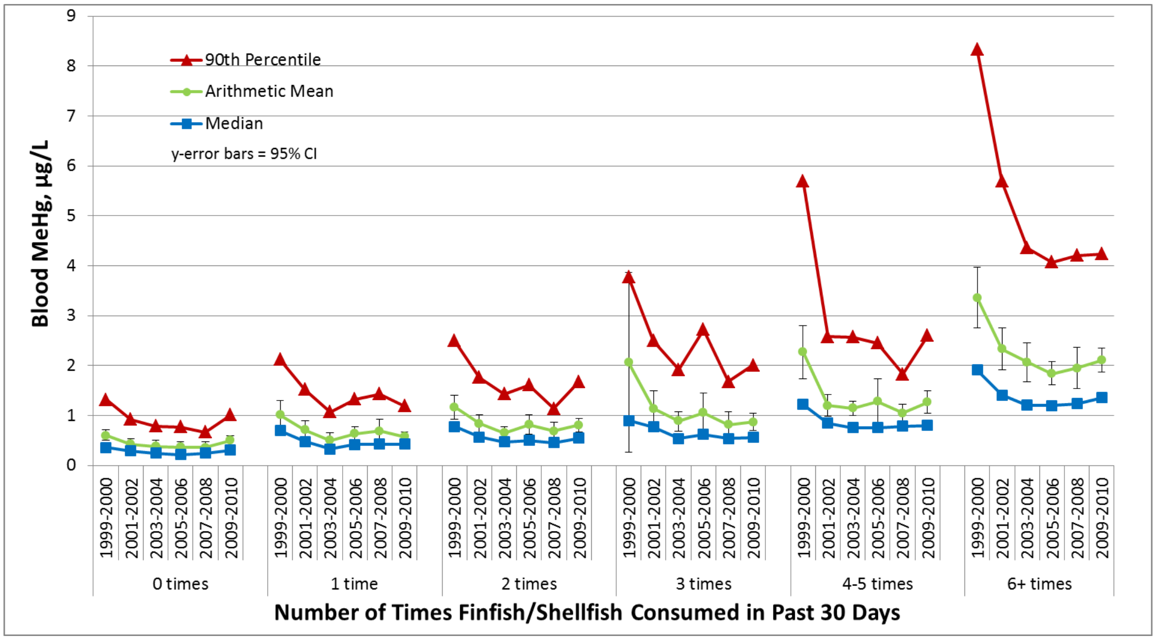
Figure 7a presents the distribution of mean blood MeHg concentrations by the 30-day frequency of total fish consumption and NHANES survey release (2013-March 2020). Detailed tabulations are in Table A.9a. Blood MeHg concentration increases with frequency of fish consumption ($p<0.0001$). This agrees with previous studies that people who eat fish more frequently tend to have higher blood mercury concentrations (Birch *et al.*, 2014; Mahaffey *et al.*, 2004; Mahaffey *et al.*, 2009; United States Environmental Protection Agency, 2013). The distribution of blood MeHg concentrations over time are not consistent by frequency of consumption groups. The arithmetic mean of blood MeHg concentration for women who ate fish six or more times decreases from 2.22 (1.66, 2.77) μg/L in 2013-2014 to 1.66 (1.47, 1.85) μg/L in 2017-March 2020. For women who ate fish two times, the mean blood MeHg concentration in 2005-2006 (1.04(0.55,1.53) μg/L) is higher than that in survey releases 2013-2014 and 2017-March 2020. The blood MeHg concentrations have small variations for those who do not eat fish or ate fish one, three, four and five times. Based on the study of fish consumption of NHANES 1999-2010 as presented in Figure 7b (United States Environmental Protection Agency, 2013), there is statistically significant decreasing trend of blood MeHg concentration over time, indicating that women who consume fish more often may be shifting to fish with lower concentrations of mercury. Detailed tabulations for Figure 7b are in Table A.9b.

Figure 7a. *Mean blood MeHg concentrations by reported frequency of total fish consumption in 30 days, women aged 16-49 years, NHANES 2013-March 2020 (with 95% confidence intervals, median, and 90th percentile)*



Note: Data for Figure 7a is in Table A.9a in Appendix A.

Figure 7b. *Mean blood MeHg concentrations by reported frequency of total fish consumption in 30 days, women aged 16-49 years, NHANES 1999–March 2010 (with 95% confidence intervals, median, and 90th percentile)*



Note: Data for Figure 7b is in Table A.9b in Appendix A.

3.3.4 Relationship Between Fish Consumption and Intake of Mercury with Demographic Factors

This section examines the statistical association between fish consumption and demographic characteristics using the method detailed in *Trend in Blood Mercury Concentrations and Fish Consumption Among U.S. Women of Childbearing Age NHANES 1999-2010* (United States Environmental Protection Agency, 2013). Estimates of the amount of fish consumed in the previous 30 days, mercury intake, and mercury intake per unit body weight were calculated using the method described in section 2.5. Logistic regression was applied to model the probability of a person reporting any fish consumption in the previous 30 days using education, race/ethnicity, income, and age. For those who reported consumption of fish, five regression models were fit to predict fish consumption and mercury intake variables from demographic characteristics. The five variables were (1) mercury intake per unit body weight and the four components of this variable, (2) number of meals in the previous 30 days, (3) amount of fish consumed in a meal, (4) the mercury concentration in the fish consumed calculated as the ratio of mercury intake to fish consumption in the previous 30 days, and (5) the inverse of body weight. The model results are presented in Tables A.10 to A.15.

Figure 8 presents the results from the logistic regression models by education groups of NHANES 2013-March 2020. Education is categorized as less than, equal to, or greater than the median education level for the participant's age for NHANES releases 2013-2014, 2015-2016, and 2017-March 2020, and an additional unknown level for participants 16-19 years in NHANES 2017-March 2020. The percentages in parentheses next to the education group, e.g., <median for age (30%), are the percent of participants categorized in the education group with lower than median education level for age. The grey star and the error bars plotted on the second y-axis are the percent of women who reported fish consumption in the previous 30 days. The remaining colored symbols and error bars are the relative ratios (RR) and 95 percent confidence intervals from the regression models predicting (1) the log-transformed frequency of fish consumption in the previous 30 days (maroon open diamond); (2) the log-transformed amount fish in a meal (meal size, green filled diamond); (3) the log-transformed mercury concentration in the fish consumed (red filled diamond); (4) the log-transformed inverse of body weight (blue filled dot); and (5) the log-transformed mercury intake per unit body weight (black filled square). The horizontal line on the plot at RR=1 represents the geometric mean response for a hypothetical population equally divided among categories for education. This line is used to represent the response for a typical participant. If a symbol

is above the line at RR=1, then that education group is higher than the geometric mean for a typical participant for that fish consumption or mercury intake variable. For example, women with greater than median education level of the participant's age (maroon open diamond of >Median of age) eat fish more frequently than typical women (horizontal line). The blue dot is the RR of the inverse of body weight. A RR less than one indicates higher body weight compared to a typical participant and a RR greater than one indicates lower body weight than typical.

There are significant differences ($p<0.05$) for all fish consumption and mercury intake variables by education except the mercury concentration in fish consumed ($p=0.25$). The percent of women who consumed fish in the previous 30 days and mercury intake per unit body weight increase with increasing known level of education. Women with less than median level education have the lowest mercury intake per body weight: they generally eat fish less frequently, eat a smaller meal size, and have the highest body weight. The proportion of women with unknown education level who consumed fish in the previous 30 days is the highest among all groups. They eat fish more frequently compared to women with less than median level education and median level education; however, their meal size and mercury concentration in fish consumed are the lowest, resulting in relative low mercury intake per unit body weight.

Figure 8. Relative ratios and 95 percent confidence intervals from models predicting fish consumption and mercury intake variables by education, NHANES 2013–March 2020

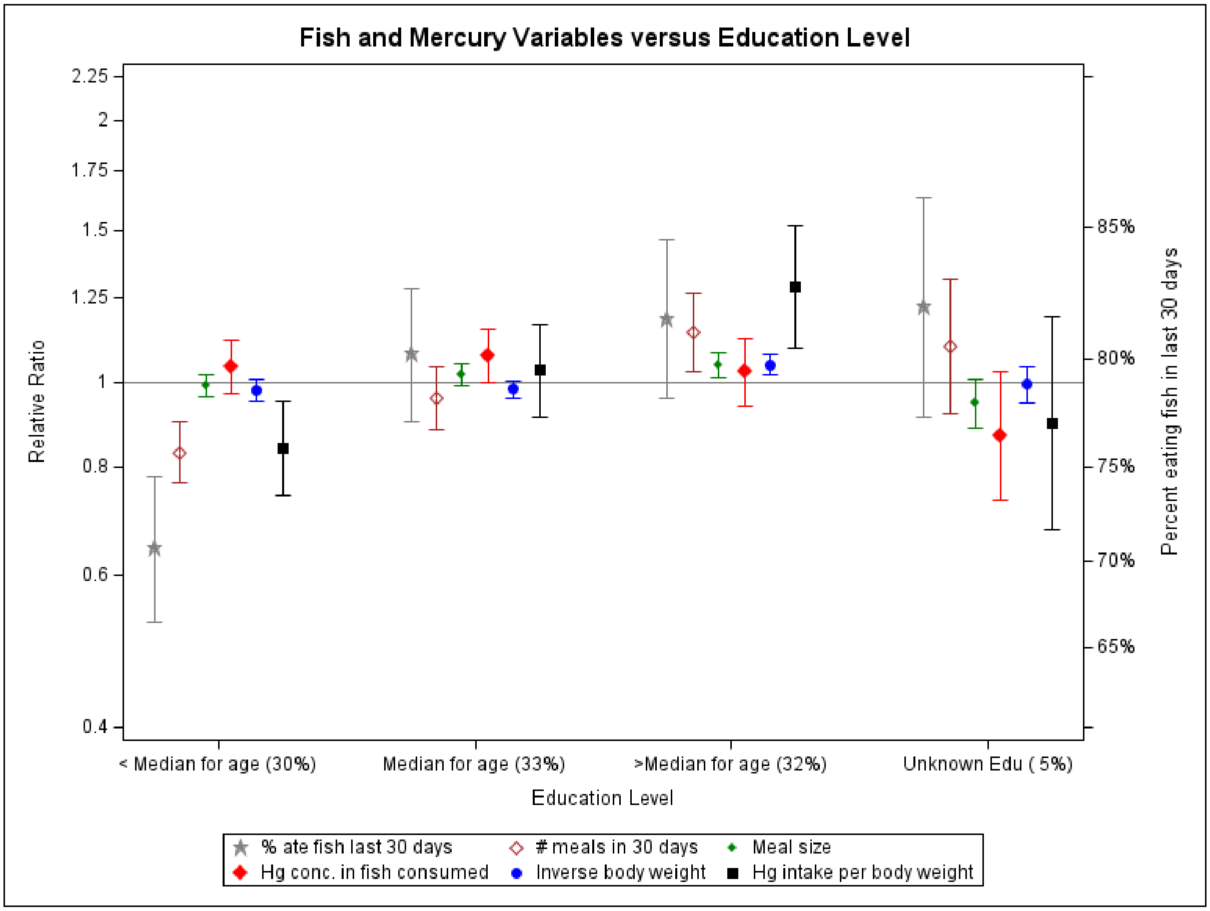


Figure 9a presents the RRs for fish consumption and mercury intake by race/ethnicity of NHANES 2013-March 2020. The p-values testing the overall significance of race/ethnicity in all models is p<0.0001, except for the model of mercury concentration of the fish consumed (p=0.21) and mercury intake per unit body weight (p=0.28). The percent of non-Hispanic Black women who consumed fish in the previous 30 days is higher compared to other racial/ethnic groups while consumption among non-Hispanic White women is lower, which is consistent with that found in NHANES 1999-2010 study (United States Environmental Protection Agency, 2013) presented in Figure 9b.

Figure 9a. *Relative ratios and 95 percent confidence intervals from models predicting fish consumption and mercury intake variables by race/ethnicity, NHANES 2013–March 2020*

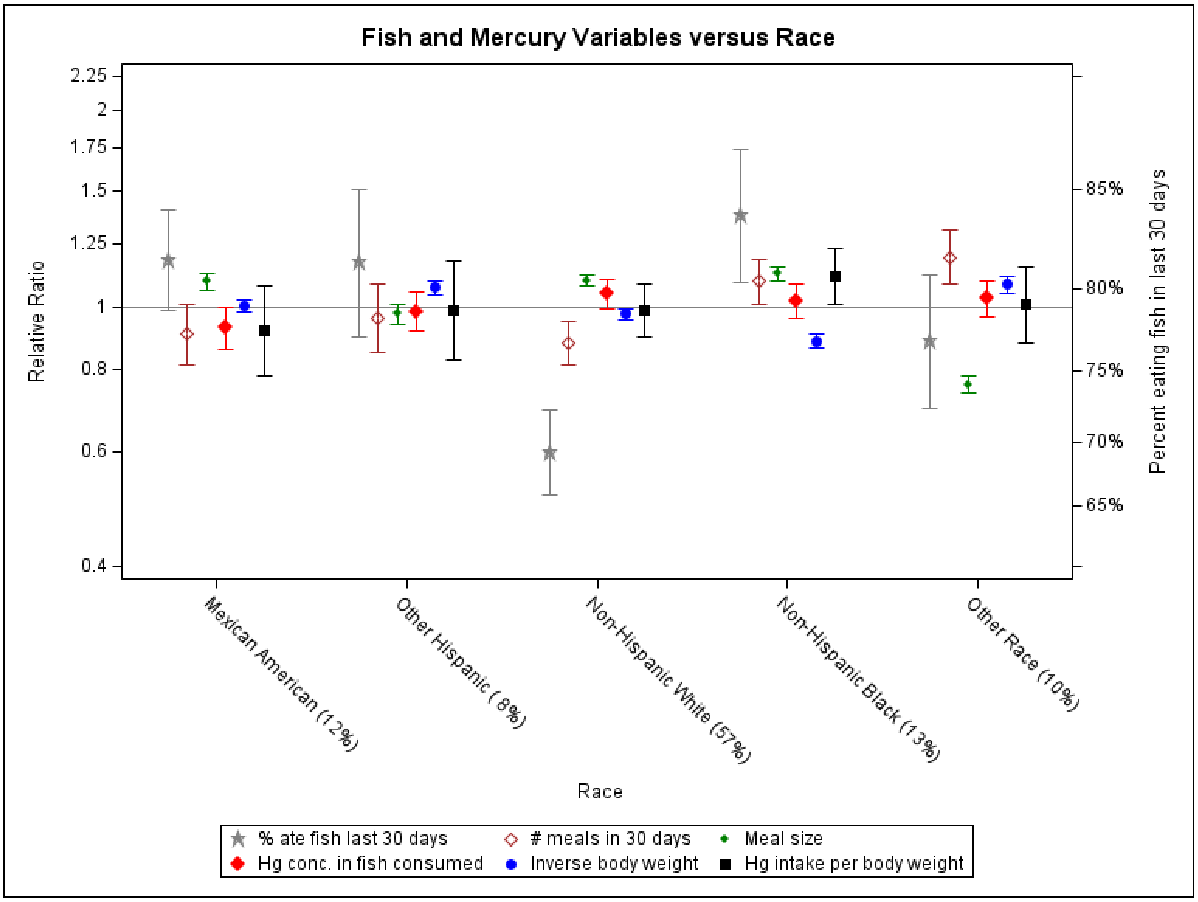
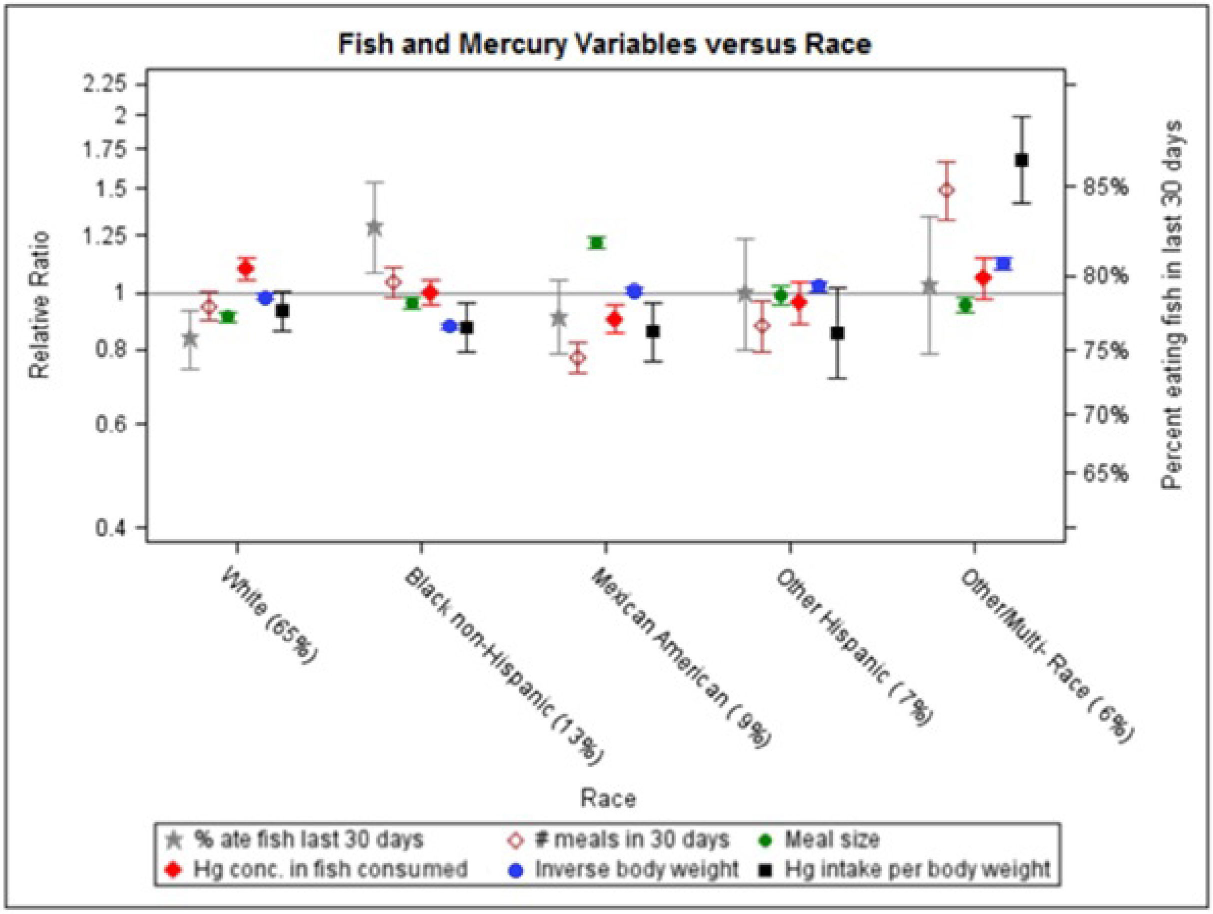


Figure 9b. Relative ratios and 95 percent confidence intervals from models predicting fish consumption and mercury intake variables by race/ethnicity, NHANES 1999–2010



In general, non-Hispanic Black women consume the largest meal size, eat fish more frequently, consume fish with higher mercury concentration, and have higher body weights than a typical woman of childbearing age, resulting in the highest mercury intake per unit body weight of the racial/ethnic groups in NHANES 2013-March 2020. In NHANES 1999-2010 (Figure 9b), non-Hispanic Black women have similar distributions compared to a typical woman of childbearing age except they consume smaller than typical meal size, resulting in a less than typical mercury intake per unit body weight.

In NHANES 2013-March 2020, women who identify as "Other Race" eat fish the most frequently, consume fish with higher mercury concentration, have lower than typical body weight; however, while they consume the smallest meal size, they have a slightly higher than typical mercury intake per unit body weight. In NHANES 1999-2010, women of "Other Race" have the same trends in these fish consumption and mercury intake variables. With a close to typical meal size, they have the largest mercury intake per unit body weight of all racial/ethical groups.

In NHANES 2013-March 2020, non-Hispanic White women generally consume fish the least frequently and have higher than typical body weight; however, they consume larger meals, consume fish with higher than typical concentration of mercury, resulting in a close to typical mercury intake per unit body weight. In NHANES 1999-2010, the fish consumption and mercury intake variables of non-Hispanic White women follow the same trends except they consumed smaller than typical meal size and yield a less than typical mercury intake per unit body weight.

In NHANES 2013-March 2020, Mexican American women consume larger meal sizes; however, they eat less frequently and consumed fish with lower concentration of mercury, resulting in the lowest mercury intake per unit body weight. Other Hispanic women consume fish less frequently, eat smaller meal size, consume fish with lower contraction of mercury, and have lower body weight than a typical woman of childbearing age, resulting in a close to typical mercury intake per unit body weight. The trends of the fish consumption and mercury intake variables compared to values of typical women of childbearing age are similar in Mexican American and other-Hispanic participants of NHANES 1999-2010 (Figure 9b).

Figure 10 presents the RRs for fish consumption and mercury intake variables by income of NHANES 2013-March 2020 survey releases. There are significant differences (p=0.0004) for the proportion of women who consumed fish in the previous 30 days by income. Higher income is associated with higher proportion of women who consumed fish in the previous 30 days in general. Women with income equal to or greater than five times the poverty line consume fish the most frequently, consume larger meal sizes and fish with higher concentration of mercury, and have less than typical body weight, resulting in the highest mercury intake per unit body weight. In the 2013 study of trends in fish consumption among women of childbearing age using NHANES 1999-2010 data (United States Environmental Protection Agency, 2013), income is categorized with different survey variables and therefore not comparable to this study.

Figure 10. *Relative ratios and 95 percent confidence intervals from models predicting fish consumption and mercury intake variables by income, NHANES 2013–March 2020*

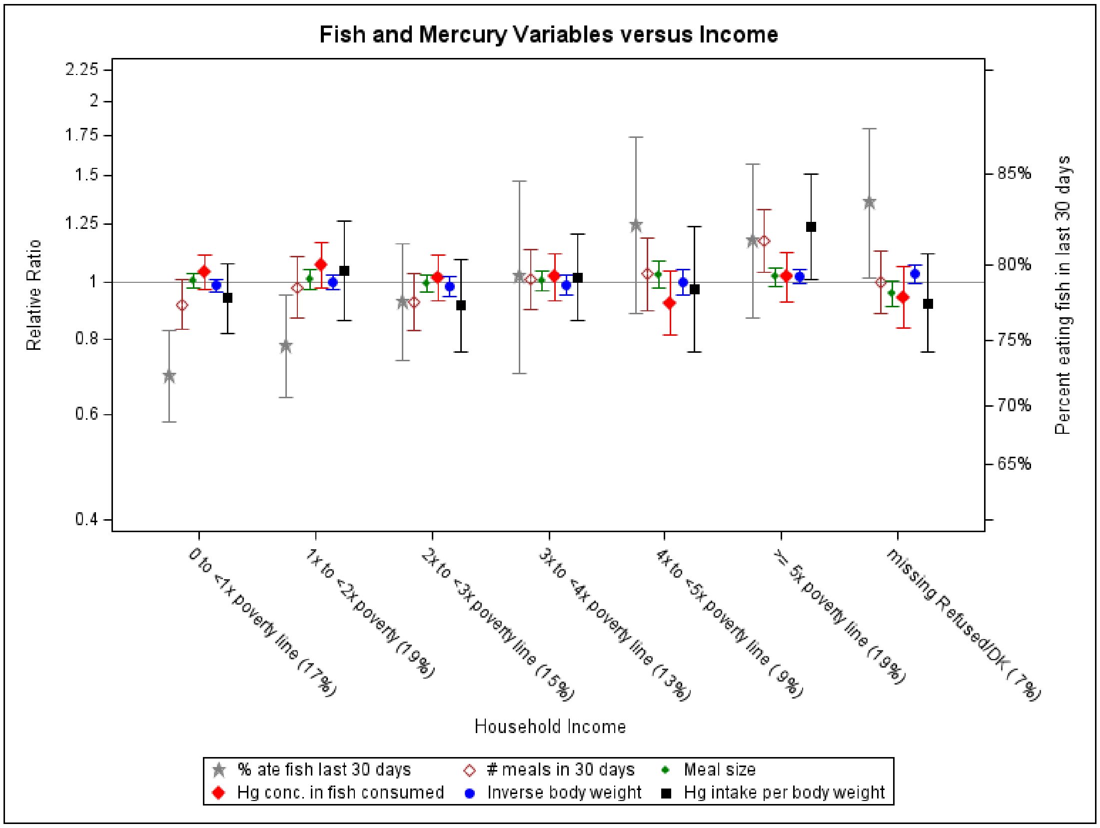


Figure 11a presents the RRs for fish consumption and mercury intake by age group. The p-values testing the overall significance of age group in all models are less than 0.05, except for the models of mercury concentration of the fish consumed (p=0.16) and amount of meal consumed (p=0.29). The proportion of women who consumed fish in the previous 30 days increases with age. As observed in a previous study on trends in blood mercury concentrations and fish consumption among U.S. women of childbearing Age NHANES 1999-2010 (Birch *et al.*, 2014; United States Environmental Protection Agency, 2013) and presented in Figure 11b, women 16-19 years eat fish the least frequently, consume the smallest meal size, have the lowest body weight, and consume fish with the lowest concentration of mercury, resulting in the lowest mercury intake per unit body weight. The value of mercury intake per unit body weight increases with age to the highest level in women 30-39 years and then drops in women 40-49 years to a level comparable to women 20-39 years. Based on NHANES 1999-2010 study (United States Environmental Protection Agency, 2013) women of 40-49 years have the highest intakes of mercury per unit body weight.

Figure 11a. *Relative ratios and 95 percent confidence intervals from models predicting fish consumption and mercury intake variables by age group, NHANES 2013–March 2020*

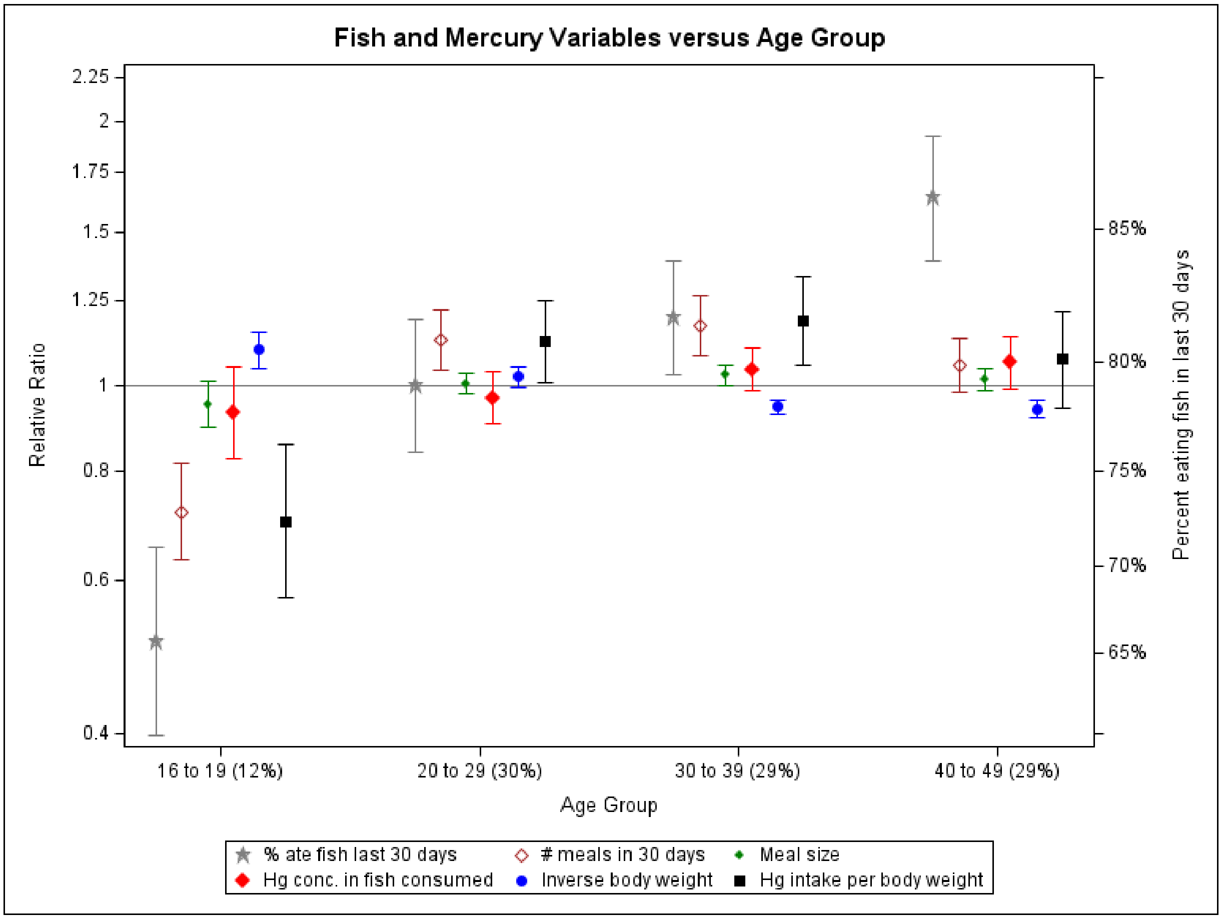
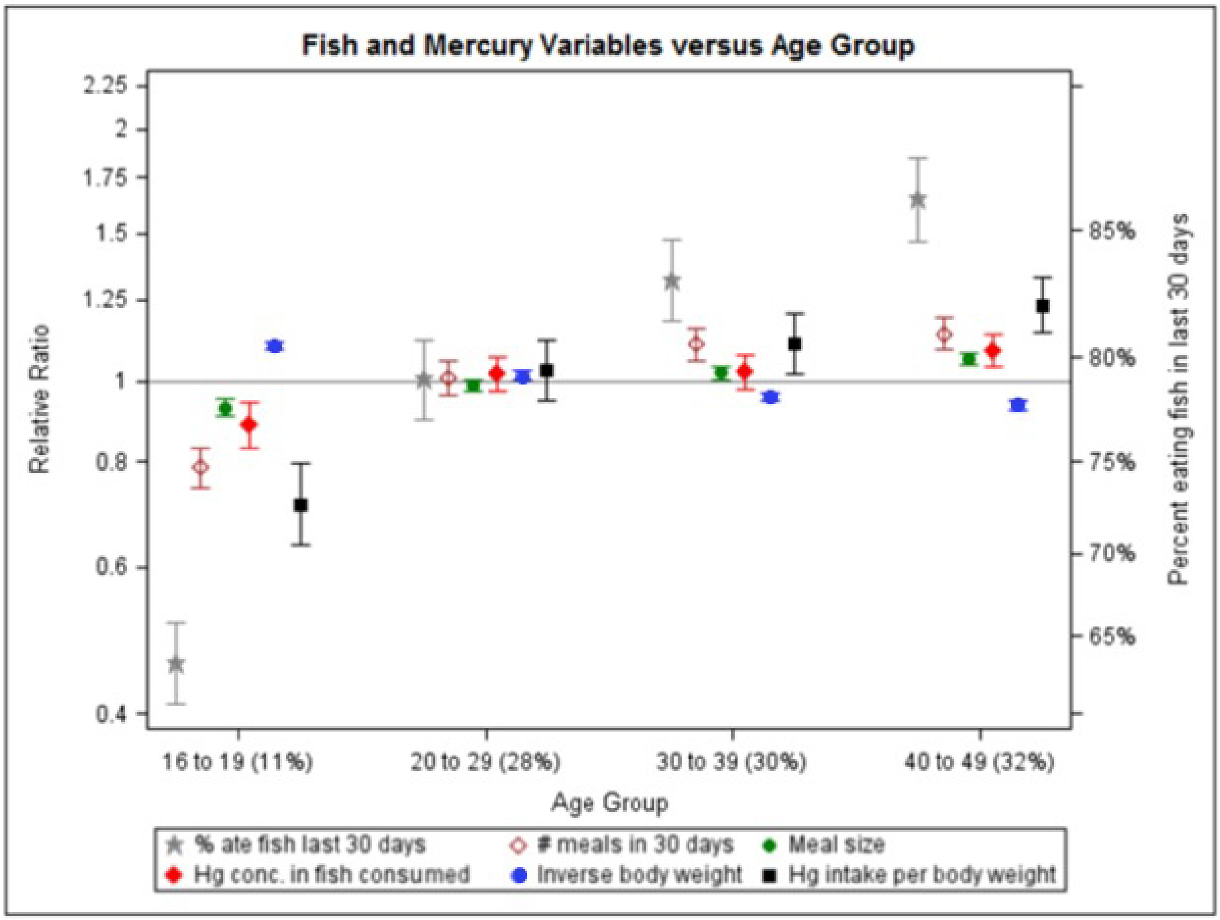


Figure 11b. *Relative ratios and 95 percent confidence intervals from models predicting fish consumption and mercury intake variables by age group, NHANES 1999–2010*



DISCUSSION AND CONCLUSIONS 4

Trends in geometric mean blood MeHg concentrations over time and by demographic characteristics

The results of this study indicate that there is a significant ($p<0.0001$, Table A.3) decreasing trend of blood MeHg concentrations over time across the ten NHANES survey releases (see Figure 1 and Table 3) after controlling for demographic characteristics. The geometric mean blood MeHg concentration is highest in NHANES survey release 1999-2000, then declines to the lowest in NHANES survey release 2017-March 2020. Additionally, the geometric mean blood MeHg concentration in the 2005-2006 release is slightly higher than that in the 2003-2004 and 2007-2008 releases, while the geometric mean blood MeHg in the 2009-2010 release is slightly higher than those in the 2007-2008 and 2011-2012 releases. This does not appear to be a meaningful increase and is likely due to the fluctuations in the data. The geometric mean blood MeHg concentration in NHANES 1999-2000 is 1.94 times higher than the geometric mean in NHANES 2017-March 2020 data, representing a 48 percent decrease between NHANES 1999-2000 and 2017-March 2020. Similar decreasing trends in blood MeHg concentration over time are found in NHANES 1999-2010 (Birch *et al.*, 2014; United States Environmental Protection Agency, 2013). The studies using NHANES 1999-2010 found that the linear time trend in the mean of blood MeHg concentrations was statistically significant ($p=0.006$), but there was no significant trend from 2001 to 2010 ($p=0.74$). With additional NHANES survey releases in this study, excluding survey release 1999-2000 does not change the significance of the linear trend from 2001-March 2020.

The percentages of women of childbearing age with blood MeHg concentrations over 5.8 µg/L in 1999-2000 is about 3.5 times that found in 2001-March 2020, representing a 71 percent decrease. There is a significant difference between the survey releases for blood MeHg concentrations (Rao-Scott Chi-square $p<0.001$), with 1999-2000 having approximately three times the amount of women with levels over 5.8 µg/L compared to the other NHANES releases. However, no significance difference ($p=0.12$) is found between the survey releases after removing survey release NHANES 1999-2000. Similar patterns were found in previous studies of NHANES 1999-2010 (Birch *et al.*, 2014; United States Environmental Protection Agency, 2013).

There are significantly ($p<0.05$) decreasing trends of blood MeHg concentrations over time by most demographic characteristics across these NHANES survey releases 1999-2004, 2005-2010, 2011-2016, and 2017-March 2020. The geometric mean blood MeHg concentration in women of “Other Race” in 1999-2004 is 1.82 times higher than the geometric mean for the same demographic in 2017-March 2020, representing a 45 percent decrease between NHANES 1999-2004 and 2017-March 2020. Within each of these survey release periods, higher blood MeHg concentrations are observed with increasing age, ratio of family income to poverty, education level, and among participants who reported their race as “Other Race.”

Association of blood MeHg concentration with intake and demographic characteristics

A multivariable model is used to investigate the association between MeHg concentration and TUI through fish consumption and other demographic characteristics. The model found the following factors to be significantly associated with blood MeHg are (1) TUI through fish consumption ($p<0.0001$), (2) education ($p=0.0007$), (3) race/ethnicity ($p<0.0001$), (4) NHANES survey release ($p<0.0001$), (5) log-transformed hematocrit ($p=0.005$), and (6) log-transformed body weight ($p=0.002$). In addition, the rate of increase in blood MeHg concentration due to usual intake of mercury varies by education, race/ethnicity, and log-transformed body weight. Household income is marginally significant at the 5 percent level ($p=0.054$) in predicting blood MeHg concentrations.

Geographic differences in blood mercury

The geographic findings of this study (Appendix B) are similar to what was found in previous studies (Cusack *et al.*, 2017; Mahaffey *et al.*, 2009). There are geographic differences in blood MeHg concentrations with higher levels among residents of coastal counties compared to non-coastal counties. Residents of the Northeast region have the highest blood MeHg concentrations of the four regions and residents of the Midwest have the lowest blood MeHg concentrations.

Trends in frequency of fish consumption and the association of fish consumption and mercury intake with demographic characteristics

One limitation of this study is that the analysis of fish consumption over the previous 30 days used data from NHANES 2013-March 2020, and results were compared to a previous study using NHANES 1999-2010 (United States Environmental Protection Agency, 2013). NHANES 2011-2012 was not published during the previous study and was not included in the current study, leaving a gap between the two studies. This gap limits the ability to investigate the trend in fish consumption from 1999 to March 2020.

Blood MeHg concentrations are positively associated with the frequency of fish consumption in both NHANES 2013-March 2020 and NHANES 1999-2010. There are no significant differences in the reported frequency of consumption of fish over the previous 30 days across NHANES survey releases 2013-March 2020 while significant differences of reported frequency of consumption are found across the six NHANES survey releases between 1999 and 2010 (United States Environmental Protection Agency, 2013). The association between the frequency of fish consumption and demographic characteristics are consistent between NHANES 1999-2000 and NHANES 2013-March 2020, respectively. Women of older age and with higher income tend to eat fish more frequently. Individuals of “Other Race” eat fish more frequently compared to Mexican American, non-Hispanic White, non-Hispanic Black, and other Hispanic. Women with higher education levels are found to eat fish more frequently.

The estimated amounts of total fish eaten over the previous 30 days in NHANES 2013-March 2020 are at the higher end of those found in NHANES 1999-2010. The estimated mercury intake from total fish consumption over the previous 30 days in NHANES 2013-March 2020 are lower than those found in NHANES 1999-2010. This suggests that women of childbearing age are probably choosing to eat fish with lower mercury concentration leading to lower estimates of mercury intake per unit body weight in NHANES 2013-March 2020 compared to those found in NHANES 1999-2010.

In addition to continuing to monitor the time trend in blood MeHg and fish consumption, a future study on the geographic distribution of blood MeHg using NHANES releases of 2013-2014 and later would be a valuable supplement to this study, helping to investigate trends in geographic differences in blood MeHg.

QUALITY CONTROL/QUALITY ASSURANCE

5

This section details the steps that were taken to ensure the quality of the results.

The fish tissue mercury concentration database developed for previous EPA studies on trends in blood mercury concentrations and fish consumption was updated with data on fish samples collected from 2013 to 2020. Data were downloaded when they were available online. Other data extracted from peer reviewed journal articles and reports were checked by a second individual to ensure all information were correct.

The NHANES 2003-2010 24-hour recall data were processed to extract all reports of fish consumption for the 2014 U.S. EPA report (United States Environmental Protection Agency, 2014), *Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010)*. At that time, the processing was done independently by two individuals and results were compared. A final program with macros applicable to all NHANES releases in general was created to process NHANES 24-hour dietary recall data. In the study of the geographic distributions of blood mercury concentration (Appendix B) of NHANES 1999-2012, additions were made to that code to include processing of the NHANES 1999-2000, 2001-2002, and 2011-2012 data, based on the code for the NHANES 2003-2010 data. The current analysis is built upon these previous analyses with the addition of NHANES 2013-2014, 2015-2016, and 2017-March 2020 data.

This analysis utilized the software created for the estimation of usual fish consumption rates, the EPA Method, developed for *Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010)* (United States Environmental Protection Agency, 2014). This software has previously undergone quality checks. This analysis also utilized the INDIVINT macro, which is one of three NCI Method programs. It is available from NCI.

The imputation method was evaluated using the NHANES 2011-2012 data on methyl and ethyl mercury.

The models used a large number of potential predictors. These were very useful in avoiding misleading results that may be found in simpler models that do not account for these interrelationships.

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Appendix A

Extended Data Tables

Table A.1. Fish tissue mercury concentrations used in analysis, by species

Species group	µg Hg/g fish	Species group	µg Hg/g fish	Species group	µg Hg/g fish
Swordfish	0.739	*Snapper*	0.106	*Herring/Shad*	0.042
Barracuda	0.483	*Catfish*	0.090	*Smelt*	0.036
Shark	0.410	*Fish, not specified*	0.083	*Salmon*	0.036
Ray	0.410	*Haddock*	0.066	*Mullet*	0.032
Mackerel	0.311	*Cod*	0.065	[3]*Shellfish, not specified*	0.029
Tuna (Fresh/Frozen)	0.281	*Crab*	0.064	*Octopus*	0.017
Pike	0.229	*Croaker*	0.058	*Abalone*	0.016
Pompano/Mahi Mahi	0.190	*Trout*	0.056	*Sardine*	0.016
Perch/Bass/Walleye/ Bluegill	0.179	*Whitefish*	0.054	*Anchovy*	0.016
Lobster	0.173	*Crayfish*	0.053	*Mussel*	0.015
Halibut	0.170	*Whiting*	0.052	*Scallop*	0.015
Rockfish/Redfish/Orange Roughy	0.169	*Flatfish*	0.050	*Shrimp*	0.014
Sea Bass	0.165	*Squid*	0.049	*Oyster*	0.014
Eel	0.152	*Breaded Fish Products*	0.047	*Clam*	0.011
[1]*Tuna*	0.123	*Conch*	0.047	*Pollock*	0.011
Sturgeon	0.122	*Snail*	0.047	*Jellyfish*	0.010
Tuna (Canned)	0.113	[2]*Other shellfish*	0.047	*Tilapia*	0.010
Carp/Sucker	0.109	*Porgy/Scup*	0.046	*Caviar/Roe*	0.000

[1] Tuna, weighted mean of Tuna (Fresh/Frozen) and Tuna (Canned).

[2] Other shellfish, weighted mean of abalone, conch, jellyfish, octopus, squid, and snail.

[3] Shellfish, NS (non-specified), weighted mean of abalone, clam, conch, crayfish, jellyfish, lobster, mussel, octopus, oyster, scallop, shrimp, squid, crab, and snail.

Table A.2. Distribution of blood MeHg concentrations (µg/L), by NHANES survey releases, age, income, and race/ethnicity, women aged 16-49 years, NHANES 2013-March 2020

	N	Arithmetic mean (95% CI)	Geometric mean (95% CI)	Selected percentiles (95% CI)				
				25th	50th	75th	90th	95th
NHANES Survey Release								
1999-2000	1632	1.83 (1.43, 2.22)	0.93 (0.78, 1.12)	0.41 (0.31, 0.51)	0.89 (0.68, 1.09)	1.88 (1.16, 2.60)	4.56 (3.25, 5.86)	6.82 (3.57, 10.07)
2001-2002	1799	1.30 (1.13, 1.47)	0.72 (0.65, 0.79)	0.34 (0.29, 0.38)	0.70 (0.60, 0.79)	1.46 (1.23, 1.70)	2.92 (2.56, 3.28)	4.42 (3.44, 5.39)
2003-2004	1615	1.06 (0.91, 1.22)	0.53 (0.45, 0.61)	0.24 (0.19, 0.29)	0.52 (0.40, 0.64)	1.21 (0.98, 1.44)	2.60 (2.00, 3.19)	3.77 (2.87, 4.67)
2005-2006	1788	1.13 (0.99, 1.27)	0.58 (0.51, 0.66)	0.25 (0.18, 0.32)	0.63 (0.52, 0.73)	1.33 (1.07, 1.59)	2.71 (2.19, 3.23)	3.99 (2.93, 5.05)
2007-2008	1486	0.99 (0.84, 1.13)	0.52 (0.46, 0.59)	0.25 (0.20, 0.29)	0.51 (0.43, 0.59)	1.06 (0.82, 1.30)	2.39 (1.81, 2.97)	3.46 (2.70, 4.23)
2009-2010	1780	1.18 (1.08, 1.29)	0.67 (0.61, 0.73)	0.31 (0.26, 0.37)	0.64 (0.53, 0.74)	1.38 (1.15, 1.61)	2.73 (2.41, 3.04)	4.03 (3.50, 4.55)
2011-2012	1428	0.93 (0.75, 1.11)	0.52 (0.44, 0.60)	0.23 (0.20, 0.26)	0.45 (0.37, 0.54)	0.98 (0.65, 1.32)	2.32 (1.66, 2.99)	3.31 (2.22, 4.41)
2013-2014	814	0.98 (0.84, 1.12)	0.50 (0.45, 0.55)	0.23 (0.18, 0.28)	0.43 (0.37, 0.49)	0.94 (0.78, 1.11)	2.21 (1.62, 2.80)	3.66 (3.13, 4.20)
2015-2016	740	0.90 (0.80, 1.01)	0.50 (0.45, 0.56)	0.24 (0.21, 0.27)	0.44 (0.37, 0.51)	0.94 (0.77, 1.10)	2.19 (1.71, 2.68)	3.38 (2.79, 3.96)
2017-2020	2154	0.87 (0.75, 0.98)	0.48 (0.43, 0.54)	0.18 (0.15, 0.21)	0.43 (0.36, 0.50)	1.01 (0.79, 1.22)	1.99 (1.54, 2.44)	3.06 (2.29, 3.83)
Race/Ethnicity								
Mexican American	3396	0.69 (0.65, 0.73)	0.44 (0.42, 0.46)	0.24 (0.23, 0.26)	0.42 (0.39, 0.45)	0.80 (0.74, 0.85)	1.44 (1.33, 1.56)	2.09 (1.77, 2.41)
Other Hispanic	1259	1.16 (1.00, 1.31)	0.66 (0.62, 0.71)	0.31 (0.28, 0.34)	0.65 (0.59, 0.71)	1.39 (1.24, 1.54)	2.60 (2.27, 2.92)	3.68 (3.02, 4.34)
Non-Hispanic White	5725	1.05 (0.98, 1.11)	0.54 (0.51, 0.57)	0.23 (0.22, 0.25)	0.51 (0.47, 0.54)	1.17 (1.09, 1.24)	2.54 (2.27, 2.82)	3.84 (3.52, 4.17)
Non-Hispanic Black	3497	1.13 (1.05, 1.21)	0.66 (0.62, 0.70)	0.32 (0.30, 0.34)	0.64 (0.60, 0.69)	1.27 (1.16, 1.37)	2.38 (2.10, 2.66)	3.61 (3.19, 4.03)
Other Race	1359	2.01 (1.85, 2.17)	0.95 (0.88, 1.03)	0.34 (0.29, 0.38)	0.94 (0.82, 1.06)	2.50 (2.18, 2.83)	5.27 (4.64, 5.90)	7.64 (6.26, 9.01)
Age, Years								
16 to 19	3349	0.63 (0.59, 0.68)	0.36 (0.35, 0.38)	0.16 (0.15, 0.17)	0.33 (0.30, 0.35)	0.69 (0.63, 0.75)	1.46 (1.32, 1.60)	2.10 (1.94, 2.26)
20 to 29	4111	0.97 (0.91, 1.03)	0.52 (0.49, 0.55)	0.23 (0.20, 0.25)	0.49 (0.45, 0.53)	1.12 (1.01, 1.22)	2.34 (2.14, 2.55)	3.43 (3.01, 3.84)
30 to 39	3943	1.22 (1.13, 1.32)	0.63 (0.60, 0.66)	0.28 (0.26, 0.29)	0.60 (0.56, 0.65)	1.34 (1.22, 1.45)	2.92 (2.54, 3.29)	4.30 (3.79, 4.81)
40 to 49	3833	1.27 (1.19, 1.34)	0.68 (0.65, 0.72)	0.32 (0.30, 0.34)	0.65 (0.60, 0.69)	1.39 (1.28, 1.51)	3.03 (2.75, 3.30)	4.31 (4.00, 4.62)
Annual Income								
0 to <1x poverty line	3814	0.79 (0.73, 0.85)	0.44 (0.42, 0.47)	0.22 (0.20, 0.24)	0.41 (0.38, 0.45)	0.84 (0.78, 0.90)	1.67 (1.49, 1.84)	2.74 (2.41, 3.07)
1x to <2x poverty	3556	0.83 (0.78, 0.88)	0.46 (0.44, 0.48)	0.22 (0.20, 0.24)	0.43 (0.40, 0.46)	0.90 (0.83, 0.97)	1.76 (1.59, 1.94)	2.74 (2.40, 3.07)
2x to <3x poverty line	1995	1.00 (0.92, 1.08)	0.53 (0.50, 0.57)	0.25 (0.23, 0.27)	0.50 (0.46, 0.54)	1.11 (0.98, 1.24)	2.40 (2.17, 2.63)	3.31 (2.78, 3.85)
3x to <4x poverty line	1580	1.06 (0.98, 1.14)	0.57 (0.53, 0.61)	0.25 (0.21, 0.28)	0.56 (0.50, 0.62)	1.17 (1.05, 1.28)	2.54 (2.18, 2.90)	3.74 (3.33, 4.15)
4x to <5x poverty line	1102	1.15 (1.04, 1.27)	0.62 (0.57, 0.66)	0.29 (0.26, 0.32)	0.59 (0.51, 0.68)	1.25 (1.11, 1.38)	2.71 (2.19, 3.23)	4.36 (3.35, 5.38)
>= 5x poverty line	2051	1.66 (1.55, 1.78)	0.89 (0.83, 0.94)	0.39 (0.34, 0.43)	0.92 (0.84, 1.01)	2.02 (1.80, 2.24)	3.98 (3.66, 4.30)	5.90 (5.03, 6.77)
Missing/Refused/ DK	1138	1.25 (1.08, 1.42)	0.64 (0.58, 0.71)	0.27 (0.24, 0.31)	0.57 (0.50, 0.65)	1.47 (1.14, 1.79)	3.01 (2.20, 3.83)	4.51 (3.28, 5.74)
Education								
<Median education for age	6139	0.89 (0.83, 0.94)	0.47 (0.45, 0.49)	0.22 (0.21, 0.24)	0.43 (0.40, 0.46)	0.92 (0.86, 0.98)	1.83 (1.67, 1.99)	2.91 (2.58, 3.24)
Median education for age	5313	0.98 (0.93, 1.03)	0.55 (0.52, 0.57)	0.25 (0.24, 0.27)	0.53 (0.49, 0.56)	1.13 (1.05, 1.21)	2.25 (2.04, 2.46)	3.25 (2.98, 3.53)
>Median education for age	3411	1.52 (1.42, 1.62)	0.80 (0.75, 0.85)	0.35 (0.31, 0.38)	0.79 (0.72, 0.87)	1.82 (1.63, 2.01)	3.78 (3.53, 4.04)	5.33 (4.69, 5.97)
Unknown education	373	0.51 (0.42, 0.61)	0.33 (0.29, 0.38)	0.16 (0.15, 0.17)	0.27 (0.21, 0.34)	0.58 (0.45, 0.72)	1.10 (0.65, 1.55)	1.61 (,)[a]

[a] Missing confidence interval because of stratum with single sampling unit.

Table A.3. Regression parameter estimates and p-values from models predicting log-transformed blood MeHg concentrations

Dependent variable	**Log-transformed MeHg**						
Parameter	**Estimate**	**LCL**	**UCL**	**tValue**	**Probt**	**fValue**	**ProbF**
Intercept	0.8410	0.5293	1.1528	5.3297	0.0000		
Factors affecting the intercept							
Education						**5.6554**	**0.0007**
< Median for age	-0.2932	-0.5570	-0.0293	-2.1952	0.0297		
>Median for age	0.2599	-0.0359	0.5558	1.7356	0.0846		
Unknown education	0.0788	-0.5782	0.7357	0.2369	0.8131		
Median for age	-0.0455	-0.2813	0.1903	-0.3814	0.7034		
Annual Income						**2.0628**	**0.0541**
0 to <1x poverty line	-0.0968	-0.1848	-0.0088	-2.1742	0.0312		
1x to <2x poverty	-0.1135	-0.1999	-0.0270	-2.5935	0.0104		
2x to <3x poverty line	0.0021	-0.1169	0.1212	0.0353	0.9719		
3x to <4x poverty line	-0.0285	-0.1468	0.0898	-0.4758	0.6349		
4x to <5x poverty line	0.1043	-0.0336	0.2422	1.4936	0.1373		
>= 5x poverty line	0.1345	0.0076	0.2614	2.0942	0.0379		
Missing/Refused/DK	-0.0022	-0.1654	0.1610	-0.0262	0.9791		
Race/Ethnicity						**6.6549**	**2.37E-05**
Mexican American	-0.4295	-0.6110	-0.2480	-4.6743	0.0000		
Other Hispanic	0.1070	-0.1179	0.3318	0.9399	0.3488		
Non-Hispanic White	0.4437	0.1775	0.7099	3.2926	0.0012		
Non-Hispanic Black	-0.0661	-0.2674	0.1352	-0.6487	0.5175		
Other Race	-0.0551	-0.3539	0.2437	-0.3642	0.7162		
NHANES Survey release						**6.0979**	**1.28E-08**
1999-2000	0.4773	0.3125	0.6422	5.7200	0.0000		
2001-2002	0.0918	-0.0898	0.2734	0.9991	0.3193		
2003-2004	-0.1155	-0.2421	0.0111	-1.8028	0.0734		
2005-2006	-0.0901	-0.2296	0.0495	-1.2754	0.2041		
2007-2008	0.0132	-0.1029	0.1292	0.2243	0.8228		
2009-2010	0.1350	0.0166	0.2534	2.2534	0.0257		
2011-2012	-0.1197	-0.2953	0.0559	-1.3462	0.1802		
2013-2014	-0.1850	-0.2957	-0.0742	-3.3010	0.0012		
2015-2016	-0.0640	-0.2403	0.1123	-0.7169	0.4745		
2017-2020	-0.1431	-0.2852	-0.0011	-1.9909	0.0483		
Age, decade (centered)	0.0212	-0.0290	0.0714	0.8328	0.4063		
Log-transformed body weight (centered)	-0.7472	-1.2101	-0.2843	-3.1887	0.0017		
Log-transformed hematocrit (centered)	1.8543	0.5673	3.1413	2.8462	0.0050		
Age, decade (centered)*log-transformed body weight (centered)	-0.0769	-0.2327	0.0789	-0.9753	0.3310		

Dependent variable	**Log-transformed MeHg**						
Parameter	**Estimate**	**LCL**	**UCL**	**tValue**	**Probt**	**fValue**	**ProbF**
Factors Predicting the Slope for Transformed Usual Fish Intake							
Transformed usual fish intake	1.5657	1.3056	1.8258	11.8926	0.0000		
Transformed usual fish intake*log-transformed body weight (centered)	-0.6468	-1.0244	-0.2691	-3.3839	0.0009		
Transformed usual fish intake*log-transformed hematocrit (centered)	0.8567	-0.2088	1.9222	1.5885	0.1143		
Transformed usual fish intake*Race/Ethnicity						**8.4232**	**8.63E-07**
Transformed usual fish intake*Mexican American	-0.2898	-0.4434	-0.1361	-3.7279	0.0003		
Transformed usual fish intake*Other Hispanic	-0.0686	-0.2514	0.1141	-0.7422	0.4591		
Transformed usual fish intake*Non-Hispanic White	0.5229	0.3130	0.7328	4.9212	0.0000		
Transformed usual fish intake*Non-Hispanic Black	-0.1758	-0.3507	-0.0010	-1.9865	0.0488		
Transformed usual fish intake*Other Race	0.0113	-0.2342	0.2569	0.0911	0.9276		
Transformed usual fish intake*Education						**3.7225**	**0.0109**
Transformed usual fish intake*< Median for age	-0.1855	-0.3953	0.0243	-1.7470	0.0827		
Transformed usual fish intake*>Median for age	0.1903	-0.0485	0.4290	1.5741	0.1175		
Transformed usual fish intake*Unknown Edu	0.0261	-0.5024	0.5547	0.0977	0.9223		
Transformed usual fish intake*Median for age	-0.0309	-0.2208	0.1589	-0.3221	0.7479		
TUIV	-0.0177	-0.1347	0.0993	-0.2986	0.7657		

Note: p-values in bold are for the F-Test for differences across categories in categorical predictors.

Table A.4a. Weighted percentages and their standard errors for categorized reports of 30-day frequency of consumption of fish, by NHANES survey releases, income, race/ethnicity, age, and education, women aged 16-49 years, NHANES 2013-March 2020

Parameter		**Percent (standard error)**						
		N	**0 times**	**1 time**	**2 times**	**3 times**	**4-5 times**	**6+ times**
NHANES Survey Release								
Total Fish	2013-2014	814	27.2 (2.4)	16.0 (2.0)	11.6 (1.2)	8.9 (1.1)	9.8 (1.4)	26.4 (2.2)
	2015-2016	740	26.5 (2.1)	15.2 (1.3)	10.1 (2.0)	7.8 (1.1)	14.9 (1.4)	25.5 (2.5)
	2017-March 2020	2,154	25.5 (1.6)	13.8 (1.1)	12.4 (1.2)	9.0 (0.9)	13.3 (1.1)	26.1 (2.1)
Finfish Only	2013-2014	814	39.3 (2.6)	19.0 (2.2)	11.2 (1.2)	7.4 (1.1)	8.3 (1.4)	14.7 (1.4)
	2015-2016	740	38.0 (1.9)	17.1 (1.7)	12.6 (1.6)	8.7 (1.4)	10.9 (1.7)	12.8 (1.5)
	2017-March 2020	2,154	37.8 (1.3)	15.4 (1.2)	14.6 (1.0)	8.7 (0.6)	10.2 (1.1)	13.3 (0.9)
Shellfish Only	2013-2014	814	49.3 (2.6)	16.0 (1.2)	13.3 (1.0)	6.1 (1.1)	6.9 (1.3)	8.4 (1.6)
	2015-2016	740	49.1 (4.0)	17.9 (2.2)	12.3 (1.4)	5.6 (1.2)	6.2 (0.9)	9.0 (1.3)
	2017-March 2020	2,154	47.6 (3.1)	17.7 (1.1)	11.2 (0.9)	8.2 (1.2)	8.1 (1.4)	7.3 (1.0)
Income								
Total Fish	0 to <1x poverty line	876	33.5 (1.8)	16.1 (1.4)	11.3 (1.4)	11.1 (1.5)	11.1 (1.4)	16.9 (1.9)
	1x to <2x poverty line	856	30.8 (2.1)	15.9 (1.9)	9.6 (1.4)	9.5 (1.3)	11.2 (1.3)	23.1 (2.0)
	2x to <3x poverty line	516	27.0 (2.6)	17.3 (2.3)	11.3 (1.8)	11.2 (1.8)	10.9 (1.8)	22.3 (2.1)
	3x to <4x poverty line	368	25.2 (3.9)	14.0 (2.4)	12.9 (2.3)	6.0 (1.3)	15.2 (2.2)	26.8 (4.1)
	4x to <5x poverty line	251	20.0 (3.1)	13.1 (2.5)	15.3 (3.3)	8.8 (2.3)	10.5 (2.3)	32.2 (4.4)
	>= 5x poverty line	498	21.0 (2.5)	11.7 (2.1)	10.1 (1.6)	5.8 (1.4)	15.1 (1.9)	36.4 (2.9)
	Missing/Refused/DK	343	19.5 (2.5)	15.9 (2.5)	13.9 (2.9)	7.3 (1.9)	16.8 (3.3)	26.6 (3.6)
Finfish Only	0 to <1x poverty line	876	45.5 (1.9)	17.6 (1.6)	13.1 (1.4)	8.0 (1.3)	5.6 (0.8)	10.2 (1.4)
	1x to <2x poverty line	856	42.1 (2.2)	17.0 (1.8)	11.9 (1.7)	8.7 (1.0)	9.4 (1.2)	10.9 (1.4)
	2x to <3x poverty line	516	40.1 (2.7)	20.8 (2.9)	13.7 (1.9)	4.9 (0.8)	8.5 (1.5)	12.0 (1.8)
	3x to <4x poverty line	368	37.0 (3.9)	16.1 (2.6)	11.1 (1.9)	9.7 (2.1)	11.8 (2.5)	14.3 (3.0)
	4x to <5x poverty line	251	32.0 (3.8)	15.1 (3.2)	15.5 (3.4)	8.7 (1.9)	11.1 (3.0)	17.5 (3.2)
	>= 5x poverty line	498	31.9 (2.7)	14.1 (2.1)	12.1 (2.0)	10.6 (1.6)	12.4 (2.1)	18.9 (1.8)
	Missing/Refused/DK	343	34.3 (3.2)	18.3 (2.3)	17.4 (3.2)	6.3 (1.5)	12.6 (2.5)	11.0 (2.3)
Shellfish Only	0 to <1x poverty line	876	56.5 (2.4)	16.6 (1.3)	9.2 (1.2)	7.0 (1.1)	6.0 (1.0)	4.6 (0.8)
	1x to <2x poverty line	856	54.2 (2.7)	18.2 (1.8)	10.1 (1.2)	5.0 (0.9)	5.9 (0.8)	6.6 (1.3)
	2x to <3x poverty line	516	49.4 (3.1)	16.5 (2.6)	14.0 (2.1)	6.6 (1.5)	6.2 (1.3)	7.2 (1.4)
	3x to <4x poverty line	368	48.4 (4.5)	17.5 (3.0)	15.8 (2.5)	3.2 (0.9)	7.9 (2.1)	7.2 (2.1)
	4x to <5x poverty line	251	44.0 (4.3)	19.5 (3.6)	9.9 (1.9)	8.5 (2.7)	9.4 (2.2)	8.6 (2.3)
	>= 5x poverty line	498	39.6 (3.5)	16.0 (2.3)	13.8 (2.0)	7.4 (1.3)	9.8 (2.3)	13.4 (1.9)
	Missing/Refused/DK	343	41.4 (3.9)	18.1 (2.6)	12.5 (2.4)	14.4 (2.9)	4.7 (1.1)	8.8 (2.1)

Parameter			Percent (standard error)					
		N	0 times	1 time	2 times	3 times	4-5 times	6+ times
Race/Ethnicity								
Total Fish	Mexican American	624	23.4 (1.8)	16.9 (1.7)	14.6 (1.5)	10.8 (1.4)	14.5 (1.5)	19.9 (2.1)
	Other Hispanic	380	21.2 (2.3)	17.8 (2.1)	12.4 (2.9)	9.6 (1.4)	12.7 (2.8)	26.3 (2.9)
	Non-Hispanic White	1,199	30.0 (1.7)	15.4 (1.2)	10.4 (1.3)	7.5 (0.9)	11.8 (1.3)	24.8 (1.7)
	Non-Hispanic Black	877	18.4 (2.1)	12.5 (1.1)	13.4 (1.3)	10.7 (1.2)	15.6 (1.4)	29.4 (2.5)
	Other Race	628	22.3 (2.1)	10.1 (1.5)	11.0 (1.3)	9.2 (1.6)	12.1 (2.1)	35.4 (2.7)
Finfish Only	Mexican American	624	40.5 (2.2)	20.2 (1.7)	14.5 (1.3)	8.9 (1.3)	6.0 (1.2)	9.9 (1.9)
	Other Hispanic	380	34.5 (2.3)	20.5 (1.9)	13.8 (2.0)	7.8 (1.7)	8.9 (1.3)	14.5 (2.0)
	Non-Hispanic White	1,199	41.4 (1.5)	16.0 (1.3)	12.2 (1.1)	7.2 (0.8)	10.5 (1.1)	12.7 (1.0)
	Non-Hispanic Black	877	31.8 (2.2)	16.7 (1.8)	16.7 (1.4)	9.8 (1.4)	10.1 (1.2)	14.8 (2.0)
	Other Race	628	29.2 (2.2)	15.7 (1.5)	10.9 (1.3)	12.6 (2.2)	11.2 (1.6)	20.3 (2.2)
Shellfish Only	Mexican American	624	39.8 (2.2)	24.5 (1.6)	15.4 (1.4)	8.3 (1.3)	7.7 (1.0)	4.2 (1.0)
	Other Hispanic	380	43.9 (2.7)	21.6 (2.3)	12.0 (1.7)	6.7 (1.3)	7.1 (1.5)	8.6 (2.2)
	Non-Hispanic White	1,199	53.1 (2.9)	16.2 (1.4)	10.7 (1.0)	6.3 (1.1)	6.9 (1.2)	6.7 (0.8)
	Non-Hispanic Black	877	42.5 (2.7)	13.6 (1.3)	15.8 (1.4)	8.3 (1.1)	8.6 (1.2)	11.3 (1.5)
	Other Race	628	43.6 (2.9)	16.0 (1.9)	11.4 (1.6)	6.5 (1.2)	6.5 (0.9)	15.9 (1.9)
Age								
Total Fish	16 to 19 years	654	41.1 (2.6)	18.3 (2.6)	11.2 (1.5)	8.6 (1.2)	10.3 (2.0)	10.5 (1.7)
	20 to 29 years	963	29.2 (1.8)	14.5 (1.4)	9.8 (1.1)	8.7 (1.2)	12.0 (1.3)	25.8 (1.8)
	30 to 39 years	1,056	24.4 (1.7)	13.4 (1.2)	10.8 (1.5)	8.6 (1.0)	12.2 (1.1)	30.6 (1.9)
	40 to 49 years	1,035	19.3 (1.7)	15.2 (1.7)	14.1 (1.5)	8.8 (1.0)	15.0 (1.4)	27.7 (2.0)
Finfish Only	16 to 19 years	654	58.2 (2.6)	19.6 (2.1)	8.3 (1.2)	7.5 (1.5)	3.7 (0.9)	2.6 (0.6)
	20 to 29 years	963	42.1 (1.8)	14.9 (1.6)	13.9 (1.7)	6.2 (1.0)	9.1 (1.3)	13.8 (1.3)
	30 to 39 years	1,056	33.9 (1.8)	16.1 (1.4)	14.0 (1.1)	9.5 (1.7)	11.9 (1.5)	14.5 (1.4)
	40 to 49 years	1,035	30.8 (2.1)	18.7 (1.9)	13.0 (1.4)	9.7 (1.3)	11.1 (1.5)	16.7 (1.5)
Shellfish Only	16 to 19 years	654	59.4 (2.6)	15.9 (1.9)	8.5 (1.0)	7.2 (1.3)	5.5 (1.4)	3.6 (0.9)
	20 to 29 years	963	48.1 (2.6)	17.3 (1.8)	11.5 (1.3)	5.8 (1.0)	8.6 (1.2)	8.7 (1.2)
	30 to 39 years	1,056	46.3 (2.5)	15.9 (1.2)	11.3 (1.2)	8.3 (1.2)	8.3 (1.3)	9.9 (1.2)
	40 to 49 years	1,035	46.8 (2.7)	19.2 (1.6)	15.0 (1.3)	6.3 (1.1)	5.4 (1.0)	7.3 (1.2)
Education								
Total Fish	< Median for age	1,175	33.8 (2.0)	16.9 (1.6)	12.3 (1.3)	9.1 (1.0)	10.9 (1.3)	16.9 (1.5)
	Median for age	1,256	24.3 (1.7)	16.4 (1.3)	11.9 (1.2)	8.7 (1.0)	13.8 (1.3)	24.9 (1.6)
	>Median for age	904	19.9 (2.0)	10.8 (1.3)	10.7 (1.4)	8.0 (1.2)	12.9 (1.4)	37.7 (2.6)
	Unknown education	373	35.6 (2.7)	17.6 (3.3)	8.9 (1.6)	9.9 (1.7)	15.1 (3.6)	13.0 (2.5)
Finfish Only	< Median for age	1,175	46.4 (2.0)	19.1 (1.7)	13.8 (1.3)	6.7 (0.9)	6.8 (1.0)	7.3 (0.9)
	Median for age	1,256	36.5 (1.7)	18.1 (1.4)	13.3 (1.2)	7.8 (1.0)	10.4 (1.0)	14.0 (1.2)
	>Median for age	904	30.0 (2.1)	13.3 (1.5)	13.0 (1.4)	9.9 (1.1)	13.2 (1.6)	20.5 (1.7)
	Unknown education	373	55.2 (3.6)	18.8 (2.9)	7.4 (1.6)	11.7 (2.5)	3.3 (1.1)	3.5 (1.0)

Parameter		Percent (standard error)						
		N	0 times	1 time	2 times	3 times	4-5 times	6+ times
Shellfish	< Median for age	1,175	55.0 (2.5)	17.7 (1.4)	12.1 (1.3)	5.8 (0.9)	4.6 (0.9)	4.8 (0.8)
	Median for age	1,256	49.7 (2.6)	17.7 (1.5)	11.0 (0.9)	6.9 (0.8)	6.6 (0.7)	8.0 (1.1)
	>Median for age	904	40.6 (2.8)	16.2 (1.7)	13.8 (1.4)	7.4 (1.4)	10.3 (1.7)	11.7 (1.4)
	Unknown education	373	51.6 (3.3)	18.6 (2.2)	8.6 (1.4)	9.0 (1.8)	6.8 (2.1)	5.4 (1.8)

Note: Data from NHANES 2011-2012 data was not included in the current study.

Table A.4b. Percentages and their standard errors for categorized reports of 30-day frequency of consumption of fish, by NHANES survey release, income, race/ethnicity, and age for women aged 16-49 years, NHANES 1999-2010 (United States Environmental Protection Agency, 2013)

Parameter		**N**	***Percent (standard error)***					
			0 times	**1 time**	**2 times**	**3 times**	**4-5 times**	**6+ times**
NHANES Survey Release								
Total Fish	1999-2000	1,637	21.8 (2.3)	14.7 (1.1)	13.6 (1.2)	8.9 (1.6)	14.6 (1.0)	26.4 (3.0)
	2001-2002	1,780	16.9 (1.1)	13.3 (1.4)	13.5 (1.6)	10.4 (1.0)	16.9 (1.2)	28.9 (1.5)
	2003-2004	1,599	21.3 (1.6)	12.5 (1.7)	13.0 (1.1)	9.8 (0.9)	14.4 (1.2)	29.0 (2.0)
	2005-2006	1,792	20.1 (2.2)	10.7 (1.1)	11.9 (0.8)	9.4 (0.9)	13.8 (1.1)	34.2 (3.0)
	2007-2008	1,493	24.7 (1.5)	14.8 (1.0)	11.4 (0.7)	9.4 (0.9)	12.9 (1.0)	26.9 (1.5)
	2009-2010	1,786	20.2 (1.9)	14.5 (0.9)	10.5 (0.6)	7.8 (0.8)	15.2 (1.1)	31.8 (1.6)
Finfish Only	1999-2000	1,637	32.9 (1.8)	17.7 (1.1)	16.9 (0.8)	7.5 (1.9)	11.4 (1.2)	13.6 (1.9)
	2001-2002	1,780	25.6 (1.5)	17.2 (1.4)	17.0 (1.5)	11.5 (0.7)	13.4 (1.4)	15.4 (1.3)
	2003-2004	1,599	31.2 (2.1)	16.8 (1.3)	14.6 (0.9)	10.3 (1.0)	12.0 (1.1)	15.2 (1.4)
	2005-2006	1,792	29.8 (2.6)	14.6 (1.0)	12.8 (0.7)	10.1 (0.7)	15.3 (0.9)	17.4 (2.5)
	2007-2008	1,493	35.9 (1.6)	16.0 (1.2)	13.5 (0.9)	9.1 (0.7)	11.6 (1.0)	14.0 (1.3)
	2009-2010	1,786	32.5 (1.9)	15.1 (1.0)	14.3 (1.2)	8.6 (1.1)	13.3 (1.3)	16.1 (1.2)
Shellfish Only	1999-2000	1,637	48.3 (3.3)	19.4 (1.8)	9.4 (1.3)	7.0 (1.0)	9.4 (1.8)	6.5 (1.7)
	2001-2002	1,780	48.3 (1.7)	17.9 (1.7)	11.8 (0.9)	7.8 (0.8)	5.6 (0.9)	8.7 (1.1)
	2003-2004	1,599	48.9 (2.4)	16.5 (1.1)	11.0 (1.2)	8.6 (1.1)	7.8 (0.9)	7.2 (1.0)
	2005-2006	1,792	44.4 (2.7)	17.1 (1.7)	12.9 (1.5)	6.9 (0.8)	9.3 (1.0)	9.5 (1.1)
	2007-2008	1,493	49.9 (1.5)	17.0 (1.0)	11.1 (1.0)	6.9 (0.9)	7.3 (0.9)	7.8 (0.7)
	2009-2010	1,786	42.2 (1.9)	17.0 (0.9)	13.7 (1.0)	9.2 (0.8)	8.2 (1.0)	9.7 (1.5)
Income								
Total Fish	<$20,000	2,216	24.8 (1.5)	16.1 (0.9)	14.5 (1.1)	9.8 (1.1)	11.8 (0.8)	23.0 (1.4)
	$20,000 to<$45,000	2,894	22.9 (1.4)	14.8 (0.9)	12.4 (0.9)	9.5 (0.7)	14.4 (0.8)	26.0 (1.2)
	$45,000 to <$75,000	1,950	21.6 (1.5)	13.7 (0.9)	11.0 (0.8)	9.7 (0.8)	14.7 (1.0)	29.4 (1.6)
	$75,000 and over	2,148	16.2 (1.0)	10.3 (0.8)	12.2 (0.8)	8.5 (0.8)	16.4 (0.9)	36.3 (1.5)
	$20,000 and over	225	21.3 (3.6)	9.9 (2.5)	10.8 (3.3)	12.9 (2.6)	9.6 (2.4)	35.5 (3.8)
	Refused/Don't Know	163	20.7 (3.9)	20.9 (4.4)	13.3 (3.6)	9.0 (2.8)	9.6 (2.9)	26.4 (5.8)
	Uncalculated*	491	21.5 (2.5)	15.2 (2.2)	10.7 (2.3)	7.4 (1.7)	17.7 (2.7)	27.4 (3.8)

Parameter		**N**	***Percent (standard error)***					
			0 times	**1 time**	**2 times**	**3 times**	**4-5 times**	**6+ times**
Finfish Only	<$20,000	2,216	35.7 (1.7)	19.7 (1.0)	14.9 (1.0)	7.5 (0.9)	10.7 (1.0)	11.6 (1.3)
	$20,000 to<$45,000	2,894	33.6 (1.6)	18.0 (1.0)	15.4 (1.0)	8.6 (0.6)	10.9 (0.8)	13.5 (1.1)
	$45,000 to <$75,000	1,950	31.8 (1.6)	16.2 (1.1)	15.5 (1.1)	9.2 (0.8)	11.8 (1.0)	15.5 (1.3)
	$75,000 and over	2,148	26.2 (1.2)	12.7 (0.8)	14.7 (0.9)	11.1 (0.8)	16.9 (1.1)	18.4 (1.1)
	$20,000 and over	225	31.1 (3.5)	10.6 (2.3)	11.8 (3.2)	12.9 (2.5)	10.7 (2.8)	23.0 (3.3)
	Refused/Don't Know	163	39.0 (6.8)	25.4 (4.8)	9.0 (2.2)	5.2 (2.1)	7.3 (2.4)	14.2 (5.2)
	Uncalculated*	491	32.7 (3.2)	16.6 (2.0)	12.0 (2.0)	12.6 (3.4)	12.2 (2.5)	13.9 (2.7)
Shellfish Only	<$20,000	2,216	55.2 (1.4)	16.2 (1.1)	9.8 (0.8)	6.0 (0.7)	5.9 (0.7)	6.9 (0.8)
	$20,000 to<$45,000	2,894	50.3 (1.6)	16.7 (0.9)	10.4 (0.8)	7.7 (0.7)	6.9 (0.8)	8.0 (0.7)
	$45,000 to <$75,000	1,950	45.8 (1.8)	17.5 (1.0)	12.8 (1.0)	8.0 (0.8)	8.8 (1.0)	7.1 (0.9)
	$75,000 and over	2,148	40.4 (1.5)	18.3 (1.2)	13.5 (0.9)	8.8 (0.7)	8.9 (1.0)	10.1 (0.9)
	$20,000 and over	225	46.6 (4.5)	16.8 (2.7)	10.4 (2.7)	7.7 (2.2)	8.9 (2.7)	9.7 (2.9)
	Refused/Don't Know	163	41.0 (4.9)	24.8 (4.4)	9.1 (2.9)	5.4 (1.8)	15.6 (4.1)	4.0 (1.6)
	Uncalculated*	491	49.2 (3.4)	19.7 (3.0)	8.9 (1.6)	6.1 (1.7)	7.4 (1.8)	8.6 (2.3)
Race/Ethnicity								
Total Fish	Mexican American	2,589	22.9 (1.1)	16.9 (1.0)	15.9 (1.0)	11.8 (0.8)	14.2 (0.9)	18.3 (1.1)
	Other Hispanic	751	21.1 (2.3)	20.3 (1.9)	10.2 (1.6)	9.7 (1.2)	12.3 (1.5)	26.5 (2.8)
	Non-Hispanic White	4,043	21.4 (0.9)	12.9 (0.7)	12.3 (0.6)	9.2 (0.6)	14.4 (0.6)	29.8 (1.2)
	Non-Hispanic Black	2,230	17.1 (1.2)	12.9 (0.8)	13.0 (0.8)	8.6 (0.7)	18.2 (1.1)	30.2 (1.2)
	Other Race	474	19.5 (2.6)	7.1 (1.2)	7.2 (1.2)	7.0 (1.4)	12.6 (1.8)	46.6 (3.4)
Finfish Only	Mexican American	2,589	38.9 (1.5)	21.4 (1.0)	15.0 (0.8)	8.7 (0.8)	8.3 (0.6)	7.8 (0.8)
	Other Hispanic	751	34.7 (2.6)	20.9 (2.4)	13.9 (1.5)	7.1 (1.1)	8.4 (1.2)	15.0 (2.2)
	Non-Hispanic White	4,043	31.5 (1.0)	14.9 (0.7)	15.1 (0.6)	9.6 (0.6)	13.4 (0.7)	15.5 (0.8)
	Non-Hispanic Black	2,230	25.8 (1.3)	19.0 (1.1)	15.7 (0.9)	10.3 (0.8)	13.6 (0.9)	15.6 (0.9)
	Other Race	474	25.7 (2.6)	11.9 (1.9)	10.7 (1.6)	10.3 (1.4)	17.2 (1.9)	24.1 (3.0)
Shellfish Only	Mexican American	2,589	44.7 (1.6)	21.6 (1.1)	14.2 (0.9)	8.2 (0.5)	6.5 (0.7)	4.7 (0.5)
	Other Hispanic	751	47.5 (3.0)	19.5 (1.7)	10.5 (1.4)	9.1 (1.2)	5.8 (1.1)	7.7 (1.2)
	Non-Hispanic White	4,043	48.3 (1.2)	17.5 (0.8)	11.3 (0.6)	7.2 (0.5)	7.9 (0.6)	7.7 (0.7)
	Non-Hispanic Black	2,230	45.5 (1.4)	16.3 (1.1)	12.7 (0.8)	7.4 (0.7)	8.4 (0.6)	9.6 (0.8)
	Other Race	474	38.4 (3.1)	10.6 (1.7)	10.6 (1.6)	11.8 (1.8)	11.6 (1.5)	17.0 (2.2)

Parameter		N	Percent (standard error)					
			0 times	1 time	2 times	3 times	4-5 times	6+ times
Age								
Total Fish	16 to 19 years	2,439	38.9 (1.6)	17.9 (1.2)	10.4 (0.7)	7.2 (0.7)	10.6 (0.9)	15.1 (1.1)
	20 to 29 years	2,739	23.4 (1.3)	14.2 (1.0)	13.2 (0.9)	9.8 (0.9)	13.6 (1.0)	25.7 (1.4)
	30 to 39 years	2,495	18.2 (1.1)	12.5 (1.0)	12.4 (0.9)	9.8 (0.7)	14.6 (0.8)	32.4 (1.4)
	40 to 49 years	2,414	1.05 (1.0)	12.1 (0.8)	12.0 (0.7)	9.0 (0.7)	16.8 (0.8)	35.1 (1.3)
Finfish Only	16 to 19 years	2,439	53.7 (1.7)	16.5 (1.1)	9.3 (0.8)	6.2 (0.7)	6.9 (0.8)	7.4 (0.8)
	20 to 29 years	2,739	36.1 (1.4)	16.9 (1.0)	13.7 (0.9)	8.9 (0.7)	11.3 (0.8)	13.1 (1.1)
	30 to 39 years	2,495	28.7 (1.2)	16.1 (0.9)	15.4 (0.9)	10.3 (0.7)	13.2 (0.8)	16.2 (0.9)
	40 to 49 years	2,414	22.1 (1.1)	15.6 (0.9)	17.2 (1.0)	10.4 (0.8)	15.8 (0.9)	19.0 (1.2)
Shellfish Only	16 to 19 years	2,439	58.8 (1.4)	17.9 (1.3)	9.4 (0.8)	4.7 (0.5)	4.9 (0.5)	4.3 (0.7)
	20 to 29 years	2,739	47.9 (1.4)	18.2 (1.0)	11.5 (0.8)	7.6 (0.7)	7.4 (0.7)	7.4 (0.7)
	30 to 39 years	2,495	43.7 (1.5)	18.1 (1.0)	11.4 (0.8)	8.2 (0.7)	8.8 (0.8)	9.7 (0.8)
	40 to 49 years	2,414	45.3 (1.5)	16.0 (1.0)	12.7 (0.9)	8.4 (0.7)	8.6 (0.9)	8.9 (0.8)

* Uncalculated indicates that the participant is residing in a multi-family dwelling and one or more of the families only reported a range for their family income, either <$20,000 or >$20,000. Thus NCHS did not calculate household income for these participants.

Table A.5. Estimated amount of fish consumed (g) in last 30 days, by NHANES survey releases, women aged 16-49 years, NHANES 2013-March 2020

		N	**Arithmetic mean (95% CI)**	**Selected percentiles (95% CI)**				
				25th	**50th**	**75th**	**90th**	**95th**
Estimated Amount of Fish Consumed (g) in Last 30 Days								
Shellfish	2013-2014	814	97.6(69.2,126.0)	0.0(-20.7,20.7)	28.1(7.3,48.9)	107.5(74.0,141.1)	266.7(186.9,346.5)	407.4(285.6,529.1)
	2015-2016	740	91.3(77.8,104.7)	0.0(-21.2,21.2)	28.6(7.4,49.8)	99.3(70.4,128.2)	271.0(189.8,352.3)	417.4(354.2,480.7)
	2017-March 2020	2154	93.0(79.8,106.1)	0.0(-20.9,20.9)	37.9(16.7,59.0)	104.6(76.3,132.9)	249.3(201.1,297.5)	393.7(326.9,460.4)
Finfish	2013-2014	814	237.8(203.7,271.8)	0.0(-34.4,34.4)	81.4(57.5,105.3)	301.0(234.7,367.3)	679.8(585.7,773.9)	952.5(706.5,1198.6)
	2015-2016	740	227.5(190.6,264.4)	0.0(-34.4,34.4)	98.4(67.7,129.0)	299.4(237.3,361.4)	597.4(455.1,739.6)	918.6(671.1,1166.0)
	2017-March 2020	2154	232.6(212.8,252.4)	0.0(-30.6,30.6)	102.7(78.0,127.4)	296.8(259.1,334.4)	643.9(555.5,732.3)	937.7(771.5,1103.9)
Total Fish	2013-2014	814	335.3(278.9,391.8)	0.0(-27.9,27.9)	143.2(92.3,194.0)	435.4(329.9,540.9)	855.3(739.2,971.3)	1216.6(911.8,1521.5)
	2015-2016	740	318.8(271.4,366.2)	0.0(-22.3,22.3)	161.1(111.5,210.7)	413.8(327.9,499.6)	789.1(616.8,961.3)	1114.6(811.3,1418.0)
	2017-March 2020	2154	325.6(296.2,354.9)	0.0(-21.3,21.3)	161.5(127.7,195.2)	420.4(364.2,476.7)	822.1(716.7,927.4)	1228.8(1077.5,1380.0)

Table A.6. Estimated mercury intake (µg) in last 30 days, by NHANES survey releases, women aged 16-49 years, NHANES 2013-March 2020

		N	**Arithmetic mean (95% CI)**	**Selected percentiles (95% CI)**				
				25th	**50th**	**75th**	**90th**	**95th**
Estimated Mercury Intake (ug) in Last 30 Days								
Shellfish	2013-2014	814	3.65(2.30,4.99)	0.00(-0.29,0.29)	0.34(0.05,0.63)	2.71(1.02,4.39)	10.01(4.57,15.46)	17.51(13.26,21.77)
	2015-2016	740	3.37(2.75,3.99)	0.00(-0.29,0.29)	0.36(0.07,0.65)	2.05(0.56,3.55)	11.87(7.72,16.02)	19.47(13.46,25.48)
	2017-March 2020	2154	3.22(2.74,3.70)	0.00(-0.29,0.29)	0.52(0.23,0.81)	2.10(1.02,3.18)	9.63(6.69,12.56)	15.84(13.93,17.75)
Finfish	2013-2014	814	21.97(19.47,24.47)	0.00(-1.82,1.82)	8.03(5.29,10.78)	26.25(22.40,30.09)	57.05(46.69,67.41)	91.87(68.70,115.04)
	2015-2016	740	19.46(16.42,22.50)	0.00(-1.76,1.76)	8.55(6.99,10.12)	23.04(17.89,28.20)	47.94(35.97,59.90)	81.46(50.33,112.59)
	2017-March 2020	2154	20.51(18.37,22.65)	0.00(-1.70,1.70)	8.02(6.85,9.19)	23.63(20.57,26.69)	54.35(46.25,62.44)	85.81(69.88,101.74)
Total Fish	2013-2014	814	25.62(22.16,29.08)	0.00(-0.57,0.57)	9.39(6.48,12.30)	30.93(26.22,35.64)	66.46(51.48,81.44)	104.26(75.57,132.94)
	2015-2016	740	22.83(19.55,26.12)	0.00(-0.30,0.30)	9.91(7.34,12.47)	29.16(24.93,33.39)	55.94(39.64,72.23)	84.27(51.47,117.07)
	2017-March 2020	2154	23.73(21.24,26.21)	0.00(-0.29,0.29)	9.55(7.94,11.16)	28.59(25.14,32.03)	62.66(55.21,70.11)	91.02(75.33,106.72)

Table A.7. Estimated mercury intake per unit body weight (µg Hg/kg bw) in last 30 days, by NHANES survey releases, women aged 16-49 years, NHANES 2013-March 2020

		N	**Arithmetic Mean (95% CI)**	**Selected percentiles (95% CI)**				
				25th	**50th**	**75th**	**90th**	**95th**
Estimated Mercury Intake per Unit Body Weight (µg Hg/kg bw) in Last 30 Days								
Shellfish	2013-2014	814	0.05(0.03,0.06)	0.00(0.00,0.00)	0.00(0.00,0.01)	0.03(0.01,0.05)	0.13(0.07,0.19)	0.24(0.16,0.31)
	2015-2016	740	0.05(0.04,0.06)	0.00(0.00,0.00)	0.00(0.00,0.01)	0.03(0.02,0.05)	0.15(0.10,0.20)	0.26(0.21,0.32)
	2017-March 2020	2154	0.04(0.04,0.05)	0.00(0.00,0.00)	0.01(0.00,0.01)	0.03(0.02,0.05)	0.12(0.09,0.15)	0.22(0.19,0.25)
Finfish	2013-2014	814	0.31(0.28,0.35)	0.00(-0.03,0.03)	0.09(0.05,0.13)	0.36(0.30,0.42)	0.84(0.60,1.08)	1.30(0.98,1.62)
	2015-2016	740	0.27(0.23,0.31)	0.00(-0.03,0.03)	0.10(0.07,0.12)	0.32(0.26,0.38)	0.72(0.53,0.91)	1.12(0.78,1.45)
	2017-March 2020	2154	0.28(0.25,0.31)	0.00(-0.02,0.02)	0.10(0.08,0.12)	0.32(0.27,0.37)	0.74(0.60,0.87)	1.15(0.90,1.41)
Total Fish	2013-2014	814	0.36(0.31,0.41)	0.00(-0.01,0.01)	0.13(0.08,0.17)	0.44(0.35,0.52)	0.93(0.69,1.17)	1.39(0.92,1.87)
	2015-2016	740	0.32(0.27,0.37)	0.00(0.00,0.00)	0.13(0.10,0.17)	0.39(0.32,0.46)	0.82(0.60,1.04)	1.34(0.92,1.76)
	2017-March 2020	2154	0.32(0.29,0.36)	0.00(0.00,0.00)	0.13(0.10,0.16)	0.38(0.34,0.43)	0.81(0.71,0.92)	1.30(1.09,1.51)

Table A.8. Estimated amounts of fish consumed (g), mercury intake (μg), and mercury intake per unit body weight (μg/kg), by race/ethnicity, age, income, and education, women aged 16-49 years, NHANES 2013-March 2020

Parameter		**N**	**Arithmetic mean (95% CI)**	**25th**	**50th**	**75th**	**90th**	**95th**
Estimated Amount of Fish Consumed (g)								
Race/ Ethnicity	Mexican American	624	300.4(250.9,349.9	37.6(17.7,57.5)	149.3(126.3,172.3)	373.1(308.8,437.3)	706.0(549.8,862.3)	1013.3(709.0,1317.5)
	Other Hispanic	380	329.6(267.9,391.3)	32.6(14.7,50.5)	155.2(112.3,198.2)	424.1(322.0,526.3	769.2(544.4,994.0)	1331.9(678.9,1984.8)
	Non-Hispanic White	1199	305.4(278.1,332.7)	0.0(-20.5,20.5)	143.4(109.4,177.4)	412.7(352.5,473.0)	791.8(715.6,868.0)	1151.5(972.1,1330.9)
	Non-Hispanic Black	877	443.2(375.9,510.5)	71.2(38.7,103.6)	232.0(196.2,267.8	510.9(424.2,597.7)	1057.1(764.7,1349.5)	1600.3(1048.8,2151.8)
	Other Race	628	324.7(288.3,361.1)	38.8(14.8,62.7)	174.7(130.6,218.7)	449.0(387.1,510.9)	871.1(694.4,1047.8)	1170.1(973.9,1366.4)
Age, Years	16 to 19	654	142.0(122.8,161.1)	0.0(-21.2,21.2)	59.5(42.8,76.2)	200.6(157.4,243.9)	384.4(295.2,473.6)	594.0(496.3,691.8)
	20 to 29	963	319.4(286.1,352.7)	0.0(-21.4,21.4)	147.8(118.9,176.7)	436.9(374.3,499.4)	843.9(711.4,976.3)	1146.5(977.5,1315.5)
	30 to 39	1056	374.6(336.3,413.0)	31.4(9.0,53.8)	186.9(138.7,235.0)	503.0(430.1,575.9)	959.7(800.7,1118.7)	1300.1(1052.0,1548.1)
	40 to 49	1035	358.5(326.7,390.3)	58.9(44.0,73.8)	195.5(158.4,232.5)	464.5(400.9,528.1)	857.6(800.3,914.9)	1391.3(1106.7,1675.9)
Annual Income	0 to <1x poverty line	876	265.9(223.9,307.9)	0.0(-21.1,21.1)	105.3(78.4,132.2)	317.7(254.0,381.4)	689.2(556.7,821.7)	993.5(738.6,1248.3)
	1x to <2x poverty	856	277.0(243.7,310.3)	0.0(-21.4,21.4)	130.8(97.5,164.2)	389.2(339.6,438.8)	734.6(618.8,850.3)	1039.6(784.4,1294.9)
	2x to <3x poverty line	516	295.4(250.0,340.8)	0.0(-29.0,29.0)	136.4(101.2,171.7)	369.1(280.8,457.5)	762.5(547.6,977.5)	1184.7(813.2,1556.1)
	3x to <4x poverty line	368	317.8(256.3,379.2)	0.0(-33.6,33.6)	161.4(97.9,224.9)	463.5(314.6,612.4)	820.2(631.9,1008.5)	1104.4(717.8,1491.0)
	4x to <5x poverty line	251	396.0(326.0,466.0)	45.1(1.2,89.0)	199.6(127.5,271.8)	531.1(390.1,672.0)	968.8(709.1,1228.5)	1373.9(585.9,2161.8)
	>= 5x poverty line	498	426.3(382.0,470.6)	44.7(8.1,81.4)	279.3(209.4,349.2)	591.6(509.8,673.3)	1085.6(954.2,1217.0)	1349.8(1175.0,1524.6)
	Missing/Refused/DK	343	331.6(287.7,375.6)	42.4(14.2,70.7)	192.6(134.4,250.7)	380.8(316.6,444.9)	773.9(631.5,916.3)	1098.7(566.2,1631.3)
Education	<Median education for age	1175	234.0(208.8,259.2)	0.0(-22.0,22.0)	95.8(71.0,120.6)	296.7(238.8,354.5)	630.0(539.0,721.0)	907.8(749.0,1066.5)
	Median education for age	1256	337.9(297.0,378.8)	32.1(10.5,53.7)	155.0(126.9,183.1)	416.2(358.9,473.5)	801.5(684.7,918.3)	1362.7(1098.3,1627.2)
	>Median education for age	904	425.4(387.7,463.2)	64.8(41.9,87.8)	273.8(214.3,333.3)	626.2(561.2,691.3)	1024.1(904.8,1143.4)	1376.7(1180.9,1572.4)
	Unknown education	373	170.2(137.0,203.4)	0.0(-20.9,20.9)	76.4(38.2,114.6)	254.2(182.6,325.7)	437.8(307.4,568.1)	656.0(516.1,796.0)
Estimated Mercury Intake (μg)								
Race/ Ethnicity	Mexican American	624	22.30(17.24,27.37)	0.43(0.19,0.68)	9.39(6.61,12.18)	25.28(19.43,31.12)	56.13(47.26,65.01)	82.21(43.82,120.60)
	Other Hispanic	380	24.49(19.88,29.10)	0.41(0.17,0.65)	10.39(7.56,13.23)	28.28(21.98,34.57)	63.97(52.32,75.62)	83.77(50.14,117.41)
	Non-Hispanic White	1199	22.83(20.90,24.75)	0.00(-0.27,0.27)	9.11(7.29,10.93)	28.19(24.99,31.38)	60.57(52.58,68.57)	95.47(78.19,112.75)
	Non-Hispanic Black	877	32.03(27.29,36.77)	1.12(-0.29,2.52)	15.38(11.82,18.95)	36.45(31.17,41.73)	72.63(56.01,89.26)	123.50(87.85,159.15)
	Other Race	628	22.15(19.27,25.04)	0.86(-0.35,2.07)	9.38(7.02,11.73)	29.42(24.25,34.59)	62.97(49.79,76.15)	89.73(67.39,112.06)
Age, Years	16 to 19	654	9.12(7.94,10.31)	0.00(-0.30,0.30)	1.91(0.51,3.31)	12.41(9.90,14.91)	26.18(22.06,30.30)	35.65(25.90,45.40)
	20 to 29	963	22.18(19.86,24.51)	0.00(-0.30,0.30)	9.14(7.50,10.78)	27.23(23.90,30.56)	63.87(52.50,75.23)	88.93(71.51,106.35)
	30 to 39	1056	26.69(23.82,29.56)	0.40(-0.17,0.97)	12.20(9.44,14.95)	34.90(30.45,39.35)	62.99(54.08,71.90)	97.75(70.58,124.91)
	40 to 49	1035	29.16(26.05,32.26)	0.94(0.14,1.74)	12.23(10.29,14.16)	33.68(28.68,38.68)	73.81(59.19,88.42)	128.91(98.42,159.40)

Parameter		***N***	***Arithmetic mean (95% CI)***	***25th***	***50th***	***75th***	***90th***	***95th***
Annual Income	0 to <1x poverty line	876	19.86(16.85,22.86)	0.00(-0.30,0.30)	5.09(2.39,7.80)	21.05(17.57,24.52)	53.88(43.83,63.92)	77.27(56.77,97.77)
	1x to <2x poverty	856	20.93(18.40,23.46)	0.00(-0.30,0.30)	9.13(6.45,11.80)	29.47(24.45,34.49)	57.89(47.15,68.63)	81.20(66.02,96.37)
	2x to <3x poverty line	516	20.88(17.23,24.53)	0.00(-0.63,0.63)	9.04(6.82,11.27)	25.22(20.33,30.11)	50.15(34.18,66.11)	89.64(54.93,124.34)
	3x to <4x poverty line	368	24.51(18.35,30.66)	0.00(-0.78,0.78)	11.17(6.59,15.74)	29.99(20.99,38.99)	55.44(31.80,79.08)	90.28(33.13,147.43)
	4x to <5x poverty line	251	26.63(21.46,31.81)	0.73(-0.87,2.32)	12.32(8.30,16.34)	33.69(25.86,41.52)	68.71(31.54,105.89)	113.20(55.38,171.01)
	>= 5x poverty line	498	31.51(27.44,35.58)	0.90(-0.70,2.51)	16.96(12.44,21.49)	38.01(32.23,43.79)	80.89(63.29,98.49)	113.00(82.33,143.68)
	Missing/Refused/DK	343	24.78(19.75,29.81)	0.59(-0.01,1.19)	9.77(7.62,11.93)	24.10(16.46,31.73)	63.60(51.90,75.31)	121.19(70.30,172.08)
Education	<Median education for age	1175	17.79(15.82,19.76)	0.00(-0.30,0.30)	5.29(2.57,8.01)	19.82(16.25,23.39)	48.82(39.91,57.72)	72.54(61.62,83.45)
	Median education for age	1256	24.47(21.55,27.38)	0.40(0.10,0.70)	10.12(8.25,11.99)	29.58(26.50,32.65)	61.80(52.37,71.23)	101.15(72.12,130.19)
	>Median education for age	904	31.45(28.30,34.61)	1.25(-0.09,2.60)	16.17(12.27,20.06)	38.70(34.86,42.54)	76.40(62.63,90.17)	129.84(100.67,159.02)
	Unknown education	373	10.63(8.46,12.80)	0.00(-0.30,0.30)	2.60(0.78,4.42)	13.30(8.43,18.18)	28.74(24.80,32.68)	44.81(27.84,61.78)
Estimated Mercury Intake per Unit Body Weight (µg Hg/kg bw)								
Race/ Ethnicity	Mexican American	624	0.32(0.24,0.41)	0.01(0.00,0.01)	0.12(0.09,0.16)	0.34(0.27,0.42)	0.79(0.66,0.92)	1.20(0.75,1.66)
	Other Hispanic	380	0.37(0.29,0.44)	0.01(0.00,0.01)	0.14(0.10,0.19)	0.39(0.29,0.49)	0.95(0.70,1.19)	1.39(1.12,1.66)
	Non-Hispanic White	1199	0.31(0.29,0.34)	0.00(0.00,0.00)	0.12(0.09,0.14)	0.40(0.36,0.44)	0.79(0.66,0.92)	1.26(0.97,1.55)
	Non-Hispanic Black	877	0.38(0.33,0.43)	0.02(-0.01,0.04)	0.18(0.14,0.22)	0.44(0.40,0.49)	0.96(0.68,1.24)	1.42(1.13,1.72)
	Other Race	628	0.36(0.31,0.41)	0.01(-0.01,0.03)	0.13(0.09,0.17)	0.42(0.35,0.49)	1.01(0.75,1.27)	1.41(1.16,1.67)
Age, Years	16 to 19	654	0.14(0.12,0.16)	0.00(-0.01,0.01)	0.02(0.00,0.04)	0.19(0.15,0.22)	0.42(0.36,0.48)	0.63(0.53,0.72)
	20 to 29	963	0.32(0.29,0.35)	0.00(0.00,0.00)	0.13(0.10,0.16)	0.37(0.31,0.43)	0.88(0.69,1.07)	1.37(1.17,1.57)
	30 to 39	1056	0.36(0.31,0.40)	0.00(0.00,0.01)	0.15(0.11,0.19)	0.45(0.40,0.49)	0.88(0.75,1.02)	1.32(0.96,1.67)
	40 to 49	1035	0.39(0.35,0.44)	0.01(0.00,0.02)	0.16(0.13,0.19)	0.44(0.38,0.50)	0.98(0.78,1.18)	1.71(1.19,2.23)
Annual Income	0 to <1x poverty line	876	0.26(0.23,0.30)	0.00(0.00,0.00)	0.07(0.05,0.09)	0.29(0.24,0.35)	0.70(0.56,0.85)	1.06(0.77,1.34)
	1x to <2x poverty	856	0.28(0.25,0.31)	0.00(0.00,0.00)	0.11(0.07,0.14)	0.36(0.30,0.42)	0.80(0.63,0.97)	1.27(1.08,1.46)
	2x to <3x poverty line	516	0.28(0.23,0.34)	0.00(-0.01,0.01)	0.11(0.08,0.13)	0.32(0.25,0.40)	0.77(0.55,0.99)	1.12(0.72,1.52)
	3x to <4x poverty line	368	0.33(0.25,0.41)	0.00(-0.01,0.01)	0.13(0.07,0.20)	0.41(0.32,0.49)	0.74(0.47,1.01)	1.17(0.39,1.95)
	4x to <5x poverty line	251	0.38(0.30,0.46)	0.01(-0.01,0.03)	0.17(0.10,0.24)	0.45(0.36,0.54)	0.94(0.48,1.39)	1.56(0.75,2.37)
	>= 5x poverty line	498	0.46(0.39,0.52)	0.01(-0.01,0.04)	0.21(0.15,0.26)	0.52(0.42,0.62)	1.19(0.98,1.39)	1.77(1.37,2.17)
	Missing/Refused/DK	343	0.36(0.28,0.43)	0.01(-0.01,0.03)	0.14(0.11,0.17)	0.32(0.24,0.41)	0.79(0.40,1.17)	1.52(0.83,2.20)
Education	<Median education for age	1175	0.24(0.21,0.26)	0.00(0.00,0.00)	0.07(0.04,0.10)	0.26(0.21,0.31)	0.66(0.53,0.79)	0.99(0.83,1.16)
	Median education for age	1256	0.33(0.29,0.37)	0.00(0.00,0.01)	0.14(0.12,0.17)	0.39(0.35,0.43)	0.79(0.64,0.93)	1.34(1.01,1.68)
	>Median education for age	904	0.45(0.41,0.49)	0.02(0.00,0.04)	0.22(0.17,0.27)	0.53(0.46,0.59)	1.14(0.95,1.34)	1.90(1.47,2.33)
	Unknown education	373	0.17(0.13,0.20)	0.00(0.00,0.00)	0.04(0.01,0.07)	0.20(0.11,0.30)	0.44(0.32,0.55)	0.67(0.46,0.88)

Table A.9a. Blood MeHg concentrations (μg/L), by frequency of consuming fish, by NHANES survey releases, women aged 16-49 years, NHANES 2013-March 2020

Survey release	Times eaten in 30 days	N	Arith. Mean (95% CI)	Selected percentiles (95% CI)				
				25th	50th	75th	90th	95th
2013-2014	0	201	0.31 (0.25,0.37)	0.14 (0.13,0.14)	0.20 (0.15,0.24)	0.30 (0.20,0.40)	0.53 (0.04,1.02)	0.92 (0.19,1.66)
	1	137	0.61 (0.40,0.82)	0.16 (0.12,0.21)	0.32 (0.27,0.37)	0.57 (0.38,0.77)	1.09 (0.69,1.49)	1.47 (.,.)[a]
	2	111	0.63 (0.54,0.73)	0.27 (0.19,0.35)	0.42 (0.29,0.54)	0.72 (0.46,0.99)	1.31 (0.90,1.73)	1.60 (0.67,2.53)
	3	77	0.62 (0.54,0.70)	0.32 (0.26,0.38)	0.56 (0.45,0.66)	0.84 (0.66,1.02)	1.08 (0.48,1.69)	1.19 (.,.)[a]
	4-5	79	0.86 (0.76,0.97)	0.37 (0.26,0.48)	0.52 (0.45,0.59)	0.90 (0.71,1.09)	1.66 (0.71,2.62)	3.23 (2.21,4.24)
	6 and up	209	2.22 (1.66,2.77)	0.59 (0.47,0.72)	1.24 (0.96,1.52)	2.64 (1.81,3.47)	4.40 (2.84,5.96)	7.84 (2.69,12.99)
2015-2016	0	197	0.31 (0.26,0.36)	0.15 (0.14,0.15)	0.21 (0.16,0.26)	0.31 (0.27,0.35)	0.49 (0.37,0.60)	0.76 (0.49,1.03)
	1	106	0.42 (0.31,0.52)	0.17 (0.13,0.21)	0.30 (0.27,0.33)	0.46 (0.34,0.57)	0.61 (0.47,0.76)	0.78 (-0.18,1.74)
	2	80	1.04 (0.55,1.53)	0.27 (0.22,0.32)	0.49 (0.35,0.63)	0.89 (0.39,1.39)	2.04 (-0.99,5.07)	4.01 (.,.)[a]
	3	69	0.71 (0.52,0.90)	0.35 (0.22,0.48)	0.51 (0.30,0.71)	0.87 (0.43,1.30)	1.09 (.,.)[a]	1.42 (.,.)[a]
	4-5	100	1.00 (0.79,1.21)	0.45 (0.37,0.54)	0.68 (0.48,0.88)	1.11 (0.69,1.52)	2.01 (0.64,3.39)	3.01 (1.36,4.67)
	6 and up	188	1.77 (1.51,2.02)	0.59 (0.39,0.78)	1.11 (0.90,1.33)	2.42 (1.75,3.09)	3.81 (2.69,4.93)	5.38 (3.47,7.29)
2017-March 2020	0	554	0.34 (0.29,0.40)	0.15 (0.14,0.15)	0.16 (0.15,0.17)	0.34 (0.24,0.43)	0.61 (0.42,0.80)	1.00 (0.63,1.38)
	1	290	0.48 (0.38,0.58)	0.16 (0.15,0.17)	0.28 (0.24,0.32)	0.53 (0.31,0.75)	1.31 (0.74,1.89)	1.54 (1.14,1.94)
	2	252	0.55 (0.46,0.64)	0.21 (0.16,0.25)	0.43 (0.36,0.51)	0.64 (0.44,0.84)	1.11 (0.66,1.57)	1.34 (0.69,1.99)
	3	211	0.78 (0.65,0.91)	0.25 (0.18,0.32)	0.39 (0.26,0.53)	0.95 (0.70,1.20)	1.67 (1.31,2.03)	2.25 (1.83,2.67)
	4-5	282	1.06 (0.83,1.29)	0.33 (0.25,0.40)	0.62 (0.47,0.78)	1.16 (0.72,1.61)	2.73 (1.90,3.56)	3.44 (1.67,5.22)
	6 and up	565	1.66 (1.47,1.85)	0.61 (0.51,0.70)	1.08 (0.88,1.28)	2.01 (1.51,2.50)	3.68 (2.84,4.52)	4.65 (3.24,6.06)

Note: Data from NHANES 2011-2012 data was not included in the current study.

[a] Missing confidence interval because of stratum with single sampling unit.

Table A.9b. Blood MeHg concentrations (ug/L), by frequency of consuming fish, by NHANES survey release, women aged 16-49 years, NHANES 1999-2010 (United States Environmental Protection Agency, 2013)

Survey release	**Times eaten in 30 days**	**N**	**Arith. Mean (95% CI)**	**Selected percentiles (95% CI)**				
				25th	**50th**	**75th**	**90th**	**95th**
1999-2000	0	428	0.60 (0.50,0.71)	0.21 (0.12,0.39)	0.36 (0.27,0.47)	0.69 (0.56,0.85)	1.32 (1.08,1.61)	1.74 (1.31,2.31)
	1	279	1.01 (0.72,1.30)	0.37 (0.25,0.53)	0.70 (0.54,0.90)	1.18 (0.79,1.75)	2.12 (1.27,3.53)	3.11 (1.69,5.71)
	2	223	1.17 (0.93,1.40)	0.38 (0.27,0.53)	0.78 (0.58,1.04)	1.54 (1.30,1.83)	2.50 (1.75,3.57)	3.55 (2.59,4.86)
	3	154	2.06 (0.26,3.86)	0.46 (0.16,1.33)	0.90 (0.60,1.37)	1.40 (0.49,4.02)	3.77 (0.86,16.40)	10.87 (3.09,38.27)
	4-5	227	2.27 (1.74,2.80)	0.67 (0.54,0.82)	1.22 (0.89,1.67)	2.83 (1.88,4.27)	5.69 (4.43,7.29)	7.10 (5.50,9.17)
	6 and up	326	3.36 (2.75,3.97)	1.02 (0.81,1.30)	1.91 (1.52,2.41)	4.38 (3.60,5.34)	8.33 (6.28,11.07)	11.81 (10.29,13.54)
2001-2002	0	401	0.43 (0.33,0.54)	0.16 (0.05,0.49)	0.29 (0.21,0.41)	0.55 (0.42,0.72)	0.92 (0.77,1.09)	1.19 (0.97,1.46)
	1	248	0.71 (0.53,0.90)	0.30 (0.19,0.46)	0.48 (0.38,0.60)	0.79 (0.63,1.01)	1.52 (0.95,2.43)	2.02 (1.41,2.89)
	2	250	0.84 (0.67,1.01)	0.32 (0.22,0.46)	0.57 (0.43,0.77)	1.10 (0.85,1.42)	1.76 (1.38,2.25)	2.14 (1.21,3.76)
	3	188	1.14 (0.78,1.50)	0.37 (0.23,0.59)	0.77 (0.58,1.01)	1.31 (1.05,1.63)	2.50 (1.33,4.70)	3.22 (1.78,5.83)
	4-5	274	1.20 (0.99,1.42)	0.44 (0.34,0.58)	0.85 (0.68,1.06)	1.60 (1.24,2.06)	2.58 (1.96,3.39)	3.44 (2.73,4.35)
	6 and up	419	2.33 (1.92,2.75)	0.73 (0.62,0.86)	1.41 (1.28,1.55)	2.82 (2.53,3.14)	5.69 (4.27,7.59)	7.16 (5.04,10.18)
2003-2004	0	365	0.38 (0.27,0.50)	0.14 (0.03,0.57)	0.25 (0.16,0.40)	0.44 (0.34,0.57)	0.79 (0.57,1.10)	1.19 (0.76,1.85)
	1	237	0.50 (0.36,0.65)	0.15 (0.07,0.34)	0.33 (0.20,0.53)	0.57 (0.38,0.85)	1.07 (0.70,1.63)	1.40 (0.80,2.46)
	2	205	0.65 (0.52,0.78)	0.26 (0.15,0.46)	0.47 (0.36,0.61)	0.77 (0.64,0.93)	1.43 (1.03,2.00)	2.05 (1.29,3.26)
	3	162	0.89 (0.69,1.08)	0.31 (0.20,0.46)	0.54 (0.44,0.66)	1.13 (0.81,1.58)	1.92 (1.37,2.68)	3.09 (2.19,4.35)
	4-5	241	1.15 (1.00,1.29)	0.41 (0.29,0.58)	0.76 (0.63,0.92)	1.33 (1.12,1.57)	2.57 (1.81,3.65)	4.19 (2.63,6.67)
	6 and up	389	2.07 (1.68,2.46)	0.64 (0.51,0.81)	1.21 (0.99,1.48)	2.61 (1.92,3.54)	4.36 (3.20,5.92)	6.24 (3.62,10.77)
2005-2006	0	433	0.37 (0.25,0.48)	0.11 (0.03,0.39)	0.22 (0.12,0.38)	0.45 (0.33,0.61)	0.77 (0.60,0.98)	1.10 (0.83,1.46)
	1	248	0.64 (0.50,0.78)	0.20 (0.10,0.38)	0.42 (0.32,0.57)	0.80 (0.63,1.01)	1.33 (1.00,1.77)	1.77 (1.14,2.76)
	2	224	0.82 (0.63,1.01)	0.26 (0.16,0.41)	0.50 (0.39,0.64)	0.97 (0.80,1.17)	1.61 (1.12,2.31)	2.65 (1.25,5.60)
	3	173	1.06 (0.68,1.45)	0.32 (0.20,0.49)	0.62 (0.47,0.81)	1.11 (0.64,1.91)	2.72 (1.28,5.79)	3.22 (1.85,5.60)
	4-5	235	1.28 (0.82,1.73)	0.40 (0.26,0.61)	0.76 (0.62,0.93)	1.45 (1.14,1.84)	2.45 (1.16,5.16)	3.86 (1.38,10.76)
	6 and up	479	1.84 (1.61,2.08)	0.64 (0.56,0.75)	1.20 (1.01,1.44)	2.38 (2.00,2.83)	4.07 (3.34,4.95)	5.77 (4.31,7.73)
2007-2008	0	374	0.36 (0.25,0.47)	0.15 (0.05,0.41)	0.25 (0.16,0.39)	0.43 (0.34,0.53)	0.67 (0.54,0.83)	0.96 (0.72,1.29)
	1	251	0.69 (0.45,0.92)	0.23 (0.13,0.40)	0.43 (0.31,0.60)	0.72 (0.49,1.06)	1.43 (0.99,2.08)	1.92 (1.05,3.50)
	2	190	0.69 (0.52,0.86)	0.27 (0.17,0.43)	0.46 (0.35,0.60)	0.72 (0.60,0.88)	1.14 (0.72,1.82)	1.89 (1.21,2.96)
	3	136	0.82 (0.57,1.07)	0.31 (0.19,0.49)	0.54 (0.42,0.69)	0.84 (0.66,1.05)	1.68 (0.93,3.02)	2.51 (1.18,5.34)
	4-5	197	1.05 (0.87,1.23)	0.45 (0.34,0.60)	0.79 (0.62,1.01)	1.32 (1.16,1.49)	1.83 (1.51,2.21)	2.34 (1.22,4.49)
	6 and up	345	1.95 (1.54,2.37)	0.64 (0.50,0.82)	1.24 (0.94,1.62)	2.61 (2.10,3.24)	4.21 (2.96,5.99)	6.72 (4.49,10.06)
2009-2010	0	413	0.50 (0.40,0.60)	0.19 (0.08,0.45)	0.31 (0.22,0.42)	0.56 (0.48,0.66)	1.01 (0.73,1.39)	1.41 (1.13,1.75)
	1	250	0.58 (0.50,0.67)	0.25 (0.16,0.40)	0.43 (0.34,0.54)	0.76 (0.63,0.93)	1.19 (1.02,1.38)	1.51 (1.20,1.91)
	2	213	0.81 (0.67,0.94)	0.33 (0.23,0.46)	0.55 (0.46,0.67)	1.05 (0.76,1.46)	1.68 (1.45,1.93)	2.06 (1.50,2.82)
	3	132	0.87 (0.70,1.04)	0.34 (0.24,0.48)	0.56 (0.43,0.73)	1.00 (0.74,1.33)	2.01 (1.36,2.97)	2.53 (1.96,3.26)
	4-5	258	1.27 (1.05,1.50)	0.47 (0.37,0.60)	0.80 (0.61,1.06)	1.55 (1.20,2.00)	2.60 (2.23,3.03)	3.15 (2.29,4.35)
	6 and up	520	2.11 (1.87,2.35)	0.77 (0.66,0.91)	1.36 (1.15,1.61)	2.72 (2.49,2.98)	4.24 (3.54,5.08)	6.47 (5.61,7.47)

Table A.10. Parameter estimates and odds ratio from the logistic model predicting the probability of reporting any fish consumption in the previous 30 days, NHANES 2013-March 2020

	Parameter	**Std. error**	**p-Value**	**Odds ratio**
Intercept	1.3154	0.06	<0.0001	
Income, Overall			0.0004	
0 to <1x poverty line	-0.3618	0.09	<0.0001	0.70
1x to <2x poverty line	-0.2491	0.10	0.0133	0.78
2x to <3x poverty line	-0.0800	0.11	0.4851	0.92
3x to <4x poverty line	0.0170	0.19	0.9276	1.02
4x to <5x poverty line	0.2168	0.17	0.2108	1.24
>= 5x poverty line	0.1546	0.15	0.3051	1.17
Missing/Refused/DK	0.3025	0.15	0.0430	1.35
Race, Overall			<0.0001	
Mexican American	0.1636	0.09	0.0733	1.18
Non-Hispanic Black	0.3179	0.12	0.0081	1.37
Non-Hispanic White	-0.5135	0.08	<0.0001	0.60
Other Hispanic	0.1544	0.13	0.2407	1.17
Other Race	-0.1225	0.12	0.3129	0.88
Education, Overall			<0.0001	
< Median for age	-0.4417	0.10	<0.0001	0.64
Median for age	0.0740	0.09	0.4152	1.08
>Median for age	0.1674	0.11	0.1204	1.18
Unknown education	0.2003	0.15	0.1773	1.22
Age, Overall			<0.0001	
16 to 19	-0.6722	0.13	<0.0001	0.51
20 to 29	-0.0005	0.09	0.9953	1.00
30 to 39	0.1792	0.08	0.0182	1.20
40 to 49	0.4935	0.08	<0.0001	1.64

Table A.11. Parameter estimates and relative ratios from the model predicting the log-transformed frequency of fish consumption in the previous 30 days (times), NHANES 2013-March 2020

	Parameter	**Std. error**	**p-Value**	**Relative ratio**
Intercept	1.3014	0.04	<0.0001	
Income, Overall			0.1650	
0 to <1x poverty line	-0.0871	0.05	0.0754	0.92
1x to <2x poverty line	-0.0237	0.06	0.6931	0.98
2x to <3x poverty line	-0.0781	0.06	0.1681	0.92
3x to <4x poverty line	0.0075	0.06	0.8975	1.01
4x to <5x poverty line	0.0281	0.07	0.6920	1.03
>= 5x poverty line	0.1556	0.06	0.0125	1.17
Missing/Refused/DK	-0.0023	0.06	0.9694	1.00
Race, Overall			<0.0001	
Mexican American	-0.0966	0.05	0.0810	0.91
Non-Hispanic Black	0.0889	0.04	0.0344	1.09
Non-Hispanic White	-0.1258	0.04	0.0020	0.88
Other Hispanic	-0.0401	0.06	0.5124	0.96
Other Race	0.1737	0.05	0.0008	1.19
Education, Overall			<0.0001	
< Median for age	-0.1865	0.04	<0.0001	0.83
Median for age	-0.0414	0.04	0.3249	0.96
>Median for age	0.1342	0.05	0.0146	1.14
Unknown education	0.0937	0.09	0.3092	1.10
Age, Overall			<0.0001	
16 to 19	-0.3314	0.06	<0.0001	0.72
20 to 29	0.1203	0.04	0.0044	1.13
30 to 39	0.1582	0.04	0.0002	1.17
40 to 49	0.0529	0.04	0.1498	1.05

Table A.12. *Parameter estimates and relative ratios from the model predicting the log-transformed amount of fish consumed in a meal (meal size) (g), NHANES 2013-March 2020*

	Parameter	**Std. error**	**p-Value**	**Relative ratio**
Intercept	4.1932	0.01	<0.0001	
Income, Overall			0.4531	
0 to <1x poverty line	0.0017	0.01	0.9062	1.00
1x to <2x poverty line	0.0072	0.02	0.7051	1.01
2x to <3x poverty line	-0.0102	0.02	0.5414	0.99
3x to <4x poverty line	0.0043	0.02	0.8293	1.00
4x to <5x poverty line	0.0272	0.03	0.3020	1.03
>= 5x poverty line	0.0166	0.02	0.3624	1.02
Missing/Refused/DK	-0.0467	0.02	0.0670	0.95
Race, Overall			<0.0001	
Mexican American	0.0881	0.02	<0.0001	1.09
Non-Hispanic Black	0.1170	0.01	<0.0001	1.12
Non-Hispanic White	0.0923	0.01	<0.0001	1.10
Other Hispanic	-0.0247	0.02	0.1802	0.98
Other Race	-0.2727	0.01	<0.0001	0.76
Education, Overall			0.0155	
< Median for age	-0.0096	0.01	0.5160	0.99
Median for age	0.0208	0.01	0.1598	1.02
>Median for age	0.0450	0.02	0.0080	1.05
Unknown education	-0.0562	0.03	0.0958	0.95
Age, Overall			0.2898	
16 to 19	-0.0482	0.03	0.1143	0.95
20 to 29	0.0050	0.01	0.7275	1.00
30 to 39	0.0270	0.01	0.0628	1.03
40 to 49	0.0162	0.01	0.2479	1.02

Table A.13. Parameter estimates and relative ratios from the model predicting the log-transformed mercury concentration of the fish consumed (μg/g), NHANES 2013-March 2020

	Parameter	**Std. error**	**p-Value**	**Relative ratio**
Intercept	-2.9757	0.03	<0.0001	
Income, Overall			0.4026	
0 to <1x poverty line	0.0347	0.03	0.2938	1.04
1x to <2x poverty line	0.0606	0.04	0.1782	1.06
2x to <3x poverty line	0.0140	0.04	0.7537	1.01
3x to <4x poverty line	0.0173	0.05	0.7131	1.02
4x to <5x poverty line	-0.0836	0.06	0.1897	0.92
>= 5x poverty line	0.0178	0.05	0.7121	1.02
Missing/Refused/DK	-0.0609	0.06	0.3112	0.94
Race, Overall			0.2109	
Mexican American	-0.0755	0.04	0.0510	0.93
Non-Hispanic Black	0.0201	0.03	0.5046	1.02
Non-Hispanic White	0.0447	0.03	0.0891	1.05
Other Hispanic	-0.0176	0.03	0.6127	0.98
Other Race	0.0283	0.03	0.3708	1.03
Education, Overall			0.2515	
< Median for age	0.0432	0.04	0.2366	1.04
Median for age	0.0703	0.04	0.0508	1.07
>Median for age	0.0273	0.05	0.5543	1.03
Unknown education	-0.1408	0.09	0.1102	0.87
Age, Overall			0.1633	
16 to 19	-0.0711	0.06	0.2513	0.93
20 to 29	-0.0322	0.04	0.3688	0.97
30 to 39	0.0428	0.03	0.1317	1.04
40 to 49	0.0605	0.04	0.0953	1.06

Table A.14. Parameter estimates and relative ratios from the model predicting the log-transformed inverse of body weight (1/kg), NHANES 2013-March 2020

	Parameter	Std. error	p-Value	Relative ratio
Intercept	-4.2811	0.01	<0.0001	
Income, Overall			0.4767	
0 to <1x poverty line	-0.0143	0.01	0.2739	0.99
1x to <2x poverty line	-0.0016	0.01	0.9120	1.00
2x to <3x poverty line	-0.0182	0.02	0.3644	0.98
3x to <4x poverty line	-0.0126	0.02	0.5212	0.99
4x to <5x poverty line	-0.0031	0.02	0.8997	1.00
>= 5x poverty line	0.0217	0.01	0.1222	1.02
Missing/Refused/DK	0.0282	0.02	0.1238	1.03
Race, Overall			<0.0001	
Mexican American	0.0009	0.01	0.9383	1.00
Non-Hispanic Black	-0.1202	0.01	<0.0001	0.89
Non-Hispanic White	-0.0249	0.01	0.0151	0.98
Other Hispanic	0.0675	0.01	<0.0001	1.07
Other Race	0.0767	0.02	<0.0001	1.08
Education, Overall			0.0016	
< Median for age	-0.0218	0.02	0.1645	0.98
Median for age	-0.0186	0.01	0.1388	0.98
>Median for age	0.0465	0.01	0.0011	1.05
Unknown education	-0.0061	0.03	0.8079	0.99
Age, Overall			<0.0001	
16 to 19	0.0934	0.02	0.0004	1.10
20 to 29	0.0236	0.01	0.1029	1.02
30 to 39	-0.0563	0.01	<0.0001	0.95
40 to 49	-0.0607	0.01	<0.0001	0.94

Table A.15. Parameter estimates and relative ratios from the model predicting the log-transformed mercury intake per unit body weight (µg/kg), NHANES 2013-March 2020

	Parameter	Std. error	p-Value	Relative ratio
Intercept	-1.7622	0.06	<0.0001	
Income, Overall			0.5203	
0 to <1x poverty line	-0.0651	0.07	0.3499	0.94
1x to <2x poverty line	0.0424	0.10	0.6660	1.04
2x to <3x poverty line	-0.0926	0.09	0.3087	0.91
3x to <4x poverty line	0.0165	0.09	0.8481	1.02
4x to <5x poverty line	-0.0314	0.12	0.7995	0.97
>= 5x poverty line	0.2118	0.10	0.0435	1.24
Missing/Refused/DK	-0.0817	0.10	0.4038	0.92
Race, Overall			0.2830	
Mexican American	-0.0832	0.08	0.3079	0.92
Non-Hispanic Black	0.1058	0.05	0.0363	1.11
Non-Hispanic White	-0.0137	0.05	0.7691	0.99
Other Hispanic	-0.0150	0.09	0.8678	0.99
Other Race	0.0060	0.07	0.9303	1.01
Education, Overall			0.0003	
< Median for age	-0.1747	0.06	0.0074	0.84
Median for age	0.0311	0.06	0.6178	1.03
>Median for age	0.2530	0.08	0.0033	1.29
Unknown education	-0.1094	0.14	0.4509	0.90
Age, Overall			0.0035	
16 to 19	-0.3573	0.10	0.0010	0.70
20 to 29	0.1166	0.06	0.0404	1.12
30 to 39	0.1717	0.06	0.0057	1.19
40 to 49	0.0689	0.06	0.2890	1.07

Appendix B

Geographic Distribution of Blood MeHg in the General U.S. Population Using NHANES 2009-2012

B1. Introduction

This analysis documents a study of the 1999-2012 National Health and Nutrition Examination Survey (NHANES) blood mercury and fish consumption data from the general U.S. population of women 16 to 49 years. Trends over time in blood methylmercury (MeHg) concentrations and demographic characteristics that are related to blood mercury concentrations have been updated and addressed with additional NHANES data 2013-March 2020 in the main report. Information presented in this appendix summarizes the analysis of the geographic distribution of blood mercury using NHANES 2009-2012 to reflect levels of recent years at the time of analysis and the blood MeHg modeling using NHANES 1999-2012.

B2. Methods

This geographic analysis applied the same methods detailed in sections 2.1 to 2.4 in the main report. In addition, serum cotinine concentration from laboratory tests and alcohol consumption data collected from questionnaires were included in this analysis. Serum cotinine served as a biomarker for assessing smoking status. The serum cotinine concentrations were log-transformed. Alcohol consumption has been shown to be related to blood mercury levels (Park and Lee, 2013). Alcohol consumption data are available for participants age 20 years and older. The analysis variable used in the model has four levels – greater than or equal to 12 drinks in past year, less than 12 drinks in past year, participants less than 20 years old, and participants with missing data for this variable.

Household annual income is derived using two sets of questions, the first for less than or greater than $20K and the second with a more detailed breakdown. The seven income categories used for the analysis are: less than $20K, $20K to $45K, greater than $45K to $75K, greater than $75K, greater than or equal to $20K (if second, more detailed question not answered), “refused” or “don’t know,” and missing information.

U.S. Census Region and coastal status data were obtained from the NCHS Research Data Center (http://www.cdc.gov/rdc/) through a proposal process for access to non-publicly available NHANES data. NCHS analysts derived the census region variable from the state of residence of the participant and the coastal status variable from the county of residence. If a county was adjacent to the Atlantic Ocean, Pacific Ocean, Gulf of Mexico, or one of the Great Lakes, it was considered coastal. All other counties were considered non-coastal. A list of coastal counties based on methods detailed in Mahaffey et al 2009, regardless of the geographic association of NHANES participants can be found in Table B.1. All analyses utilizing these restricted access variables were conducted at NCHS Research Data Center in Hyattsville, MD.

Table B.1. List of coastal counties

State	Coastal counties	State	Coastal counties	State	Coastal counties
Alabama	Baldwin County	Florida	Alachua County	Florida	Sarasota County
Alabama	Mobile County	Florida	Baker County	Florida	Seminole County
Alaska	Aleutians East Borough	Florida	Bay County	Florida	St. Johns County
Alaska	Aleutians West	Florida	Bradford County	Florida	St. Lucie County
Alaska	Anchorage Borough	Florida	Brevard County	Florida	Sumter County
Alaska	Bethel	Florida	Broward County	Florida	Suwannee County
Alaska	Bristol Bay Borough	Florida	Calhoun County	Florida	Taylor County
Alaska	City & Borough of Juneau	Florida	Charlotte County	Florida	Union County
Alaska	City & Borough of Sitka	Florida	Citrus County	Florida	Volusia County
Alaska	Dillingham	Florida	Clay County	Florida	Wakulla County
Alaska	Haines Borough	Florida	Collier County	Florida	Walton County
Alaska	Kenai Peninsula Borough	Florida	Columbia County	Florida	Washington County
Alaska	Ketchikan Gateway Borough	Florida	DeSoto County	Georgia	Bryan County
Alaska	Kodiak Island Borough	Florida	Dixie County	Georgia	Camden County
Alaska	Lake And Peninsula Borough	Florida	Duval County/City of Jacksonville	Georgia	Chatham County
Alaska	Nome	Florida	Escambia County	Georgia	Glynn County
Alaska	North Slope Borough	Florida	Flagler County	Georgia	Liberty County
Alaska	Northwest Arctic Borough	Florida	Franklin County	Georgia	McIntosh County
Alaska	Prince of Wales-Outer Ketchikan	Florida	Gadsden County	Hawaii	Hawaii County
Alaska	Skagway-Hoonah-Angoon	Florida	Gilchrist County	Hawaii	Honolulu City and County
Alaska	Valdez-Cordova	Florida	Glades County	Hawaii	Kalawao
Alaska	Wade Hampton	Florida	Gulf County	Hawaii	Kauai County
Alaska	Wrangell-Petersburg	Florida	Hamilton County	Hawaii	Maui County
Alaska	Yakutat	Florida	Hardee County	Illinois	Cook
California	Alameda County	Florida	Hendry County	Illinois	DuPage
California	Contra Costa County	Florida	Hernando County	Illinois	Kane
California	Del Norte County	Florida	Highlands County	Illinois	Lake
California	Humboldt County	Florida	Hillsborough County	Illinois	McHenry
California	Los Angeles County	Florida	Holmes County	Illinois	Will
California	Marin County	Florida	Indian River County	Indiana	Lake
California	Mendocino County	Florida	Jackson County	Indiana	LaPorte
California	Monterey County	Florida	Jefferson County	Indiana	Porter
California	Napa County	Florida	Lafayette County	Louisiana	Assumption Parish
California	Orange County	Florida	Lake County	Louisiana	Cameron Parish
California	San Diego County	Florida	Lee County	Louisiana	Iberia Parish
California	San Francisco City & County	Florida	Leon County	Louisiana	Jefferson Parish
California	San Luis Obispo County	Florida	Levy County	Louisiana	Lafayette Consolidated Government
California	San Mateo County	Florida	Liberty County	Louisiana	Lafourche Parish
California	Santa Barbara County	Florida	Madison County	Louisiana	Livingston Parish
California	Santa Clara County	Florida	Manatee County	Louisiana	Orleans Parish
California	Santa Cruz County	Florida	Marion County	Louisiana	Plaquemines Parish
California	Solano County	Florida	Martin County	Louisiana	St. Bernard Parish
California	Sonoma County	Florida	Miami-Dade County	Louisiana	St. Charles Parish
California	Ventura County	Florida	Monroe County	Louisiana	St. James Parish
Connecticut	Fairfield County	Florida	Nassau County	Louisiana	St. John The Baptist Parish
Connecticut	Hartford County	Florida	Okaloosa County	Louisiana	St. Mary Parish
Connecticut	Middlesex County	Florida	Okeechobee County	Louisiana	St. Tammany Parish
Connecticut	New Haven County	Florida	Orange County	Louisiana	Tangipahoa Parish
Connecticut	New London County	Florida	Osceola County	Louisiana	Terrebonne Parish
Connecticut	Tolland County	Florida	Palm Beach County	Louisiana	Vermilion Parish
Connecticut	Windham County	Florida	Pasco County	Maine	Androscoggin County
Delaware	Kent County	Florida	Pinellas County	Maine	Cumberland County
Delaware	New Castle County	Florida	Polk County	Maine	Hancock County
Delaware	Sussex County	Florida	Putnam County	Maine	Kennebec County
District of Columbia	District of Columbia	Florida	Santa Rosa County	Maine	Knox County

State	***Coastal counties***	***State***	***Coastal counties***	***State***	***Coastal counties***
Maine	Lincoln County	Michigan	Marquette	New York	Queens County
Maine	Sagadahoc County	Michigan	Mason	New York	Richmond County (Staten Island)
Maine	Waldo County	Michigan	Menominee	New York	Rockland County
Maine	Washington County	Michigan	Midland	New York	Suffolk County
Maine	York County	Michigan	Monroe	New York	Westchester County
Maryland	Anne Arundel County	Michigan	Muskegon	North Carolina	Beaufort County
Maryland	Baltimore City	Michigan	Oakland	North Carolina	Bertie County
Maryland	Baltimore County	Michigan	Oceana	North Carolina	Brunswick County
Maryland	Calvert County	Michigan	Ontonagon	North Carolina	Camden County
Maryland	Caroline County	Michigan	Ottawa	North Carolina	Carteret County
Maryland	Cecil County	Michigan	Presque Isle	North Carolina	Chowan County
Maryland	Charles County	Michigan	Saginaw	North Carolina	Craven County
Maryland	Dorchester County	Michigan	Sanilac	North Carolina	Currituck County
Maryland	Harford County	Michigan	Schoolcraft	North Carolina	Dare County
Maryland	Howard County	Michigan	St. Clair	North Carolina	Hyde County
Maryland	Kent County	Michigan	Tuscola	North Carolina	Jones County
Maryland	Montgomery County	Michigan	Van Buren	North Carolina	New Hanover County
Maryland	Prince George's County	Michigan	Washtenaw	North Carolina	Onslow County
Maryland	Queen Anne's County	Michigan	Wayne	North Carolina	Pamlico County
Maryland	Somerset County	Minnesota	Carlton	North Carolina	Pasquotank County
Maryland	St. Mary's County	Minnesota	Cook	North Carolina	Pender County
Maryland	Talbot County	Minnesota	Lake	North Carolina	Perquimans County
Maryland	Wicomico County	Minnesota	St. Louis	North Carolina	Tyrrell County
Maryland	Worcester County	Mississippi	Hancock County	North Carolina	Washington County
Massachusetts	Barnstable County	Mississippi	Harrison County	Ohio	Ashtabula
Massachusetts	Bristol County	Mississippi	Jackson County	Ohio	Cuyahoga
Massachusetts	Dukes County	New Hampshire	Rockingham County	Ohio	Erie
Massachusetts	Essex County	New Hampshire	Strafford County	Ohio	Geauga
Massachusetts	Middlesex County	New Jersey	Atlantic County	Ohio	Huron
Massachusetts	Nantucket County	New Jersey	Bergen County	Ohio	Lake
Massachusetts	Norfolk County	New Jersey	Burlington County	Ohio	Lorain
Massachusetts	Plymouth County	New Jersey	Camden County	Ohio	Lucas
Massachusetts	Suffolk County	New Jersey	Cape May County	Ohio	Medina
Michigan	Alcona	New Jersey	Cumberland County	Ohio	Ottawa
Michigan	Alger	New Jersey	Essex County	Ohio	Sandusky
Michigan	Allegan	New Jersey	Glouchester County	Ohio	Seneca
Michigan	Alpena	New Jersey	Hudson County	Ohio	Summit
Michigan	Antrim	New Jersey	Middlesex County	Ohio	Wood
Michigan	Arenac	New Jersey	Monmouth County	Oregon	Clatsop County
Michigan	Baraga	New Jersey	Ocean County	Oregon	Columbia County
Michigan	Bay	New Jersey	Passaic County	Oregon	Coos County
Michigan	Benzie	New Jersey	Salem County	Oregon	Curry County
Michigan	Berrien	New Jersey	Union County	Oregon	Douglas County
Michigan	Charlevoix	New York	Cattaraugus	Oregon	Lane County
Michigan	Cheboygan	New York	Cayuga	Oregon	Lincoln County
Michigan	Chippewa	New York	Chautauqua	Oregon	Multnomah County
Michigan	Delta	New York	Erie	Oregon	Tillamook County
Michigan	Emmet	New York	Genesee	Oregon	Washington County
Michigan	Genesee	New York	Jefferson	Pennsylvania	Crawford
Michigan	Gladwin	New York	Livingston	Pennsylvania	Erie
Michigan	Gogebic	New York	Monroe	Pennsylvania	Delaware County
Michigan	Grand Traverse	New York	Niagara	Pennsylvania	Montgomery County
Michigan	Houghton	New York	Onondaga	Pennsylvania	Philadelphia County
Michigan	Huron	New York	Ontario	Rhode Island	Bristol County
Michigan	Iosco	New York	Orleans	Rhode Island	Kent County
Michigan	Kalkaska	New York	Oswego	Rhode Island	Newport County
Michigan	Keweenaw	New York	Seneca	Rhode Island	Providence County
Michigan	Lapeer	New York	Wayne	Rhode Island	Washington County
Michigan	Leelanau	New York	Wyoming	South Carolina	Beaufort County
Michigan	Luce	New York	Bronx County	South Carolina	Berkeley County
Michigan	Mackinac	New York	Kings County (Brooklyn)	South Carolina	Charleston County
Michigan	Macomb	New York	Nassau County	South Carolina	Colleton County
Michigan	Manistee	New York	New York County (Manhattan)	South Carolina	Georgetown County

State	Coastal counties	State	Coastal counties	State	Coastal counties
South Carolina	Horry County	Virginia	Henrico County	Washington	Jefferson County
South Carolina	Jasper County	Virginia	Isle of Wight County	Washington	King County
Texas	Aransas County	Virginia	James City County	Washington	Kitsap County
Texas	Brazoria County	Virginia	King and Queen County	Washington	Mason County
Texas	Calhoun County	Virginia	King George County	Washington	Pacific County
Texas	Cameron County	Virginia	Lancaster County	Washington	Pierce County
Texas	Chambers County	Virginia	Manassas City	Washington	San Juan County
Texas	Galveston County	Virginia	Manassas Park City	Washington	Skagit County
Texas	Harris County	Virginia	Matthews County	Washington	Snohomish County
Texas	Jackson County	Virginia	Middlesex County	Washington	Thurston County
Texas	Jefferson County	Virginia	New Kent County	Washington	Wahkiakum County
Texas	Kenedy County	Virginia	Newport News City	Washington	Whatcom County
Texas	Kleberg County	Virginia	Norfolk City	Wisconsin	Ashland
Texas	Matagorda County	Virginia	Northampton County	Wisconsin	Bayfield
Texas	Nueces County	Virginia	Northumberland County	Wisconsin	Brown
Texas	Orange County	Virginia	Poquoson City	Wisconsin	Calumet
Texas	Refugio County	Virginia	Portsmouth City	Wisconsin	Door
Texas	San Patricio County	Virginia	Prince William County	Wisconsin	Douglas
Texas	Victoria County	Virginia	Richmond City	Wisconsin	Iron
Texas	Willacy County	Virginia	Richmond County	Wisconsin	Kenosha
Virginia	Accomack County	Virginia	Stafford County	Wisconsin	Kewaunee
Virginia	Alexandria City	Virginia	Suffolk City	Wisconsin	Manitowoc
Virginia	Arlington County	Virginia	Surry County	Wisconsin	Marinette
Virginia	Charles City County	Virginia	Virginia Beach City	Wisconsin	Milwaukee
Virginia	Chesapeake City	Virginia	Westmoreland County	Wisconsin	Oconto
Virginia	Clifton Forge City	Virginia	Williamsburg City	Wisconsin	Ozaukee
Virginia	Essex County	Virginia	York County	Wisconsin	Racine
Virginia	Fairfax City	Washington	Clallam County	Wisconsin	Sheboygan
Virginia	Fairfax County	Washington	Clark County	Wisconsin	Washington
Virginia	Falls Church City	Washington	Cowlitz County	Wisconsin	Waukesha
Virginia	Gloucester County	Washington	Grays Harbor County		
Virginia	Hampton City	Washington	Island County		

B3. Results

B3.1 Blood MeHg Summary Statistics of Geographic Distributions

Figure B-1 presents the geometric mean and 95 percent confidence interval of blood MeHg concentration by U.S. census region and coastal status for women 16 to 49 years during the survey period 2009-2012. Women in the Northeast region have the highest geometric mean concentrations while those in the Midwest have the lowest and those in coastal areas have higher geometric mean concentrations than those residing in non-coastal areas. Similar patterns are observed in the percentiles (Table B.2).

Figure B.1. Geometric mean and 95 percent CI of MeHg by geography (NHANES 2009-2012)

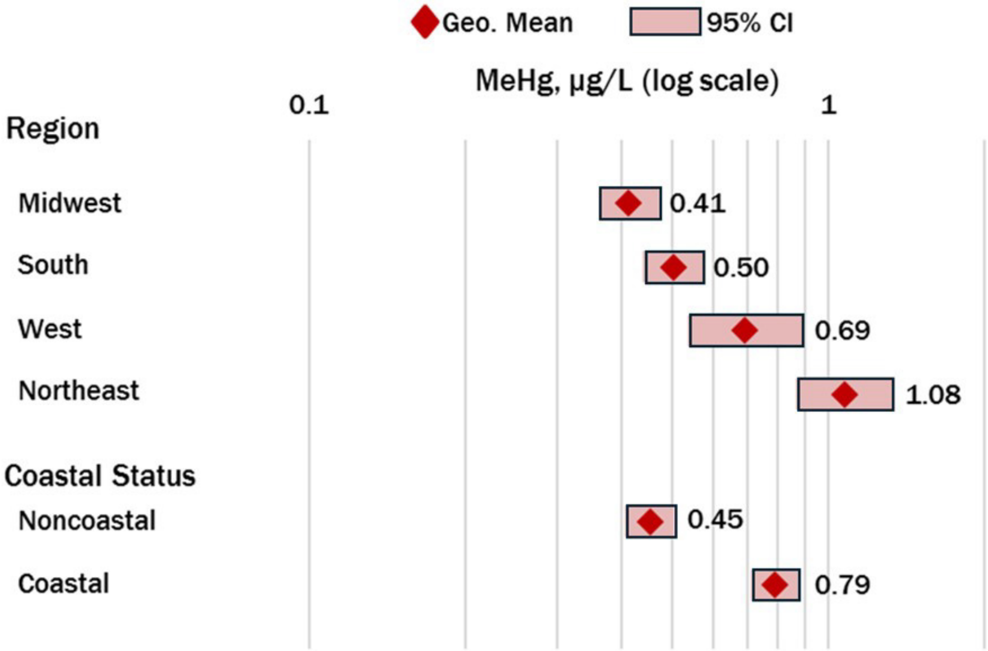


Table B.2. Distribution of blood MeHg concentrations by geography (NHANES 2009-2012)

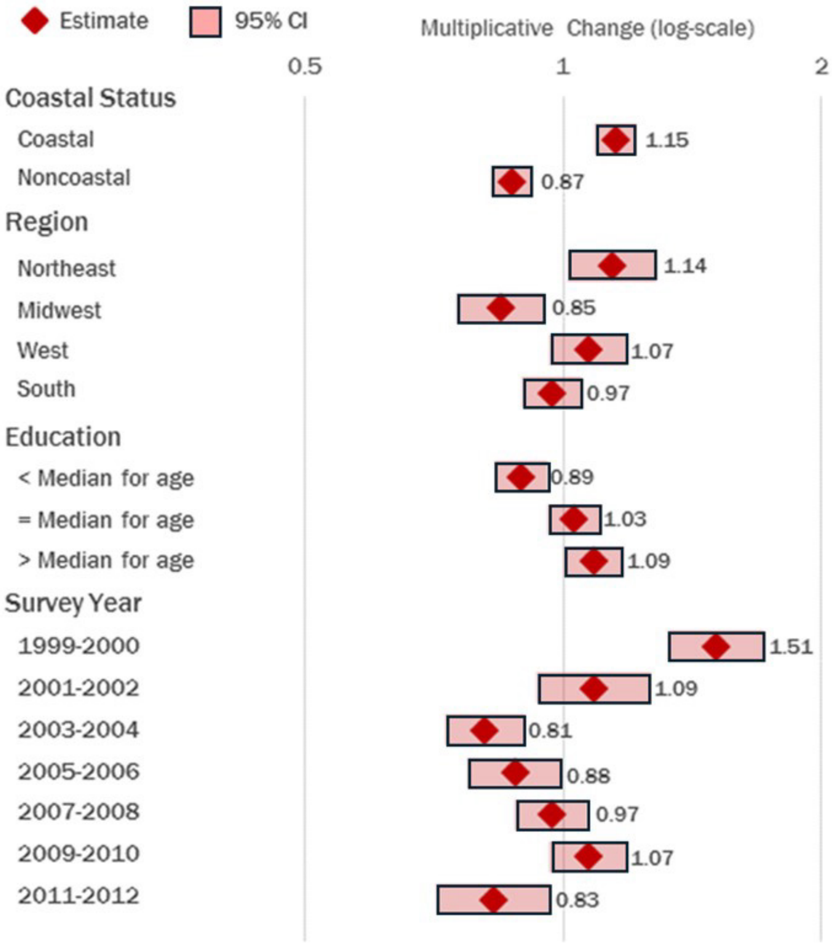
Geographic locations	N	Geometric. mean	Percentiles		
		(95% CI)	25th	75th	90th
Northeast	490	1.08 (0.87,1.33)	0.49	2.57	3.90
Midwest	678	0.41 (0.36,0.47)	0.21	0.72	1.46
West	841	0.69 (0.54,0.90)	0.31	1.51	2.71
South	1164	0.50 (0.44,0.58)	0.24	1.00	1.94
Noncoastal	1593	0.45 (0.41,0.51)	0.22	0.84	1.77
Coastal	1580	0.79 (0.71,0.88)	0.35	1.71	3.25

Note: Geometric mean and percentiles were calculated from the mean of 20 imputed values for each respondent.

B3.2 Blood MeHg Modeling

The results of the multivariable modeling of blood MeHg concentrations are described in this section. Transformed usual intake of mercury (TUI) through fish consumption (µg Hg/day) was the most highly significant predictor of blood MeHg concentration, with higher consumption associated with higher blood MeHg concentration. Additionally, the interaction between race/ethnicity and TUI is significant, indicating that blood MeHg concentration increases at different rates with increasing intake of fish mercury by racial/ethnic group. Other significant predictors include the geographic variables, education, and survey release. Figure B-2 presents the multiplicative change in blood MeHg concentration with 95 percent confidence intervals, for region, coastal status, and demographic characteristics. Coastal status and region are associated with blood MeHg concentration ($p<0.0001$ and $p=0.02$, respectively), with coastal residence and residence in the Northeast associated with higher blood MeHg concentrations. Residence in the Midwest is associated with lower blood MeHg concentration. Education is positively associated with blood MeHg concentrations ($p=0.008$). NHANES survey release is also associated with blood MeHg concentration ($p<0.0001$). The earliest study year, NHANES 1999-2000, has the highest concentrations and NHANES 2003-2004 and 2011-2012 have the lowest concentrations.

Figure B.2. Multiplicative change for statistically significant predictors of blood MeHg concentration (NHANES 1999-2012)



Of the remaining predictors in the model, only hematocrit, had a significant association with blood MeHg concentration ($p<0.0001$), with increasing hematocrit associated with increasing blood MeHg concentration. Table B.3 provides the full model results.

Table B.3. Modeling results predicting blood MeHg concentrations

Parameter	Estimate	LCL	UCL	tValue	Probt	fValue	ProbF
Intercept	0.6604	0.4314	0.8893	5.72	<0.0001		
TUI	1.3939	1.2102	1.5775	15.06	<0.0001		
TUIV	-0.0443	-0.1848	0.0962	-0.63	0.5332		
TUI x log-transformed body weight (centered)	-0.3744	-0.7538	0.0051	-1.96	0.0533		
TUI x Race/Ethnicity						9.06	<0.0001
TUI x Mexican American	-0.2616	-0.4405	-0.0828	-2.90	0.0046		
TUI x non-Hispanic Black	-0.1604	-0.3479	0.0271	-1.70	0.0929		
TUI x non-Hispanic White	0.5524	0.3438	0.7610	5.25	<0.0001		
TUI x other Hispanic	-0.0502	-0.2981	0.1978	-0.40	0.6891		
TUI x other race	-0.0802	-0.3524	0.1920	-0.58	0.5603		
Age, decade (centered)	0.0101	-0.0552	0.0754	0.31	0.7602		
Log-transformed body weight (centered)	-0.5116	-1.0021	-0.0210	-2.07	0.0414		
Log-transformed body weight2 (centered)	-0.2173	-0.6731	0.2384	-0.95	0.3466		
Coastal Status						23.70	<0.0001
Coastal	0.1395	0.0826	0.1963	4.87	<0.0001		
Non-coastal	-0.1395	-0.1963	-0.0826	-4.87	<0.0001		
Region						3.36	0.0222
Northeast	0.1305	0.0090	0.2521	2.13	0.0358		
Midwest	-0.1677	-0.2856	-0.0498	-2.82	0.0058		
West	0.0676	-0.0363	0.1716	1.29	0.2001		
South	-0.0304	-0.1111	0.0502	-0.75	0.4558		
Alcohol Consumption						2.58	0.0581
<12 drinks past year	0.1058	0.0248	0.1867	2.59	0.0111		
≥12 drinks past year	0.0264	-0.0896	0.1424	0.45	0.6527		
<20 years old	-0.0958	-0.2253	0.0338	-1.47	0.1458		
Refused/Don't know/ Missing	-0.0364	-0.2001	0.1273	-0.44	0.6602		
Household Income						1.64	0.1458
<$20K	-0.1030	-0.2217	0.0157	-1.72	0.0885		
$20K to <$45K	-0.0348	-0.1481	0.0784	-0.61	0.5429		
$45K to <$75K	0.0932	-0.0214	0.2078	1.61	0.1102		
$75K and over	0.1173	-0.0281	0.2626	1.60	0.1130		
$20K and over	0.1187	-0.1362	0.3737	0.92	0.3579		
Refused/Don't know	0.0159	-0.3140	0.3458	0.10	0.9239		
Missing	-0.2072	-0.4997	0.0853	-1.41	0.1632		
Education						5.10	0.0079
<Median for age	-0.1134	-0.1847	-0.0421	-3.15	0.0022		
Median for age	0.0300	-0.0446	0.1046	0.80	0.4269		
>Median for age	0.0834	0.0037	0.1632	2.07	0.0408		
Race/Ethnicity						4.99	0.0011
Mexican American	-0.3862	-0.6024	-0.1700	-3.54	0.0006		
Non-Hispanic Black	-0.0117	-0.2302	0.2067	-0.11	0.9155		
Non-Hispanic White	0.4682	0.1973	0.7392	3.43	0.0009		
Other Hispanic	0.0392	-0.2748	0.3532	0.25	0.8048		
Other race	-0.1095	-0.4383	0.2193	-0.66	0.5105		

Parameter	**Estimate**	**LCL**	**UCL**	**tValue**	**Probt**	**fValue**	**ProbF**
NHANES Survey Year						9.34	<0.0001
1999-2000	0.4108	0.2809	0.5406	6.28	<0.0001		
2001-2002	0.0822	-0.0725	0.2369	1.05	0.2947		
2003-2004	-0.2095	-0.3164	-0.1026	-3.89	0.0002		
2005-2006	-0.1295	-0.2556	-0.0034	-2.04	0.0444		
2007-2008	-0.0327	-0.1316	0.0663	-0.66	0.5140		
2009-2010	0.0667	-0.0392	0.1726	1.25	0.2144		
2011-2012	-0.1880	-0.3420	-0.0339	-2.42	0.0174		
Log -transformed hematocrit (centered)	1.4304	0.8855	1.9752	5.21	<0.0001		
Log -transformed cotinine (centered)	0.0298	-0.0155	0.0751	1.31	0.1950		
Log -transformed cotinine2 (centered)	-0.0251	-0.0703	0.0201	-1.10	0.2731		
Log -transformed cotinine3 (centered)	0.0164	-0.0435	0.0763	0.54	0.5880		