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ORIGINAL ARTICLE

Seafood consumption among pregnant and non-pregnant women of childbearing age in the United States, NHANES 1999–2006

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Abstract

Objectives: Long-chain polyunsaturated fatty acids found in seafood are essential for optimal neurodevelopment of the fetus. However, concerns about mercury contamination of seafood and its potential harm to the developing fetus have created uncertainty about seafood consumption for pregnant women. We compared fish and shellfish consumption patterns, as well as their predictors, among pregnant and non-pregnant women of childbearing age in the US.
Methods: Data from 1,260 pregnant and 5,848 non-pregnant women aged 16–49 years from the 1999 to 2006 National Health and Nutrition Examination Survey (NHANES) were analyzed. Frequency and type of seafood consumed and adjusted associations of multiple characteristics with seafood consumption were estimated for pregnant and non-pregnant women, separately. Time trends were also examined.
Results: There were no significant differences in the prevalence of fish or shellfish consumption, separately or combined, between pregnant and non-pregnant women using either the 30-day questionnaire or the Day 1, 24-h recall. Seafood consumption was associated with higher age, income, and education among pregnant and non-pregnant women, and among fish consumers these groups were more likely to consume ≥ 3 servings in the past 30 days. Tuna and shrimp were the most frequently reported fish and shellfish, respectively, among both pregnant and non-pregnant women. We observed no significant time trends.
Conclusion: There were no differences in seafood consumption between pregnant and non-pregnant women, and the factors related to seafood consumption were similar for both groups. Our data suggest that many women consume less than the recommended two servings of seafood a week.

Keywords: *pregnant*; *fish*; *seafood*; *NHANES*; *mercury*
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Maternal diet and nutritional status during pregnancy is an important determinant of fetal growth and development (1, 2). Fish and shellfish are the primary dietary sources of long-chain omega 3 (N-3) polyunsaturated fatty acids (LCPUFAs), specifically docosahexaenoic acid (DHA) and eicosapentaenoic acid that are essential for optimal neurodevelopment of the fetus during pregnancy and in infants (3–7). Many studies have concluded that seafood consumption is associated with a reduced proportion of small-for-gestational-age births, increase in gestational length, prolonged length of gestation, and increased birth weight (8–11). The Dietary Guidelines for Americans (DGA) recommend increasing the amount and variety of seafood consumed by choosing seafood in place of some meat and poultry for the general population and consumption of 8–12 ounces (227 to 340 g) of seafood per week from a variety of seafood types for pregnant and breastfeeding women (12). In the past few years, expert panels have released consensus guidelines (3) for DHA intake during pregnancy, including the consumption of two servings of seafood a week for pregnant and lactating women. Reports from a variety of agencies including the Centers for Disease Control and Prevention indicate that average quantities of seafood consumed by the general US population and by several specific population groups,

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including pregnant women, are below recommended levels, and only about a quarter of pregnant women in the United States are eating the amount of fish recommended to achieve DHA intake for optimal maternal and child health (3).

This lack of seafood intake may be due in part to difficulties in interpreting and balancing the recommendations to limit the intake of certain types of seafood during pregnancy due to concerns about methylmercury contamination. High concentrations of methylmercury could harm the fetus, but the results of studies assessing the association between exposures to lower concentrations of methylmercury and the neurological development of children have been inconsistent (13–17). The United States Food and Drug Administration (FDA) and the US Environmental Protection Agency (EPA) have issued warnings recommending that pregnant women and women of childbearing age who may become pregnant avoid consumption of shark, swordfish, king mackerel, and tile fish because they contain high concentrations of mercury (3, 18). Many local and state agencies issue additional fish advisories and bans relating to locally caught fish (3, 19). Although the FDA and EPA also advise consumption of two servings per week of seafood with low mercury concentrations, such as shrimp and salmon (3, 18), a quantitative study found that many pregnant women reported not consuming fish due to advice on limiting fish intake as well as a lack of information about which seafood types they should be eating (20).

The recommendations regarding seafood consumption (21, 22) that it is important for the developing fetus yet simultaneously potentially hazardous due to potential contamination with methylmercury have created challenges in providing adequate messages on seafood consumption for pregnant women. It is important to understand the fish consumption patterns in pregnant women, and how it differs from that of non-pregnant women of childbearing age, in order to gauge how current recommendations regarding seafood intake may be impacting these populations and to use as a baseline for future comparisons. The objective of this paper was to compare fish and shellfish consumption patterns, as well as their predictors, among pregnant and non-pregnant women of childbearing age in the US using data from the National Health and Nutrition Examination Survey (NHANES).

Methods

Data source

We used data obtained from the 1999 through 2006 NHANES. NHANES is a stratified, multistage probability sample of the civilian, non-institutionalized population of the US conducted by the National Center for Health Statistics (NCHS) at the US Centers for Disease Control and Prevention. The NCHS Research Ethics Review Board approved the NHANES protocol. The consent form to participate in the survey as well as storing specimens of their blood for future research was signed by all participants of the survey. NHANES includes an in-home questionnaire and a physical examination including laboratory tests at a Mobile Examination Center (MEC) (23, 24). Details of the surveys including questionnaires, data, and reports can be found on NHANES website (http://www.cdc.gov/nchs/nhanes/about_nhanes.htm).

Study sample

Our study included all women aged 16–49 years, who completed both the interview and examination portions of NHANES. The NHANES variable RIDEXPREG was used to determine pregnancy status for this study. Women who were identified as pregnant through a positive lab pregnancy test or who self-reported as pregnant at the time of the interview were considered pregnant and those who specified that they were not pregnant at the time of the interview and who did not test positive in the lab pregnancy test were considered non-pregnant. Women with missing pregnancy status and those for whom pregnancy status could not be ascertained were not included in this study. NHANES oversamples certain populations including pregnant women; however we restricted our analysis to the years 1999–2006 since starting in 2007 pregnant women were no longer oversampled pregnant women and the age ranges included in the public release dataset for pregnant women were restricted to 20–44 years of age, while for previous years there was essentially no bound (variable available for ages 8–59 years).

Fish and shellfish consumption

At the MEC, after completion of a 24-h dietary recall interview, NHANES survey participants (http://www.cdc.gov/nchs/nhanes/about_nhanes.htm, including women aged 16–49 years of age, were asked about fish and shellfish consumption during the previous 30 days. Respondents were asked whether they consumed fish and/or shellfish in the past 30 days, and if so, the frequency of consumption during that time. Participants were then asked about different types of fish and shellfish including a category for other and unknown fish or shellfish. No information was obtained about portion sizes or preparation methods through the 30-day questionnaire. We used the Day 1, 24-h dietary recall interview, to obtain information on serving sizes for both pregnant and non-pregnant women.

Covariates

Demographic information including age, race, and ethnicity; educational attainment; and poverty income ratio were self-reported at the time of the interview.

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We categorized race and ethnicity into the following categories: non-Hispanic white, non-Hispanic black, Mexican American and other race/ethnicity. Poverty income ratio is the total household income divided by the poverty threshold for the year of the interview. The poverty threshold is determined annually by the US Census Bureau, taking into account geographic location, rate of inflation, and family size (25).

Statistical analysis

Analyses were conducted using SAS (version 9.3; SAS Institute, Cary, NC) and SUDAAN (version 10.0; Research Triangle Institute, Research Triangle Park, NC). MEC examination sample weights and the appropriate sample design variables were used in the analysis to account for the complex survey design, oversampling, and differential non-response and non-coverage in order to obtain nationally representative estimates of the US civilian non-institutionalized population.

SUDAAN's Taylor series linearization method was used to calculate 95% confidence intervals (CIs) for the estimated prevalences, and Chi-square statistics were used to compare pregnant to non-pregnant women. Logistic regression was used to examine the potential associations between seafood intake and selected characteristics including age, race/ethnicity, education, and poverty income ratio in pregnant and non-pregnant women. Trend analyses were conducted using linear regression to examine seafood consumption over the four 2-year survey cycles from 1999 to 2006.

Results

We analyzed data on 7,108 women from 1999 to 2006: 1,260 pregnant women and 5,848 non-pregnant women who had completed interviews, exams, and valid pregnancy data. There were statistically significant differences in the distribution of pregnant and non-pregnant women by age group ($p \leq 0.0001$), with over 91% of pregnant women younger than 36 years of age, compared to approximately 53% of non-pregnant women in those age groups (Table 1). There were also significant differences by race/ethnicity ($p \leq 0.0001$), with a greater percentage of pregnant women compared to non-pregnant women being Mexican American, approximately 16 and 9%, respectively (Table 1). There were no significant differences by pregnancy status in the prevalence of fish, shellfish, or seafood (fish and/or shellfish) consumption over the previous 30 days (all $p > 0.05$). Fish consumption was more commonly reported than shellfish consumption, for both pregnant women (63.0 and 46.7%, respectively) and non-pregnant women (68.4 and 51.2%, respectively). Based on data from the Day 1 dietary recall, daily mean grams of seafood intake, among women who reported seafood consumption in the last 24 h, was similar for both pregnant and non-pregnant women (110.4 and 117.6 g, respectively) ($p = 0.69$).

Any seafood consumption in the 30 days prior to the MEC examination was significantly associated with increasing age for both pregnant and non-pregnant women (Table 2). Pregnant women 36–49 years of age were five and a half times more likely to have consumed fish or shellfish in the last 30 days (95% CI: 1.55, 19.52) compared to pregnant women aged 16–25 years; the corresponding association among non-pregnant women was less than two-fold (Odds Ratio [OR]: 1.98, 95% CI: 1.68, 2.33). Among non-pregnant women, non-Hispanic black race/ethnicity was significantly associated with increased odds of seafood consumption, compared to non-Hispanic white race/ethnicity (OR: 1.75, 95% CI: 1.33, 2.31). In addition, education greater than high school (OR: 1.80; 95% CI: 1.49, 2.18, reference less than high school graduate) was also associated with seafood consumption among non-pregnant women. Although similar patterns were seen among pregnant women for education, these associations were not statistically significant. There were no significant associations with poverty income ratio.

For both pregnant and non-pregnant women, those who were older, had higher education, and higher poverty income ratio were more likely to have reported consuming three or more servings of seafood in the past 30 days. Also for both pregnant and non-pregnant women, Non-Hispanic whites (53.3 and 55.8%, respectively) and Non-Hispanic blacks (53.0 and 63.6%, respectively) were more likely to report consuming three or more servings of seafood in the last 30 days compared to Mexican–Americans (38.9 and 48.2%, respectively) (Table 3). Non-pregnant women in the 'other/multiracial' category were also more likely to report higher seafood consumption (59.6%) compared to Mexican–Americans; sample size did not permit an estimate for this racial/ethnic group among pregnant women (Table 3).

Women who reported seafood consumption were then asked to report on how many occasions during the past 30 days they consumed specific types of fish and shellfish. Tuna, salmon, and catfish were the most commonly consumed fish, and shrimp and crab were the most commonly consumed shellfish among both pregnant and non-pregnant women (Table 4).

We examine trends in fish and shellfish consumption from 1999 to 2006 and found that trends appear stable over time for both pregnant and non-pregnant women ($p_{\text{trend}} = 0.41$ and 0.68, respectively) (Fig. 1).

Discussion

We observed no significant differences in the prevalence, amount, or type of consumption of fish and shellfish, separately or combined, between pregnant and non-pregnant women. However, we observed that among

Table 1. Characteristics of US pregnant and non-pregnant women in NHANES 1999–2006

	Pregnant women		Non-pregnant women	
	N[a]	%[b] (95% CI)	*N*[a]	%[b] (95% CI)
Total	1,260		5,848	
Age (years)				
16–25	586	41.6 (37.0, 46.5)	2,512	26.3 (24.8, 27.8)
26–35	595	49.6 (44.1, 55.1)	1,264	26.5 (24.9, 28.1)
36–49	79	8.8 (5.8, 13.0)	2,072	47.3 (45.3, 49.3)
		$p^* < 0.0001$		
Race				
Non-Hispanic white	559	55.1 (49.4, 60.7)	2,276	66.5 (63.2, 69.7)
Non-Hispanic black	199	15.9 (12.2, 20.4)	1,499	13.1 (11.1, 15.4)
Mexican–American	368	15.7 (12.8, 19.1)	1,552	8.6 (7.2, 10.4)
Other/multiracial	134	13.4 (9.3, 18.8)	521	11.8 (9.7, 14.2)
		$p^* < 0.0001$		
Education level				
< HS graduate	400	23.4 (19.8, 27.5)	2,130	20.7 (19.2, 22.3)
HS graduate or GED	275	18.9 (15.5, 22.8)	1,278	22.9 (21.4, 24.5)
Greater than HS	584	57.6 (53.0, 62.2)	2,435	56.3 (54.0, 58.5)
Missing	1	–[c]	5	–[c]
		$p^* = 0.17$		
Poverty income ratio[d]				
0–1.3	411	24.4 (20.6, 28.8)	1,922	23.6 (21.5, 25.9)
1.301–3.5	412	35.6 (31.9, 39.5)	1,947	32.9 (30.9, 34.9)
3.501+	346	32.7 (27.9, 37.9)	1,577	37.9 (35.4, 40.5)
Missing	91	7.3 (5.0, 10.5)	402	5.6 (4.7, 6.7)
		$p^* = 0.12$		
Fish or shellfish consumption in the past 30 days				
No	306	23.1 (18.9, 27.9)	1,286	18.9 (17.2, 20.7)
Yes	902	73.2 (67.8, 78.0)	4,337	77.8 (75.8, 79.8)
Missing	52	3.7 (2.4, 5.8)	225	3.3 (2.7, 4.2)
		$p^* = 0.14$		
Fish consumption in the past 30 days				
No	465	33.3 (28.9, 38.1)	1,933	28.3 (26.3, 30.3)
Yes	743	63.0 (57.6, 68.0)	3,692	68.4 (66.2, 70.5)
Missing	52	3.7 (2.4, 5.8)	223	3.3 (2.6, 4.1)
		$p^* = 0.08$		
Shellfish consumption in the past 30 days				
No	630	49.6 (44.9, 54.4)	2,733	45.4 (42.7, 48.0)
Yes	578	46.7 (41.7, 51.6)	2,888	51.2 (48.4, 54.1)
Missing	52	3.7 (2.35, 5.8)	227	3.4 (2.7, 4.2)
		$p^* = 0.19$		
Daily mean grams of seafood (24-h recall)[e]				
	110.4 (77.5, 143.3)		117.6 (106.9, 128.3)	
		$p^* = 0.69$		

HS, high school; GED, General Education Development; CI, confidence interval.
[a]Unweighted *N*.
[b]Weighted column percentage.
[c]Estimates suppressed because minimum degrees of freedom (12) for strata not met.
[d]Poverty income ratio is the total household income divided by the poverty threshold for the year of the interview.
[e]Among women who reported any seafood consumption in the 24-h recall.
*p-values for χ^2 test.

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Table 2. Factors associated with any seafood consumption within 30 days prior to examination among US pregnant and non-pregnant women aged 16–49, NHANES 1999–2006

	Pregnant women	Non-pregnant women
	Odds ratio (95% CI)[a]	Odds ratio (95% CI)[a]
Age (years)		
16–25	1.0 (Ref)	1.0 (Ref)
26–35	1.60 (0.99, 2.60)	1.51 (1.23, 1.85)
36–49	5.50 (1.55, 19.52)	1.98 (1.68, 2.33)
Race		
Non-Hispanic white	1.0 (Ref)	1.0 (Ref)
Non-Hispanic black	1.37 (0.79, 2.36)	1.75 (1.33, 2.31)
Mexican–American	1.10 (0.67, 1.82)	1.19 (0.94, 1.51)
Other/multiracial	0.83 (0.35, 1.95)	1.31 (0.94, 1.81)
Education level		
< HS graduate	1.0 (Ref)	1.0 (Ref)
HS graduate or GED	1.33 (0.74, 2.39)	0.93 (0.74, 1.18)
Greater than HS	1.42 (0.84, 2.39)	1.80 (1.49, 2.18)
Poverty income ratio[b]		
0–1.3	1.0 (Ref)	1.0 (Ref)
1.301–3.5	1.31 (0.70, 2.44)	0.95 (0.73, 1.24)
3.501 +	1.37 (0.67, 2.80)	1.15 (0.89, 1.48)

CI, confidence interval; HS, high school; GED, General Education Development.

[a]Odds ratios are adjusted for age, race, education level, and poverty income ratio.

[b]Poverty income ratio is the total household income divided by the poverty threshold for the year of the interview.

both groups of women substantial proportions are not consuming any seafood, which may be particularly important during pregnancy. NHANES data do not allow us to assess potential motivations for lack of seafood intake, but a contributing factor may be concern about methylmercury contamination, particularly for pregnant women. A recent qualitative study of fish consumption during pregnancy found that women reported many barriers including not remembering which fish types were better to eat during pregnancy, advice to avoid fish, as well as perceiving fish to be costly (20). Some of motivations for fish consumption in pregnant women included having a portable list of fish types and having their obstetricians advised them to eat fish (20).

Fetuses are a high-risk group for methylmercury exposure because of the increased susceptibility of the developing brain to this exposure; however, studies examining the associations between methylmercury exposure and children's neurodevelopment have had inconsistent findings (26, 27). In some of the studies assessing the impact of methylmercury on children's health, detrimental associations between prenatal mercury exposure and the neurological development of the children have been observed (13–15), while others have reported no significant associations between methylmercury exposure and adverse outcomes in children (16, 17). Measures of neurodevelopment studied included decreased physical activity levels, loss of IQ points, and decreased performance on standardized tests, including those assessing memory, attention, language, and spatial cognition. Given that permanent damage to the developing brain can possibly occur with methylmercury exposure, the FDA and EPA have issued advisories on seafood consumption for pregnant women and women of childbearing age (18). Although swordfish, king mackerel, and shark are recommended by the FDA (18) and EPA (19) to be avoided during pregnancy, there were pregnant women in NHANES that reported consuming these types of fish, although the number was small.

Although the FDA advisory clearly states the types of fish that should be avoided, it does not provide a comprehensive list of fish that are considered safe to be consumed by pregnant women. For example, the advisory states 'Eat up to 12 ounces (two average meals) a week of a variety of fish and shellfish that are lower in mercury' and lists five of the most commonly eaten fish that are low in mercury (18). A qualitative study of fish consumption during pregnancy found that many pregnant women knew that fish might contain mercury and had received advice on limiting fish consumption but had not received advice on the types of fish that are safe to consume (20). Therefore, many of the women avoided fish consumption altogether due to advice to limit intake of certain fish intake combined with a lack of information about which fish types they should be eating.

The same qualitative study of fish consumption during pregnancy revealed that women were less likely to know that fish contains DHA or what function DHA served, than they were to know about mercury contamination in seafood. Most women surveyed had not received information about which type of fish contains more DHA or less mercury (20). The DGA 2010, from the US Department of Agriculture (USDA) and the US Department of Health and Human Services (HHS), recommends consumption of at least eight ounces (227 g) of variety of seafood per week for the general public, which corresponds to intake of an average of 250 mg/d of fatty acids, including DHA; and 8 to 12 (227 to 340 g) ounces of variety of seafood per week for pregnant and breastfeeding women (12). As we reported earlier, we found that daily means grams of seafood intake was similar for both pregnant and non-pregnant women (110.4 and 117.6 g, respectively), among women who reported seafood consumption in the last 24 h.

According to the USDA, the average intake of seafood in the US is low, around ~85–113 g/week. In order to achieve the recommended amounts of seafood intake, Americans would, on average, have to double their

Table 3. Distribution of frequency of fish and shellfish consumption among US pregnant and non-pregnant women in NHANES 1999–2006

	Pregnant women						Non-pregnant women					
	No seafood consumption		1–2 times (past 30 days)		≥3 time (past 30 days)		No seafood consumption		1–2 times (past 30 days)		≥3 time (past 30 days)	
	N[a]	%[c] (95% CI)	*N*[a]	%[c] (95% CI)	*N*[a]	%[c] (95% CI)	*N*[a]	%[c] (95% CI)	*N*[a]	%[c] (95% CI)	*N*[a]	%[c] (95% CI)
Total	306	24.1 (19.6, 29.2)	342	25.8 (22.5, 29.4)	552	50.1 (45.0, 55.3)	1,286	19.6 (17.8, 21.5)	1,443	23.8 (22.6, 25.0)	2,869	56.6 (54.1, 59.1)
Age (years)												
16–25	184	32.0 (26.2, 38.5)	161	27.0 (22.5, 32.0)	211	41.0 (34.7, 47.6)	762	28.1 (25.2, 31.2)	689	26.4 (23.9, 29.0)	957	45.5 (41.9, 49.2)
26–35	114	20.8 (14.8, 28.4)	156	24.6 (19.7–30.2)	299	54.6 (48.1, 61.0)	224	19.1 (16.3, 22.2)	292	23.3 (21.0, 25.9)	693	57.6 (53.9, 61.2)
36–49	8	–[b]	25	–[b]	42	–[b]	300	15.1 (13.2, 17.3)	462	22.6 (20.9, 24.5)	1,219	62.2 (59.3, 65.1)
Race												
Non-Hispanic white	123	22.7 (16.9, 29.8)	144	24.0 (19.2, 29.6)	265	53.3 (46.5, 60.0)	516	20.5 (18.3, 23.0)	526	23.6 (21.9, 25.4)	1,153	55.8 (52.6, 59.0)
Non-Hispanic black	39	–[b]	55	–[b]	95	53.0 (45.2, 60.8)	278	14.6 (11.9, 17.6)	327	21.8 (19.4, 24.5)	815	63.6 (60.2, 66.9)
Mexican–American	103	27.3 (21.7, 33.6)	116	33.8 (28.5, 39.6)	131	38.9 (32.2, 46.1)	385	22.2 (19.4, 25.2)	465	29.6 (26.5, 33.0)	636	48.2 (44.6, 51.8)
Other/multiracial	41	–[b]	27	–[b]	61	–[b]	107	17.9 (13.7, 23.0)	125	22.6 (17.6, 28.4)	265	59.6 (53.7, 62.3)
Education level												
< HS graduate	119	32.3 (24.8, 40.9)	130	34.8 (28.0, 42.4)	132	32.9 (24.9, 41.9)	583	25.9 (23.2, 28.8)	614	28.4 (25.7, 31.2)	839	45.7 (42.3, 49.2)
HS or GED	69	–[b]	75	26.9 (19.8, 35.5)	118	47.0 (38.4, 55.8)	329	26.0 (22.2, 30.1)	323	25.4 (22.9, 28.0)	570	48.7 (45.1, 52.3)
Greater than HS	117	20.1 (14.4, 27.3)	137	21.9 (16.4, 28.6)	302	58.0 (50.4, 65.3)	372	14.7 (12.9, 16.7)	504	21.5 (19.7, 23.4)	1,459	63.9 (60.7, 66.9)
Poverty income ratio[d]												
0–1.3	115	32.4 (24.5, 41.4)	134	30.7 (24.8, 37.3)	142	37.0 (28.3, 46.5)	488	22.2 (19.2, 25.6)	530	28.6 (26.2, 31.1)	814	49.2 (46.1, 52.4)
1.301–3.5	101	23.9 (17.1, 32.4)	108	27.8 (21.0, 35.7)	188	48.4 (39.9, 56.9)	421	21.2 (18.3, 24.4)	474	22.5 (19.8, 25.5)	975	56.3 (52.3, 60.2)
3.501 +	66	–[b]	76	–[b]	188	61.1 (53.1, 68.6)	278	16.1 (13.8, 18.8)	344	22.0 (19.8, 24.4)	905	61.9 (58.4, 65.3)

HS, high school; GED, General Education Development; CI, confidence interval.
[a]Unweighted *N*.
[b]Estimates suppressed because minimum degrees of freedom (12) for strata not met.
[c]Weighted row percentage.
[d]Poverty income ratio is the total household income divided by the poverty threshold for the year of the interview.

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Table 4. Frequency of consumption of types of fish and shellfish reported[a] by US pregnant and non-pregnant women aged 16–49, NHANES, 1999–2006

	Pregnant		Non-pregnant	
	N[b]	%[c] (95% CI)	*N*[b]	%[c] (95% CI)
Fish eaten in the past 30 days	743 Women		3,692 Women	
Tuna	406	52.3 (46.1, 58.4)	1,946	58.0 (55.7, 60.3)
Salmon	161	21.2 (15.8, 27.9)	867	27.4 (24.4, 30.7)
Catfish	100	14.6 (10.3, 20.2)	631	14.2 (11.6, 17.3)
Cod	58	–[d]	259	9.5 (7.8, 11.5)
Flatfish	34	–[d]	202	6.9 (4.7, 9.9)
Sardines	29	–[d]	121	2.5 (1.9, 3.1)
Trout	25	–[d]	159	4.0 (3.1, 5.2)
Pollock	23	–[d]	141	4.7 (3.7, 5.8)
Haddock	22	–[d]	92	–[d]
Perch	17	–[d]	106	–[d]
Bass	14	–[d]	64	–[d]
Swordfish*	11	–[d]	44	–[d]
Mackerel*	8	–[d]	54	–[d]
Sea bass	7	–[d]	52	–[d]
Walleye	4	–[d]	31	–[d]
Shark*	3	–[d]	7	–[d]
Porgy	2	–[d]	13	–[d]
Pike	1	–[d]	6	–[d]
Other unknown fish	115	14.2 (10.1, 19.8)	572	14.0 (12.1, 16.2)
Shellfish eaten in the past 30 days	578 Women		2,888 Women	
Shrimp	507	88.7 (83.1, 92.6)	2,536	86.4 (84.5, 88.1)
Crabs	126	21.2 (15.1, 28.9)	715	27.7 (25.0, 30.4)
Lobsters	64	–[d]	300	12.4 (10.4, 14.7)
Clams	60	–[d]	320	13.4 (11.2, 15.9)
Scallops	51	–[d]	303	14.7 (12.7, 16.9)
Oysters	37	–[d]	215	8.3 (6.8, 10.0)
Mussels	21	–[d]	116	5.0 (4.1, 6.2)
Crayfish	18	–[d]	83	3.6 (2.5, 5.1)
Other unknown	40	–[d]	188	6.9 (5.8, 8.2)

CI, confidence interval.
*FDA & EPA advise avoiding these fish for pregnant women.
[a]Women who reported seafood consumption were then asked the number of times in the last 30 days they consumed each of the types of seafood listed in the Table.
[b]Unweighted *N*.
[c]Weighted row percentage.
[d]Estimates suppressed because minimum degrees of freedom (12) for strata not met.

consumption of seafood (28). The DGA 2010 recommendations are based on fatty acid intake from seafood and other dietary sources and not from supplementation. Although DHA can be consumed via supplementation, data from at least one study suggests that omega 3 (N-3) intake from oily fish is better incorporated into plasma lipids than from supplemental forms (29). A recent study found that blood mercury concentrations were low and significantly below the reference dose set forth by the EPA in both pregnant and non-pregnant women in the US (30). Given that blood mercury concentrations are low in addition to that seafood consumption is lower than recommended in the US population, including among pregnant women, better communication of the benefits of seafood overall and in particular DHA is warranted. A study on fish consumption among childbearing age women and risk-benefit analysis on neurodevelopment of the fetus concluded that food interventions and advisories on fish consumption should focus more on promoting intake of fish species with a high DHA content and avoiding those with high methylmercury content (31). In addition to the benefits from DHA content in fish, fish in considered a healthy food and is rich in vitamins, minerals, and proteins (32).

Strengths of our study include its large sample size and detailed data on the types of fish consumed. In addition,

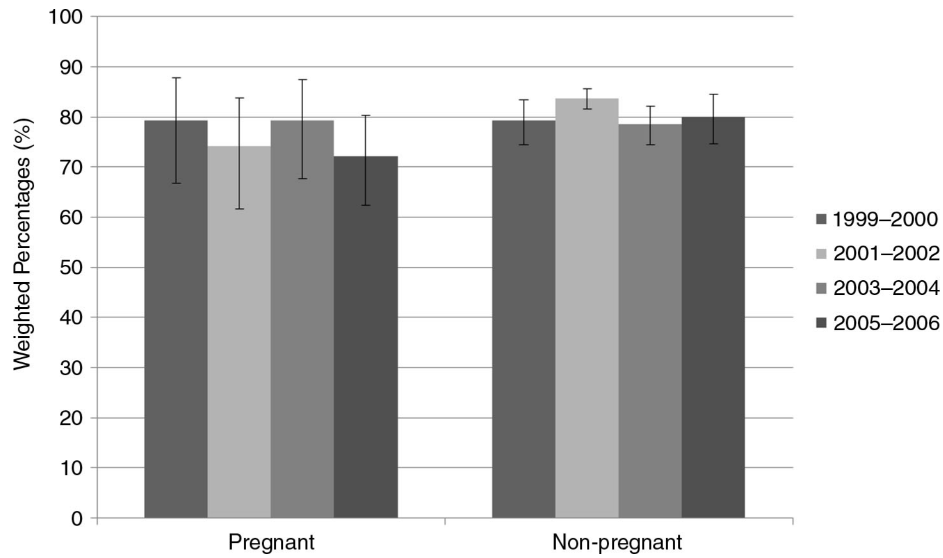

Fig. 1. Fish and Shellfish Consumption Trends among Pregnant and Non-pregnant Women in the United States (NHANES 1999–2006).

the oversampling of pregnant women during the 1999–2006 NHANES gave us sufficient power to stratify our analysis and make comparisons between pregnant and non-pregnant women. Additionally, the large sample size as well as multiple years of data allowed us to examine trends in seafood consumption over 8 years. Furthermore, our findings of lower overall seafood consumption are generalizable to the population of the US given that NHANES is a nationally representative sample of the US non-institutionalized population. There are also several limitations of the NHANES data on fish consumption. Self-reported data on fish and shellfish consumption is subject to misreporting; therefore, women may underestimate or overestimate their fish and shellfish consumption. Although the NHANES questionnaire on fish and shellfish consumption is detailed, some of the fish that were mentioned in the FDA advisory were not specifically queried in the 30-day questionnaire, for example tilefish and king mackerel. Also, information on portion sizes as well as preparation is not collected in the 30-day questionnaire. The FDA advisory recommends consumption of canned tuna due to lower concentrations of mercury, but NHANES only asks about tuna and whether it is canned or fresh tuna is not known. We attempted to address some of these limitations by using data from the first 24-h dietary recall.

Our findings complement those of other studies on seafood consumption among pregnant women and women who may become pregnant. More detailed information about health benefits and risks as well as types of seafood that are safe for consumption should be provided to pregnant women.

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Disclaimer

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