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Prevalence of Seafood Consumption among United States Adults, 2013–2014

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Abstract: Seafood is an important part of a healthy diet, and a cultural staple. The Dietary Guidelines for Americans acknowledge the importance of seafood in the American diet. This paper examines the proportion of United States adults who report eating any fish, shellfish, or seafood by sociodemographic and health-related characteristics. Using the 2013–2014 National Health and Nutrition Examination Survey (NHANES) data, this paper analyzes non-pregnant adults, 20 years of age and older who reported consuming any fish or shellfish during the last thirty days. Nearly 71 percent of respondents indicated consuming fish, 53 percent reported consuming shellfish, and 80 percent reported consuming seafood. Respondent's odds of reporting having eaten seafood increase with age and education for those who identify as non-Hispanic Black, non-Hispanic Asian, and Hispanics/Latino(s) compared to their non-Hispanic White counterparts. Health related variables including body mass index, sleep issues, depression, and whether or not one currently smokes do not affect the odds of fish, shellfish, or seafood consumption. Given the importance of seafood for a healthy diet, more targeted efforts for less educated, younger, and lower income individuals are needed to increase exposure to various types of fish and shellfish. Additionally, seafood options that are more readily available in a variety of venues can promote intake, but any increase in seafood production should be achieved in ways that are both environmentally and economically sustainable.

Keywords: Fish, Shellfish, Seafood, Consumption, NHANES

Introduction

Seafood (used herein to refer to fish and shellfish, wild or farmed) is a dietary staple among many cultural groups and is considered both nationally and globally to be an important part of a healthy diet (Food and Agriculture Organization of the United Nations and World Health Organization 2011; US Department of Health and Human Services and US Department of Agriculture 2015). The exact nutritional content of seafood differs by species, size, cultivation, and preparation practices; however, seafood is generally low in saturated fat and an excellent source of high-quality protein and micronutrients, including vitamins A, B-complex, and D; zinc; phosphorous; potassium; magnesium; selenium; and iodine (Ruxton 2011). Seafood is perhaps most revered as a major source of long chain n-3 polyunsaturated fatty acids (n-3 PUFAs), specifically eicosapentaenoic acid and docosahexaenoic acid. These n-3 PUFAs are vital for normal brain development, cognitive function, visual acuity, and cardiovascular health (Swanson, Block, and Mousa 2012).

Early studies of Greenland Eskimos suggested an association between fish consumption and reductions in death from coronary heart disease (Bang and Dyerberg 1972; 1980). Since then, a plurality of the research supports this association (Albert et al. 1998; Daviglus et al. 1997; Oomen et al. 2000). A review of over thirty studies by Mozaffarian and Rimm (2006) concludes consumption of one to two servings of fish per week, especially oily species higher in n-3 PUFAs (e.g., salmon, herring, sardines), reduces the risk of coronary death by 36 percent (95% CI, 20%-50%; P <.001) and total mortality by 17 percent (95% CI, 0%-32%; P = .046). Newer trials, though small and short-term, suggest that consumption of two to five servings of oily fish per week may also reduce triglycerides, increase high-density lipoproteins (HDL) cholesterol, lower blood pressure, improve insulin sensitivity (Ruxton 2011), and positively impact sleep (Hansen

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et al. 2014). Several studies also indicate that higher fish intakes are associated with lower risk of depression among adults (Colangelo et al. 2009; Antti Tanskanen et al. 2001) and adolescents (Murakami et al. 2010), as well as reduced risk of cognitive decline, dementia, and Alzheimer's disease (Kalmijn et al. 1997; Morris et al. 2003).

Despite these health benefits, several toxins have been found in seafood including methyl mercury, polychlorinated biphenyls (PCBs), dioxins, and pesticide residues. High levels of methyl mercury exposure, especially in utero or during infancy, have been associated with cognitive deficits, mental retardation, seizure disorders, cerebral palsy, blindness, deafness, and irreversible damage to the developing central nervous system (Mozaffarian and Rimm 2006; National Research Council 2000). Among adults, high consumption of methyl mercury containing fish may increase the risk of acute myocardial infarction or cardiovascular death (National Research Council 2000) and sensorimotor symptoms, such as paresthesia (Mozaffarian and Rimm 2006). Likewise, PCBs have been characterized by the US Environmental Protection Agency (EPA) as likely human carcinogens (US Environmental Protection Agency n.d.) and dioxins, which may alter hormone levels and fetal development (US Environmental Protection Agency n.d.). In light of these potentially harmful contaminants, several studies have performed risk-benefit analyses for seafood consumption (Food and Agriculture Organization of the United Nations and World Health Organization 2011; Hellberg, DeWitt, and Morrissey 2012; Mozaffarian and Rimm 2006), concluding that the health benefits outweigh the risks, especially when a variety of seafood is consumed at least twice per week and when certain high-mercury species are avoided by women of childbearing age.

Although fish has been identified as a source of protein in the *Dietary Guidelines for Americans* since the first version was released in 1980, it was not until thirty years later that Americans were given a quantitative recommendation for intake and encouraged to increase the amount and variety of seafood consumed in place of meat and poultry (US Department of Agriculture and US Department of Health and Human Services 2010). The 2010 *Dietary Guidelines for Americans* recommend Americans consume eight or more ounces of seafood per week (less for children), equaling about 20 percent of total protein intake. Additional provisions are made for women who are pregnant and breastfeeding, recommending the consumption of 8–12 ounces of seafood per week from a variety of seafood types while limiting white albacore tuna to six ounces per week and avoiding tilefish, shark, sword fish, and king mackerel (US Department of Agriculture and US Department of Health and Human Services 2010). The current *2015–2020 Dietary Guidelines* reiterate these recommendations, and further suggest Americans incorporate seafood as their protein choice in meals twice per week instead of meat, poultry, or eggs (US Department of Health and Human Services and US Department of Agriculture 2015).

Studies based on the National Health and Nutrition Examination Survey (NHANES) data between 1999–2010 show an average per capita seafood intake of 3.5–5.6 ounces per week, well below the *Dietary Guidelines* recommendations of eight or more ounces weekly (Jahns et al. 2014; National Cancer Institute n.d.; Nielsen et al. 2014; Papanikolaou et al. 2014; Wang et al. 2010; Rehm et al. 2016). Additionally, using "disappearance" data from the National Marine Fisheries Service (2017) estimates US per capita consumption of seafood was 4.58 ounces per week in 2016. Jahns et al. (2014) report that 80–90 percent of Americans are not meeting seafood intake recommendations and subgroup analysis indicates that women, young adults, and people with lower incomes and education levels consume less seafood. Thus, the purposes of this study are to analyze more recent NHANES data to i) describe the proportion of US adults who reported eating any fish, shellfish, or seafood after the release of the *2010 Dietary Guidelines for Americans*, and ii) estimate fish, shellfish, and seafood intake prevalence by various sociodemographic and health-related characteristics. We conclude by offering recommendations for sustainable consumption.

Methods

To examine fish consumption, we use 2013–2014 NHANES "What We Eat in America," a cross-sectional representative sample of the US civilian, non-institutionalized population which assesses the dietary, nutritional, and health habits of Americans. Collected by the US Department of Agriculture and the US Department of Health and Human Services (DHHS), NHANES uses a complex multi-stage probability sample to select participants with continuous data collection occurring in two-year cycles since 1999. During 2013 and 2014, the sample contained approximately 10,000 participants with a 68.5 percent unweighted examination response rate (Centers for Disease Control and Prevention and National Center for Health Statistics n.d.).

The NHANES protocol was approved by the National Center for Health Statistics' Research Ethics Review Board. Letters are sent to prospective participants explaining the survey and protocol, while obtaining informed consent for people ages eighteen and older. Eligible NHANES survey participants also partake in two, 24-hour dietary recall interviews. Day 1 interviews occur in person with data collection occurring at a Mobile Examination Center (MEC), while Day 2 interviews are conducted via telephone three to ten days later. Fish and shellfish consumption are collected only during the Day 1 interview via a food frequency questionnaire, whereby participants are asked to report the types and frequency of fish and shellfish consumption during the past thirty days.

Sample

Using the NHANES 2013–2014 dataset we created a subsample to examine consumption of fish, shellfish, and seafood (see Figure 1). The dataset consists of 14,332 people, and a total of 8,661 MEC participants provided complete dietary intakes for Day 1. We selected participants 20 years of age and older reducing the sample to 5,769. From this sample participants who reported consuming fish or shellfish during the last thirty days were selected for a total of 5,090. Finally, pregnant women were removed from the sample since their dietary habits may be atypical while pregnant, sometimes avoiding seafood and other times consuming more. Our total sample consists of 5,028 cases.

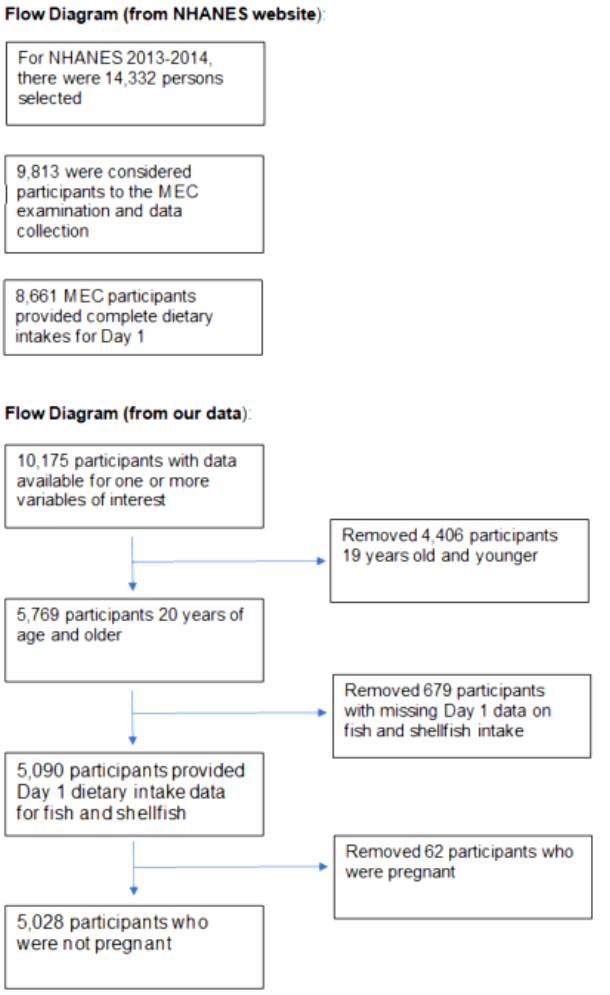

Figure 1: Sample NHANES 2013–2014 Data
Source: Pole, Dinour, and Su 2020

Variables

Table 1 lists the dependent and independent variables. The analysis relies upon three dichotomous dependent variables. To measure fish and shellfish consumption we used the following questions: i) "During the past 30 days did you eat any types of fish listed on this card?," and ii) "During the past 30 days did you eat any types of shellfish listed on this card?" A third dichotomous variable was created to reflect individuals who consumed fish and/or shellfish—called seafood. The dependent variables are coded 1 = consumption of either fish, shellfish, or seafood and 0 = no consumption.

Table 1. Cross Tabulation of US Adults > 20 Years of Age Who Report Eating Fish, Shellfish, or Seafood in the Last 30 Days by Demographic and Health-Related Characteristics, National Health and Nutrition Examination Survey 2013-2014†

	Total Sample		**Fish**			**Shellfish**			**Seafood**		
	n†	**%**	%	S.E.	P††	%	S.E.	P††	%	S.E.	P††
Gender	5028				0.86			0.90			0.90
Men	2435	48.4	70.5	1.17		52.9	1.3		79.7	1.03	
Women	2593	51.6	70.8	1.09		52.6	1.2		79.5	0.97	
Age (years)	5028				<0.0001			0.0160			<0.0001
20-30	909	18.1	57.8	1.89		48.6	1.9		68.5	1.81	
31-50	1774	35.3	68.1	1.35		55.3	1.4		78.8	1.19	
51-70	1660	33.0	78.7	1.33		53.5	1.7		85.3	1.12	
71+	685	13.6	79.2	1.79		49.4	2.3		85.8	1.49	
Education	5024				<0.0001			<0.0001			<0.0001
< High school	1027	20.4	59.1	1.88		36.1	1.8		68.8	1.77	
High school degree	1142	22.7	65.2	1.81		47.4	1.9		75.5	1.65	
Some college	1566	31.2	70.9	1.41		52.9	1.5		80.3	1.23	
Bachelor's degree	1289	25.7	79.8	1.39		64.3	1.6		86.8	1.18	
Race/Ethnicity	4023				<0.0001			<0.0001			0.0038
Non-Hispanic White	2223	55.3	70.6	1.09		51.4	1.2		79.0	0.97	
Non-Hispanic Black	453	11.3	73.7	2.34		55.6	2.6		83.7	1.92	
Non-Hispanic Asian	526	13.1	78.3	1.93		68.2	2.2		84.6	1.69	
Other races	152	3.78	71.7	4.70		53.2	4.9		79.3	4.18	
Hispanic/ Latino(a)	669	16.6	59.4	2.13		52.1	2.2		74.1	1.88	
Poverty	4757				<0.0001			<0.0001			<0.0001
>1.85 poverty level index	2401	50.5	74.2	1.10		58.3	1.2		83.1	0.95	
≤1.85 poverty level index	2356	49.5	64.4	1.21		43.7	1.3		73.3	1.12	
Body Mass Index	5028				0.42			0.03			0.25
Underweight	120	2.4	63.4	5.72		37.5	5.5		70.8	5.47	
Normal	1400	27.8	71.7	1.51		52.8	1.7		79.4	1.36	
Overweight	1608	32.0	71.3	1.41		55.0	1.6		80.7	1.21	
Obese	1900	37.8	69.8	1.31		51.6	1.4		79.2	1.15	
Currently smokes	2201				<0.0001			0.0002			<0.0001
Yes	1021	46.4	63.8	1.88		45.7	2.0		73.9	1.70	
No	1180	53.6	76.6	1.54		55.7	1.8		84.6	1.31	
Sleep Issue	5028				0.10			0.36			0.39
Yes	1459	29.0	72.7	1.44		51.5	1.64		80.5	1.26	
No	3569	71.0	69.8	0.96		53.3	1.04		79.2	0.85	
Depression	4769				0.79			0.0035			0.11
Yes	1208	25.3	70.3	1.67		54.5	1.04		80.3	0.82	
No	3561	74.7	70.8	0.94		48.4	1.82		77.6	1.54	

Notes: † Analysis based on unweighted sample sizes of adults who reported consuming any seafood in the past 30 days. †† p-value reports the Pearson's chi-square test of independence for consuming fish, shellfish and seafood among different categorical variables.

Source: Data adapted by the Centers for Disease Control and Prevention 2015

For this analysis, nine independent variables, including demographic and health variables, might predict consumption practices across the dependent variables. We created dummy variables for gender, age, education, race/ethnicity, and family monthly poverty level category (hereafter called "poverty"). The family monthly poverty level category is a ratio of monthly

family income to the DHHS poverty guidelines specific to family size. For reference, < 1.30 of the family monthly poverty level index qualifies a family for Supplemental Nutrition Assistance Program (SNAP) and free school meals; < 1.85 is the income threshold for the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and reduced-price school meals.[2] Additionally, we included the general health variables body mass index (BMI), sleep issues, depression, and currently smoke. BMI is a continuous variable based on measured weight and height, recoded into four categories based on the Centers for Disease Control and Prevention's BMI categories. The categories are as follows: below 18.5 kg/m2 is underweight; 18.5 to 24.9 kg/m2 is normal or healthy weight; 25.0 to 29.9 kg/m2 is overweight; and 30.0 kg/m2 and above is obese (Centers for Disease Control and Prevention 2017). To measure sleep issues two questions were used: i) "Have you ever told a doctor or other health professional that you have trouble sleeping?" and ii) "Have you ever been told by a doctor or other health professional that you have a sleep disorder?" Respondents who answered yes to either or both of these questions were recoded into a new variable, sleep issue, in which 1 = sleep issue, and 0 = no sleep issue. To measure depression, an additive index was created using Kroenke and Spitzer's (2002) patient health questionnaire (PHQ-9) depression scale. The PHQ-9 consists of nine questions each with a score ranging from 0 to 3 (0 = not at all depressed, 1 = several days depressed, 2 = more than half the days depressed, 3 = nearly every day depressed). These questions provide provisional diagnostics for depression along with severity. An additive index was created using nine measures with scores ranging from 0 to 27. For the depression variable scores ranging from 0–4 were coded 0 = not depressed, and 5–27 was coded 1 = depressed (Kroenke and Spitzer 2002). To measure smoking, we used the question: Do you now smoke cigarettes? Respondents who indicated "every day" or "some days" was recoded to 1 = currently smokes, and all other values were coded 0 = does not currently smoke.

Analyses

Analyses of the data were conducted using SAS 9.4 survey procedures, which accommodate complex surveys including stratification, clustering, and unequal weighting. All analyses use the sample weight WTMEC2YR to adjust for non-coverage, non-response, and oversampling in the complex survey. Statistical significance was defined as $p < .05$ for all analyses. Only adults who reported consuming any fish, shellfish, or seafood in the past thirty days were included in the analysis. Cross tabulations depict descriptive statistics for reported consumption of fish, shellfish, and seafood. Pearson's chi-square tests of independence were calculated comparing the frequency of reports of fish, shellfish, and seafood consumption among the independent variables. Logistic regression (Hosmer Jr., Lemeshow, and Sturdivant 2013) predicts the odds of fish, shellfish, or seafood consumption using all covariates with the exception of currently smokes. The variable currently smokes comprises less than half of the sample size (n = 2201), and it is not significant. To improve the power of the model, "currently smokes" was removed, and the model was refitted with the remaining covariates.

Results

Approximately 71 percent of the sample reported consuming fish in the last thirty days, while 53 percent of respondents reported consuming shellfish. About 80 percent of respondents reported eating seafood. Table 1 illustrates cross tabulations of the percentage of non-pregnant adults 20 years and older who reported eating fish, shellfish, and/or seafood. Differences across age groups, race/ethnicity, education, poverty, and currently smokes are all statistically significant for

[2] In the US, The Supplemental Nutrition and Assistance Program (SNAP) and The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) are federally funded programs administered at the state level to assist low-income families with food purchases. These programs also offer nutrition education to recipients.

reporting fish, shellfish, and seafood consumption. In general, reports of consuming fish, shellfish, and/or seafood trend upward with increasing age, education, and income. Across race/ethnicity reports of fish and/or seafood consumption appear similar with the exception of Hispanic/Latino(s) who report lower rates of consumption. Non-Hispanic Asians have the highest rates of reporting fish, shellfish, and seafood among all racial and ethnic groups. Compared to smokers a higher percentage of non-smokers report consuming fish, shellfish, and seafood. For shellfish consumption BMI and depression are significant. Fewer underweight respondents report consuming shellfish while those with depression have higher rates of reporting shellfish. All other demographic and health variables are not significant.

Fish

Logistic regression was used to predict whether or not respondents are likely to report consuming fish, shellfish, and seafood (see Table 2). Within the logistic regression model gender, poverty, BMI, sleep, and depression are not significant predictors of reporting consumption of fish. Older and more educated adults are more likely to report having consumed fish, compared to their younger and less educated counterparts. Across age groups, respondents between 51–70 and 71 years of age or older are more than two and half times as likely as 20–30 years to report having consumed fish ($p < .001$). Respondents 31–50 years of age are almost one and half times more likely than 20–30 year olds to report fish consumption ($p < 0.01$). Those with a bachelor's degree are twice as likely as individuals with a high school degree to report consuming fish ($p < .001$), and respondents with some college are 1.39 times more likely to report fish consumption than respondents with a high school degree ($p < .01$). Across race/ethnicity non-Hispanic Blacks and Asians are 1.81 and 1.55 times more likely to report consuming fish than non-Hispanic Whites ($p < .001$) and ($p < .01$), respectively.

Table 2: Logistic Regression: US Adults > 20 Years of Age Who Report Fish, Shellfish, and Seafood Consumption in the Last 30 Days, National Health and Nutrition Examination Survey 2013-2014†

	Fish††		Shellfish††		Seafood††	
Gender (1 = men, 0 = women)	-0.01(.09)	0.99	-0.02(.09)	0.99	0.03(.10)	1.03
Age (years, ref = 20-30)						
31-50	0.39(.12)**	1.48	0.25(.12)*	1.29	0.46(.13)***	1.59
51-70	1.04(.14)***	2.83	0.21(.13)	1.23	1.06(.15)***	2.88
71+	1.12(.16)***	3.06	0.21(.14)	1.24	1.20(.18)***	3.33
Education (ref = High School)						
< High School	-0.24(.14)	0.78	-0.44(.14)**	0.65	-0.29(.15)*	0.75
Some college	0.33(.16)**	1.39	0.17(.12)	1.19	0.35(.14)*	1.42
Bachelor's degree	0.71(.14)***	2.03	0.59(.13)***	1.80	0.71(.16)***	2.03
Race/Ethnicity (ref = Non-Hispanic White)						
Non-Hispanic Black	0.59(.15)***	1.81	0.51(.13)***	1.66	0.82(.17)***	2.27
Non-Hispanic Asian	0.44(.15)**	1.55	0.62(.13)***	1.86	0.44(.17)*	1.56
Other Races	0.29(.28)	1.33	0.33(.23)	1.39	0.31(.30)	1.37
Hispanic/Latino(a)	-0.01(.12)	0.99	0.43(.12)***	1.53	0.25(.14)	1.28
Poverty (1 = > 1.85 poverty level index, 0 = other)	0.15(.10)	1.16	0.39(.09)***	1.48	0.28(.11)*	1.32
BMI (ref = normal)						
Underweight	-0.37(.32)	0.69	-0.52(.30)	0.60	-0.42(.35)	0.66
Overweight	-0.02(.12)	0.98	0.17(.11)	1.18	0.12(.14)	1.12
Obese	-0.18(.12)	0.84	-0.01(.11)	1.00	-0.07(.13)	0.94
Sleep issue (1 = Yes, No = 0)	0.05(.11)	1.05	0.01(.10)	1.01	0.04(.12)	1.04
Depressed (1 = Yes, No = 0)	0.06(.11)	1.06	-0.13(.11)	0.88	-0.06(.13)	0.95

ref, reference group

Notes: † Analysis based on unweighted sample sizes of adults who reported consuming any seafood in the past 30 days.

†† The dependent variables, 1 = reported consumption, 0= reported no consumption.

*p < .05, **p < .01, ***p < .001

Source: Data adapted by the Centers for Disease Control and Prevention 2015

Shellfish

Gender, BMI, sleep, and depression are not significant predictors of reporting consumption of shellfish. Across age, 31–50 year olds are 1.29 times more likely to report consuming shellfish than 20–30 year olds ($p < .05$). Across race/ethnicity, non-Hispanic Blacks, non-Hispanic Asians, and Hispanic/Latino(s) are between 1.53 to 1.86 times more likely to report eating shellfish than non-Hispanic Whites ($p < .001$). Those with less than a high school degree are less likely to report consuming shellfish, while those with a bachelor's degree are more likely. Across education a bachelor's degree increases one's chances of shellfish consumption 1.80 times compared to respondents with a high school degree ($p < .001$). In contrast, respondents with less than a high school degree are 35 percent less likely than respondents with a high school degree to consume shellfish ($p < .01$). Along poverty the odds of shellfish consumption are greater among respondents who are 185 percent of the federal poverty level, with these respondents nearly one and half times more likely than respondents at or below the federal poverty index to consume shellfish ($p < .001$).

Seafood

Patterns of reporting seafood consumption are similar to fish. Across seafood, the independent variables gender, BMI, sleep, and depression are not significant predictors of reporting consumption. Like fish, reports of seafood consumption trends upward across age and education. Results show 31-50 year olds are 1.59 times more likely to report seafood consumption than 20-30 year olds ($p < .001$). Respondents between 51–70 years of age and 71 years of age or older are more than two and half and three times likely, respectively, to report eating seafood than 20–30 years ($p < .001$). More education increases the odds of reporting seafood consumption. The data show individuals with a bachelor's degree are almost twice as likely to report eating seafood than respondents with a high school degree ($p < .001$). Even some college results in respondents being 1.42 times more likely to report eating seafood than respondents with a high school degree ($p < .05$). Among those with less than a high school degree, respondents are 25 percent less likely to report eating seafood than their counterparts with a high school diploma ($p < .05$). Across race/ethnicity, the data show non-Hispanic Blacks are more than twice as likely than non-Hispanic Whites to consume seafood ($p < .001$). Non-Hispanic Asians are one and half times more likely to report consuming seafood than non-Hispanic Whites ($p < .05$). Finally, respondents above the family monthly poverty level index are 1.32 times more likely to report having eaten seafood than those who are below the family monthly poverty level index ($p < .05$).

Discussion

Based on our findings, 80 percent of US adults report consuming seafood over the past thirty days. Given the health benefits of fish and shellfish this is encouraging. Still, this is slightly lower than the 84 percent of adults 19 years and older reported by Jahns et al. (2014) who analyze seafood, fish, and shellfish consumption among adults participating in the 2005–2010 NHANES. More specifically, we find 71 percent of US adults report consuming any fish and 53 percent report consuming any shellfish over the past thirty days. Our results are similar to Tran et al. (2013) who find among adults 21 and older years responding to the 1999–2006 NHANES, 75–76 percent reported consumption of at least one species of fish and 53–56 percent reported consumption of at least one shellfish species over the past thirty days. While these recent results illustrate just slightly lower reported consumption this might be attributed to the inclusion of multiple NHANES cycles. Analysis of reported seafood consumption data since 2010, as it compares to the *2010 Dietary Guidelines for Americans* will offer greater insight into seafood consumption trends.

Our results support others' findings indicating higher reports of seafood consumption with increasing age and education level in the US and internationally (Verbeke and Vackier 2005; Jahns et al. 2014; Olsen 2003; Myrland et al. 2000). Consistent with Olsen's (2003) and Verbeke and Vackier's (2005) findings, differences across age may reflect generational consumption patterns, as well as attitudes toward seafood, interest in consuming a healthy diet, and perceived convenience factors that change over the life course. Taste, consistency (mouth feel), and cost—particularly of canned seafood—might also factor into higher rates of reporting consumption. These data also show the importance of education in consumption like Myrland's (2000) work. This might be due to increased exposure be it on college campuses, occupational settings, and life experiences which may differ among those with some college or a bachelor's degree.

Results for fish across race/ethnicity are similar to those from Jahns et al. (2014) though the latter study does not include non-Hispanic Asian or other races and we seek to fill this gap. While Jahns et al. (2014) find no significant difference for non-Hispanic Whites and non-Hispanic Blacks on shellfish, the 2013–2014 data are in fact significant. This might be attributed to using only one NHANES cycle, the inclusion of more racial/ethnic groups, or shifting notions of identity. Across reports of seafood consumption our results are significant for race/ethnicity except for Hispanic/Latino(s) and other races, unlike Jahns et al. (2014) in which race/ethnicity was not significant.

Like Jahns et al. (2014) and Verbeke and Vackier (2005), our results show fewer low-income adults reported shellfish and seafood consumption, though the 2013-2014 data show no significant differences across fish. These finding are not surprising since fresh seafood, particularly shellfish, might be more expensive than other animal proteins like chicken. Again, the difference on reporting fish might be attributed to only using one NHANES cycles. More studies are needed to explore differences in seafood consumption by income and the reasons for this.

With regard to health and behavior the variables BMI, sleep issues, and depression are not significant. The null findings for BMI, sleep, and depression are cautionary because we do not measure the amount of consumption. Previous studies show the quantity of servings coupled with the quality—namely oily fishes—has been associated with better health outcomes including improved insulin sensitivity, positive sleep outcomes, and lower risk of depression (Colangelo et al. 2009; Hansen et al. 2014; Ruxton 2011; Tanskanen et al. 2001).

Limitations

This research contains some limitations that should be considered. First, consumption of fish and shellfish is self-reported. This might result in recall bias, however respondents are asked to report in-take over a thirty day period so this serves to mediate some of the issues inherent in 24-hour recall. Second, the quantities of fish and shellfish consumption were not included in the analysis. We focus on sociodemographic variables to understand consumption with the goal of building on this study in future research. Third, we did not have access to respondents' geographic location, religion, or specific country of birth, all of which might influence consumption patterns. Fourth, this research only contains one NHANES cycle unlike other studies, which include multiple cycles. Our study seeks to analyze data following the publication of the 2010 Dietary Guidelines for Americans.

Implications for Practice and Future Research

Overall, we believe preferences, education, affordability, and availability might explain why people do not consume fish and/or shellfish. For example, some individuals may avoid seafood due to taste, food allergies, religious practices, or ethical concerns. Further, seafood consumption might be low if respondents are unfamiliar with preparation practices, and/or they might have limited opportunities to try different varieties. More targeted interventions for less educated, younger, and low-income individuals are needed to increase exposure to various types of

seafood. Educational initiatives through health courses, and school lunch programs should expose children and adolescents to the benefits and taste of seafood. Additionally, programs like the SNAP Education and the Expanded Food and Nutrition Education Program can promote seafood preparation techniques to increase knowledge. Affordability might prevent some respondents from consumption, particularly of shellfish, though the popularity of sushi is noteworthy (Hsin-I Feng 2012) and shrimp consumption has doubled from 1985 to 2015 (National Marine Fisheries Service 2017). Food pantries and soup kitchens, which serve food insecure populations, can promote seafood consumption by seeking donations of shelf-stable and frozen seafood.

From an availability perspective, the geographic proximity to fish mongers or seafood sources, such as lakes and oceans, may influence one's consumption. Even what is offered in grocery stores and bodegas might influence consumption. We recommend communities and neighborhoods incentivize the sale of fish in local markets and bodegas, not unlike the efforts across the country to increase fruits and vegetables, low fat milk, and whole grains through the Healthy Corner Stores initiative (US Department of Agriculture 2016). Also, fish mongers should be included in farmers markets, especially those located in low income neighborhoods. To address lower levels of consumption among younger generations, online purchases of groceries are increasingly more popular, and fish could be featured more prominently on the websites of these retailers. Overall, more research regarding why people do or do not consume seafood is required, and we need to examine how much and what kind of seafood respondents consume.

These recommendations contain a caveat: to meet increased demand we must think thoughtfully about doing so in ways that are environmentally and economically sustainable. Overfishing is currently a threat to a number of species, and this should be considered prior to increasing demand. Suggestions for mitigating overfishing include consumption of forage fish, reducing wasted seafood, and promoting responsible farmed fish and aquaculture (Cashion et al. 2017; Love et al. 2015). This can be implemented commercially and individually. Commercially, there are certification programs for wild and farmed seafood including the Marine Stewardship Council and Aquaculture Stewardship Council. Individually, there are guides for seafood consumption practices issued by Greenpeace, Marine Conservation Society, and Seafood Watch, which offer brochures and/or mobile applications to guide consumption practices. Since 1998, these organizations have advised consumers what fished or farmed seafood to eat and what to avoid. Yet, it is unclear if the general public is aware that these programs exist to help them choose more environmentally friendly seafood. Future initiatives should raise awareness about the potentially deleterious effects of overfishing while encouraging seafood consumption to ensure individuals meet the 2015–2020 Dietary Guidelines for Americans.

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