Published in final edited form as:

Environ Res. 2008 September ; 108(1): 107–116. doi:10.1016/j.envres.2008.05.003.

Fishing, fish consumption, and awareness about warnings in a university community in central New Jersey in 2007, and comparisons with 2004

Joanna Burger^{a,b,*}

^aDivision of Life Sciences, and Environmental and Occupational Health Sciences Institute, Rutgers University, 604 Allison Road, Piscataway, NJ 08854-8082, USA

^bConsortium for Risk Evaluation with Stakeholder Participation (CRESP), UMDNJ and Rutgers University, Piscataway, NJ 08854, USA

Abstract

Fish are a healthy source of protein, but the risks from consuming fish have become a national concern. Over the past 7 years, there have been a number of national advisories regarding saltwater fish. Fish consumption patterns and public knowledge about advisories and warnings have been examined for at-risk populations, but there is little information about the latter for a general population, or of temporal trends in such information acquisition. Information about the benefits and health risks of consuming fish, health warnings from the New Jersey Department of Environmental Protection and the Food and Drug Administration, belief in these warnings, and trust in different sources of information were examined in a sample of 460 people within a university community in central New Jersey in 2007. The null hypothesis of no differences in fishing, consumption, and knowledge about advisories as a function of age, gender, ethnicity, and education was tested. In 2007, only 30% of the study population fished, and 83% of the study population ate fish, either commercial or self-caught. There were differences in fishing behavior, consumption patterns, and awareness of advisories as a function of gender, ethnicity, age, and education. Most notably, nearly twice as many men as women fished, Whites fished more and Blacks and Indian/Pakistanis fished less than other ethnic groups, and people aged 23–35 fished more than did others. About 8% of fish meals were from self-caught fish, 32% were eaten in restaurants, and 60% were of fish bought in stores and cooked at home. Men ate more meals of self-caught fish than did females, and Asians ate more meals of fish in restaurants, and Blacks ate more meals of store-bought fish than other ethnic groups. The total number of fish meals consumed per month increased significantly with age. Overall, more people had heard about the benefits (92%) than the risks (78%) of fish consumption. When asked whom they trust for information about health benefits and risks from eating fish, doctors were rated the highest, followed by professors; friends and fishermen were rated the lowest. We then examined whether there were any changes from 2004 to 2007 in the knowledge of the health benefits and warnings about fish consumption, and the trustworthiness of different sources of information. In other

words, have communication efforts of the state and federal agencies resulted in any appreciable increase in overall awareness of the benefits or risks of fish consumption. The greatest change in the parameters examined from 2004 to 2007 was an overall decrease in fish consumption from an average of 7.9 meals per month in 2004 to about six meals per month in 2007. This suggests that the unintended effect of some of the warnings and advisories is to decrease overall fish consumption, rather than to switch from fish species with high levels of contaminants to those with low levels.

Keywords

Fishing; Fish consumption; Warnings; Advisories; FDA; Credibility; Trust; Temporal changes; New Jersey; Decreasing fish consumption

1. Introduction

Scientists, health professionals, and the media have devoted considerable attention to the benefits of consuming fish, as well as to the possible health risks, mainly for self-caught fish (Stern, 1993; Lange et al., 1994; Burger et al., 2001; Marien and Stern, 2005). Fish are an important source of protein, and fishing is a popular pastime in many places in the world (Toth and Brown, 1997; Burger et al., 1993; Burger, 2002), including in some urban areas (Burger et al., 1999a, 2001; Ramos and Crain, 2001). Fish provide omega-3 fatty acids that reduce cholesterol levels and the incidence of heart disease, stroke, and possibly alzheimer disease in adults, increases cognitive function, and prevents low birth weight and pre-term delivery (Daviglius et al., 2002; Patterson, 2002; Konig et al., 2005; Cohen et al., 2005a, b). However, for people consuming large amounts of some species of predatory fish, contaminant levels are sufficiently high to cause adverse human health effects (ATSDR, 1996; IOM, 1991; Hightower and Moore, 2003; Hites et al., 2004), including counteracting the cardioprotective effects (Guallar et al., 2002) and damaging developing fetuses and young children (IOM, 1991). There is a positive relationship between mercury and polychlorinated biphenyl (PCB) levels in fish, fish consumption by pregnant women, and deficits in neurobehavioral development in children (IOM, 1991; Sparks and Shepherd, 1994; Jacobson and Jacobson, 1996; Schantz, 1996; NRC, 2000). There is also a decline in fecundity in women who consume large quantities of contaminated fish from Lake Ontario (Buck et al., 2000).

State and federal agencies respond to potential health risks from contaminants in fish by issuing consumption advisories, or in rare cases, making it against the law to fish in certain waters (Burger et al., 1999a). It is mainly the states that issue advisories because they have the primary responsibility for protecting human health. The number of state fish advisories due to chemicals, such as mercury and PCBs, has increased in the USA over the last several years (EPA, 2002, 2007). Most state agencies distribute fish consumption guidance with fishing licenses, which are usually required only for freshwater fish, although more recently distribution has included health clinics and doctor's offices (Reinert et al., 1991; Burger and Gochfeld, 1991; Burger et al., 1992, 1999a, b; Velicer and Knuth, 1994; Knuth, 1995; Burger, 2000a). In the past, state agencies have dealt only with self-caught fish, although the

trend is to include information on the potential risk from consuming fish purchased commercially in supermarkets or fish stores.

Over the last several years, the US Food and Drug Administration (FDA, 2001, 2003, 2005) has issued a series of consumption advisories based on methylmercury that suggested that pregnant women and women of childbearing age who may become pregnant should (1) limit their fish consumption, (2) avoid eating four types of marine fish (shark, swordfish, king mackerel, and tilefish), and (3) limit their consumption of all other fish to just 12 ounces per week (FDA, 2001, 2005). Changes in consumption behavior are possible only if people are aware of the warnings and benefits. Despite the fact that there is a literature on awareness of fish advisories for at-risk populations, little is known about knowledge among the non-fishing public about the risks of fish consumption, nor on temporal responses to the FDA warnings.

In this paper, I examine fishing behavior, fish consumption, and awareness about the risks and benefits of fish consumption among college students and others within a university community in central New Jersey (Rutgers University) in 2007. I test the null hypotheses that (1) there were no differences in fishing behavior, fish consumption, and knowledge about the risks and benefits of fish consumption as a function of age, gender, education and ethnicity; (2) there were no differences in trust of different information sources; and (3) there were no differences in these behaviors from 2004 (Burger, 2005) to 2007 (the present study). My main objective was to determine whether people within a university community were aware of recent warnings about fish consumption, whether there were ethnic differences in the percent of people who had heard about the risks or benefits from fish consumption, and whether there were changes in the percent of people aware of the FDA warnings from 2004 to 2007. Attempts to understand and model risk, to change behavior, and to reduce the potential risks from contaminant exposure in fish will be ineffective if the risk communication aspect is ignored (Burger and Gochfeld, 2006).

2. Study of populations and protocols

The overall protocol was to interview people ($N = 460$) within a university community in central New Jersey (Rutgers University). The survey population included college students, as well as university employees who were selected from the people working at Rutgers University (including maintenance, staff, and faculty). Ages ranged from 18 to 78 years. The protocol was to go to the same places within the university and adjacent environments (restaurants and shops within the campus), and then attempt to interview every third person encountered on a walk through the location (university building, other buildings, campus walks). If the third person could not participate, the next person encountered was asked to participate. The same people were not interviewed in both years (this question was asked at the beginning, and no one had been previously interviewed), and about 50% of the respondents each year were students. Less than a dozen people declined to be interviewed (they were busy trying to finish a task or were leaving). While this represents a convenience sample, the intent of the study is to begin to understand whether people are aware of recent fish consumption advisories, whether they are aware of both the benefits and risks of fish consumption, and whether overall awareness has changed from 2004 to 2007. People were

approached, told that this was a survey from Rutgers University, and that all answers were confidential (they did not provide their names), and were then asked the questions.

Information on the questionnaire included demographics (age, sex, ethnicity, years of school, income, and occupation), fishing behavior (whether people fished, saltwater fishing, number of times/year), consumption (meals per week of different kinds of fish), awareness about risks and benefits of fish consumption, source of the warnings, and rating of trust for information about benefits and risks of fish consumption (where 1 = no trust and 5 = trust completely). The questionnaire required about 20 min to complete.

Mean values with standard errors and ranges are given in the text. Variables were compared using the non-parametric Kruskal-Wallis Analysis of variance (PROC NPAR1WAY in SAS with Wilcoxon option). This yields a χ^2 statistic, comparing distributions of responses by different independent variables (SAS, 1995).

3. Results

3.1. Demographics

The demographics of the subjects indicated a wide range in age, education, income and ethnicity (see Tables 1 and 2). Only 15% of subjects had no college experience. The 2007 sample population self-identified as: 9% Hispanic (compared to 9% in 2004), 11% Black (12% in 2004), 20% Asian (27% in 2004), 14% Indian or Middle Eastern (none identified themselves as such in 2004), 45% White (46% in 2004), and the remaining 1% did not self-identify. For New Jersey generally, people identify their ethnicity as 13% Black, 13% Hispanic, 6% Asian, and 66% White (US Census Bureau, 2004). Thus, in this study the sample had more Asians and Indian/Middle Easterners than was reported for New Jersey generally (in 2000). Some of the differences are due to increases in the Asian population over the last 5 years in New Jersey, and some are due to a higher population of Asians/Middle Easterners in the University and in central New Jersey.

3.2. Fishing behavior

Significantly more men than women fished, although there were no gender differences in the number of times fished per year (Table 3). A significantly higher percent of men fished in saltwater compared to women (Table 3). A significantly higher proportion of Whites fished than others (Table 4). There were no ethnic differences in number of days fished per year. Significantly more Whites fished in saltwater compared to freshwater than did the other ethnic groups (Table 4). There were significant age-related differences in all the parameters of fishing behavior (Table 5). A lower percentage of older people fished, but they fished for more days per year than did younger people (Table 5). Younger people fished in saltwater, whereas more older people fished in freshwater. Educational level did not affect fishing behavior (Table 6). When only those who fish are considered (Tables 3-6), the differences generally remained.

3.3. Fish consumption

Overall, 83% of all people eat fish, and people eat from 5.9 to 6.2 fish meals a month (Table 3). About 8% of fish meals were from self-caught fish, 32% were eaten in restaurants, and 60% were of fish bought in stores and cooked at home. Consumption patterns generally did not vary as a function of gender, although men ate more meals of self-caught fish than did females. When only those who consume fish are considered (bottom of Tables 3 and 4), then fish consumption rates go up to an average of 7.2 meals a month.

There were some ethnic-related differences in fish consumption patterns for the population overall, as well as for only those that eat fish. Asians ate more meals of fish in restaurants, and Blacks ate more meals of store-bought fish than other ethnic groups (Table 4).

The total number of fish meals consumed per month increased significantly with age, due mainly to an increase in fish bought in stores to eat at home (Table 5). Education also had a significant effect on overall fish consumption (Table 6). People with less than a high school education ate significantly less fish, and those who had completed college or had graduate level education ate significantly more fish than did others.

The data presented above indicate that hypothesis 1 (no differences in fishing behavior and consumption as a function of gender, ethnicity, age, or education) was rejected.

3.4. Awareness

One objective of the study was to understand whether people had heard about the benefits and risks from consuming fish. Overall, more people had heard about the benefits than the risks (Table 7). Over 90% had heard about the benefits compared to only 78% for the risks. There were no gender differences in awareness of the warnings, except for hearing about the warnings or advisories from NJDEP. A significantly higher percentage of men had heard about the warnings from NJDEP, no doubt due to their higher overall fishing rate (refer to Table 3). There were no significant gender differences in belief in the warnings (75% believed them).

While there were no ethnic differences in hearing about the overall benefits and risks from fish consumption, there were differences in awareness about freshwater fish, saltwater fish, and from NJDEP. In all cases, Whites had significantly more awareness than did the other ethnic groups, and Indian and Middle Easterners were significantly less aware (Table 7). There were no ethnic differences in whether people believed the warnings.

There were no significant differences in awareness of warnings as a function of age (Table 9). Similarly, there were no significant educational differences in awareness of the health benefits of consuming fish, but people with at least some college education were more aware of the risks of fish consumption than were those without any college (Table 10). Likewise, awareness of warnings from NJDEP and from FDA was higher in those with some college education (Table 10).

3.5. Trust in sources of information

When asked to rank different sources of information about health benefits and risks from eating fish, doctors were rated the highest, followed by professors (Table 7). Friends were rated the lowest. There were almost no differences in ratings as a function of gender (women rated doctor's higher), ethnicity (Hispanics rated fisherman higher than did others), age, or education (Tables 8-10). However, people with less than a high school education rated college professors higher than did others, while those with only a high school diploma rated professors lower than did others (Table 10). Although hypothesis 2 (no differences in trust as a function of gender, ethnicity, age, or education) was rejected because there were some differences, most endpoints showed no significant differences, and where there were differences they were not great.

4. Discussion

This study examines the relationship between fishing and fish consumption, between fish consumption and awareness about the risks and benefits of fish consumption of people in a university community interviewed in 2007, and compares similar data gathered in 2004 from the same community. Each of these aspects will be discussed below.

4.1. Fishing behavior

Overall, only 30% of the population studied in New Jersey fished, yet 83% ate fish, suggesting that understanding consumption patterns, and contaminant levels in commercial and restaurant fish is extremely important. Although there were ethnic differences in the percent of people who fish, there were no ethnic differences in the percent of people who eat fish. A higher percent of Hispanics, and a lower percent of Middle Easterners eat fish than other ethnic groups, suggesting a targeted campaign that involves information about commercial and restaurant fish should be considered. Since overall fish consumption increased with education, such campaigns should clearly include all segments of the population.

4.2. Fish consumption

Most federal and state agencies and scientists have concentrated on understanding the relationship between fishing behavior and consumption of self-caught fish, leading to risk calculations mainly for freshwater fish. Only recently has attention been focused on commercially available fish that forms the bulk of the fish consumed in the United States (Burger et al., 2002; Hightower and Moore, 2003) or to saltwater fish. The data in this paper indicated that a third of the fish meals consumed are from restaurant fish, suggesting that more attention should be directed to what is available in restaurants. States should consider conducting the same range of studies on availability of both store-bought and restaurant fish, and to contaminant levels in these fish, which might lead to potential advisories for fish with high levels of contaminants.

Most of the subjects in this study ate commercial fish obtained either from markets or in restaurants. Ninety-six percent of the fish consumed was not self-caught, which was similar to that eaten by a similar population in New Jersey in 2004 (Burger, 2005), but was higher

than the amount of nonself-caught fish eaten by sportsmen in South Carolina where self-caught fish accounted for over 30% of the fish diet (Burger, 2000b). For the NJ population, the risk from contaminants in commercial fish bears extensive examination.

While all ethnic groups are eating more fish at home than in restaurants, there were some ethnic differences (refer back to Table 4). Of commercial fish, Asians and Whites ate nearly 40% of their fish in restaurants, while only 26% of Blacks and 31% of Indian/Pakistani's did so. This has implications for risk communication and where information should be provided about contaminants. The relatively high consumption of fish in restaurants by all segments suggests that this aspect requires more attention with respect to contaminants and benefits of these fish.

While the FDA (2001, 2003, 2005) has recently issued warnings about commercial fish, the advice is limited to only a few species, and generally does not indicate the fish that are low in contaminants. That there is a potential risk from consuming some species of commercial fish is clear both from the FDA's issuance of advisories, from high levels of PCBs in fish thought to be low in contaminants, and from health effects from fish (FDA, 2001, 2003, 2005; Hightower and Moore, 2003; Hites et al., 2004; Burger and Gochfeld, 2004; Gochfeld and Burger, 2005).

In the face of conflicting information about the risks and benefits of fish consumption, the public is faced with making decisions. Information about such risk/benefit decisions is routinely provided by the media and medical press aimed at the lay public (e.g., Prevention Magazine, January 2002; Chicago Tribune articles, Roe and Hawthorne, 2005; Consumer Reports 2003, 2006; Cohen, 2006). Further, a series of studies from Harvard (Willett, 2005) examined the benefits of fish consumption on a wide range of public health endpoints, and concluded that where there are potential risks and benefits, both risk and benefit information should be provided. Recently, an Institute of Medicine (IOM, 2006) study concluded that for most people, the health benefits of eating fish and shellfish clearly outweigh any risks from contamination by toxic chemicals. How people make decisions about fish consumption is partly a function of their knowledge base, and their trust in information sources.

4.3. Knowledge, trust, and risk

People can make informed decisions about eating fish based on the potential risks and benefits only if they possess the information, and believe it (Burger, 2002; Jardine, 2003). A higher percentage of people had heard about the benefits from eating fish, compared to the risks, despite the efforts of state agencies and the FDA. While nearly 80% of the population had heard there were risks associated with eating fish, they often did not know whether those warnings were about freshwater or saltwater fish. Part of the problem is that people do not know which fish are freshwater and which are saltwater (Burger and Gochfeld, 1996).

An adequate knowledge base is the first step to making informed decisions, but it does not ensure any changes in behavior or switches in diet (fish sizes, fish species). Without knowledge, however, informed decisions cannot be made. Differences in the knowledge base that arise as a function of age, gender, or ethnicity require a targeted risk communication strategy (Velicer and Knuth, 1994; Burger and Waishwell, 2001; Jardine,

2003; Burger et al., 2003). In this study, all ethnic groups were more aware of the benefits than the risks. Although the differences were not significant, a lower percent of Blacks had heard about the risks compared, for example, to Asians. Discrepancies in awareness of advisories has been noted in a number of studies (Knuth, 1995; Connelly et al., 1996; Tilden et al., 1997; Burger et al., 1999a, b, 2001).

Even if people have heard about the benefits or risks from consuming fish, they need to believe them, which involves trust (Burger, 2000a; Jardine, 2003). In the present study, only 75% of the people believed the warnings. Further, there were significant differences in trust among possible information sources; doctors and professors were trusted the most for information about the health benefits and risks from consuming fish. Friends and other fishermen were less trusted than other sources. This is contrary to data from urban New Jersey fishermen, who tended to rely on family and friends for such information (Pflugh et al., 1999).

It is troubling that there is such a reliance on personal responsibility for reducing exposure to contaminants in fish (Halkier, 1999). People still have trouble making choices when there are multiple advisories from state and federal agencies, and when there are differences in the consumption advisories from neighboring states for the same adjoining river or other body of water (Burger et al., 1999a, b; Kamrin and Fischer, 1999). Instead, advisories should be a partnership among all those agencies responsible for issuing them, as well as with the public (Ebert, 1996; Tilden et al., 1997; Burger, 2000a).

4.4. Temporal trends

One of the objectives of the present study was to compare knowledge, awareness, and trust in 2004 and 2007, a period when there was frequent media attention, including the issuing of advisories and warnings both from NJDEP and the FDA (2001, 2005). The 2007 data were thus compared with data from 2004 from a similar population using the same protocol. While the sample was not random, the selection of people to interview in each venue within the university community followed a set protocol (every third person encountered on a prescribed transect). Although the same people were not interviewed in 2004 and 2007, the same types of people (50% students, the rest others within the community from the same locations within campus) were interviewed.

There were some differences in the demographics of the study population; there was an increase in Asians from 27% in 2004 to 34% in 2007. There was an increase in percent of meals of self-caught fish (3% in 2004, 8% in 2007), but there was no change in the percent eaten in restaurants (from 34% to 32%); decline at home (63–59%). What changed the most was the overall consumption of fish; in 2004, people ate an average of 7.9 meals per month, compared to about six meals in 2007. This suggests that perhaps the warnings about toxic chemicals in some predatory fish had the unintended consequence of decreasing the consumption of all fish, and not just specific fish. A series of studies from Harvard (Willett, 2005) that examined the positive benefits of fish consumption on public health also noted that a recent decrease in fish consumption was “probably influenced” by fears about mercury.

Despite media attention to both the risks and benefits of fish consumption, there was no change in the percent of respondents that were aware of each (Fig. 1). However, fewer people in 2007 were aware of warnings about freshwater or saltwater fish. That is, they knew there were warnings about fish consumption, but did not associate them with either freshwater or saltwater fish. More people in 2007 were aware that FDA had issued warnings about fish consumption, even though they did not associate these warnings with saltwater fish (the fish in the FDA warnings).

Overall, the disparity between awareness of health benefits (92%) and awareness of risks (78%) of fish consumption was only 14%. However, the disparity was greater for some ethnic groups than others, and the disparity increased from 2004 to 2007 (Fig. 2). For example, the disparity was only 9% for Blacks in 2004, but it was 25% in 2007. In contrast, for Asians, the disparity between awareness of benefits (90%) and risks (55%) in 2004 was greater than in 2007 (98% compared to 85%). That is, Asians appeared to become much more aware of the risks, and somewhat more aware of the benefits from 2004 to 2007. Further, both Whites and Hispanics were less aware of both the risks and benefits of fish consumption in 2007 compared to 2004. The reasons for these changes are not clear. These data result in rejection of hypothesis 3 (no differences in behavior from 2004 to 2007) in these two convenience samples.

In both years, doctors were the most trusted source for information about the health benefits and risks of eating fish. In both years, friends and other fishermen were rated the lowest as trusted sources of information. This suggests that providing doctors with information about the health benefits and risks, the trade-offs involved, and how to minimize risk from chemicals while increasing the health benefits (i.e., eating fish low in mercury or other contaminants). A recent poll of health professionals ($N = 1423$) indicated that 55% of MDs and 60% of nurses advocate moderate consumption of seafood within recommended guidelines (6–24 oz/week, depending upon risk factors, MedScape, 2006). Further, only 14% of MDs advocated consumption of any amount of seafood, and 28% of MDs did not discuss seafood consumption with their patients. That so many MDs do not discuss seafood consumption, combined with the high trust that the public surveyed in this study places on doctors, suggests the need for a more targeted information program for physicians and other health care professionals. I suggest it is critical to work collaboratively with physicians to develop the content and format for a targeted risk/benefit communication instrument that is user friendly for physicians, other health care workers, and their patients.

Acknowledgments

I thank M. Gochfeld for advice throughout the study; S. Shukla and C. Jeitner for data analysis; and C. Powers, B.D. Goldstein, and A. Stern for advice on the research and risk analysis. This research was funded by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) through the Department of Energy (DE-FG 26-00NT 40938, DE-FC01-06EW07053), NIEHS (P30ESO05022), NJ Department of Environmental Protection, and EOHHSI. The results, conclusions, and interpretations presented in this paper are solely the responsibility of the author, and should not in any way be interpreted as representing the funding agencies.

References

- Agency for Toxic Substances and Disease Registry (ATSDR). Mercury awareness for the public. Hazard Subst. Public Health. 1996; 6:4–5.

- Buck GM, Vena JE, Schisterman EF, Dmochowski J, Mendola P, Sever LE, Fitzgerald E, Kostyniak P, Greizerstein H, Olson J. Parental consumption of contaminated sport fish from Lake Ontario and predicted fecundability. *Epidemiology*. 2000; 11:383–388.
- Burger J. Consumption advisories and compliance: the fishing public and the deamplification of risk. *J. Environ. Plan. Manage.* 2000a; 43:471–488.
- Burger J. Gender differences in meal patterns: role of self-caught dish and wild game in meat and fish diets. *Environ. Res.* 2000b; 83:140–149. [PubMed: 10856187]
- Burger J. Consumption patterns and why people fish. *Environ. Res.* 2002; 90:125–135. [PubMed: 12483803]
- Burger J. Fishing, fish consumption, and knowledge about advisories in college students and others in central New Jersey. *Environ. Res.* 2005; 98:268–275. [PubMed: 15820734]
- Burger J, Gochfeld M. Fishing a superfund site: dissonance and risk perception of environmental hazards by fishermen in Puerto Rico. *Risk Anal.* 1991; 11:268–277.
- Burger J, Gochfeld M. Fish advisories: useful or difficult to interpret? *Risk Health Environ.* 1996; 23:23–33.
- Burger J, Gochfeld M. Mercury in canned tuna: white versus light and temporal variation. *Environ. Res.* 2004; 94:xx–xxx.
- Burger J, Gochfeld M. A framework and information needs for the management of the risks from consumption of self-caught fish. *Environ. Res.* 2006; 101:275–285. [PubMed: 16386241]
- Burger J, Waishwell L. Are we reaching the target audience: evaluation of a fish fact sheet. *Sci. Total Environ.* 2001; 277:77–86. [PubMed: 11589410]
- Burger J, Cooper K, Gochfeld M. Exposure assessment for heavy metal ingestion from a sport fish in Puerto Rico: estimating risk for local fishermen. *J. Toxicol. Environ. Health.* 1992; 36:355–365. [PubMed: 1507267]
- Burger J, Staine K, Gochfeld M. Fishing in contaminated waters: knowledge and risk perception of hazards by fishermen in New York City. *J. Toxicol. Environ. Health.* 1993; 39:95–105. [PubMed: 8492332]
- Burger J, Pflugh KK, Lurig L, von Hagen LA, von Hagen SA. Fishing in urban New Jersey: ethnicity affects information sources, perception, and compliance. *Risk Anal.* 1999a; 19:217–229. [PubMed: 10765401]
- Burger J, Stephens W, Boring CS, Kuklinski M, Gibbons JW, Gochfeld M. Factors in exposure assessment: ethnic and socioeconomic differences in fishing and consumption of fish caught along the Savannah River. *Risk Anal.* 1999b; 19:427–438. [PubMed: 10765415]
- Burger J, Gaines KF, Gochfeld M. Ethnic differences in risk from mercury among Savannah River fishermen. *Risk Anal.* 2001; 21:533–544. [PubMed: 11572431]
- Burger J, Boring S, Dixon C, Lord C, McMahon M, Ramos R, Shukla S, Jeitner C, Gochfeld M. Exposure of South Carolinians to commercial meats and fish within their meat and fish diet. *Sci. Total Environ.* 2002; 287:71–81. [PubMed: 11883761]
- Burger J, McDermott MH, Chess C, Bochenek E, Perez-Lugo M, Pflugh KK. Evaluating risk communication about fish consumption advisories: efficacy of a brochure versus a classroom lesson in Spanish and English. *Risk Anal.* 2003; 23:781–803. [PubMed: 12926570]
- Cohen JT. Matters of the heart and mind: risk–risk tradeoffs in eating fish containing methylmercury. *Risk Perspect.* 2006; 14:1–2.
- Cohen JT, Bellinger DC, Connor WE, Shaywitz BA. A quantitative analysis of prenatal intake of *n*-2 polyunsaturated fatty acids and cognitive development. *J. Prev. Med.* 2005a; 29:366–374.
- Cohen JT, Bellinger DC, Connor WE, Kris-Etherton PM, Lawrence RS, Savitz DA, Shaywitz BA, Teutsch SM, Gray GM. A quantitative risk-benefit analysis of changes in population fish consumption. *J. Prev. Med.* 2005b; 29:325–334.
- Connelly NA, Knuth BA, Brown TL. Sportfish consumption patterns of Lake Ontario anglers and the relationship to health advisories. *N. Am. J. Fish. Manage.* 1996; 16:90–101.
- Consumer Reports. American's fish: fair or foul?. 2003. <http://www.consumerreports.org/special/consumerInteret/Reports/0102fis0.html>

- Consumer Reports. Mercury in tuna: new safety concerns. 2006. http://www.consumerreports.org/cro/food/tuna-safety/overview/0607_tuna_ov.htm
- Daviglus M, Sheeshka J, Murkin E. Health benefits from eating fish. *Comments Toxicol.* 2002; 8:345–374.
- Ebert ES. Fish consumption and human health: developing partnerships between risk assessors and resource managers. *Am. Fish. Soc. Symp.* 1996; 16:261–270.
- Environmental Protection Agency (EPA). Update: National Listing of Fish and Wildlife Consumption Advisories. US Environmental Protection Agency; Cincinnati, OH: 2002. Available from: <http://www.epa.gov/ost/fish/advisories/general.html>
- Environmental Protection Agency (EPA). Update: National Listing of Fish and Wildlife Consumption Advisories. US Environmental Protection Agency; Cincinnati, OH: 2007. Available from: <http://www.epa.gov/ost/fish/advisories/general.html>
- Food and Drug Administration (FDA). FDA consumer advisory. 2001. <http://www.fda.gov/bbs/topics/ANSWERS/2000/advisory.html>
- Food and Drug Administration (FDA). FDA consumer advisory. 2003. <http://www.fda.gov/bbs/topics/ANSWERS/2000/advisory.html>
- Food and Drug Administration (FDA). Mercury Levels in Commercial Fish and Shellfish. US Food and Drug Administration; Washington, DC: 2005. Available from: <http://www.fda.gov/bbs/topics/ANSWERS/2000/advisory.html> [accessed 01.01.07]
- Gochfeld M, Burger J. Good fish/bad fish: a composite benefit-risk by dose curve. *Neurotoxicology.* 2005; 26:511–520. [PubMed: 15979722]
- Guallar E, Sanz-Gallardo MI, van't Veer P, Bode P, Aro A, Gomez-Aracena J, Kark JD, Riemersma RA, Martin-Moreno JM, Kok FJ. Heavy metals and Myocardial Infarction Study Group: mercury, fish oils, and the risk of myocardial infarction. *N. Engl. J. Med.* 2002; 347:1747–1754. [PubMed: 12456850]
- Halkier B. Consequences of the politicization of consumption: the example of environmentally friendly consumption practices. *J. Environ. Policy Plan.* 1999; 1:25–41.
- Hightower JM, Moore D. Mercury levels in high-end consumers of fish. *Environ. Health Perspect.* 2003; 111:604–608. [PubMed: 12676623]
- Hites RA, Foran JA, Carpenter DO, Hamilton MC, Knuth BA, Schwager SJ. Global assessment of organic contaminants in farmed salmon. *Science.* 2004; 303:226–229. [PubMed: 14716013]
- Institute of Medicine (IOM). Seafood Safety. National Academy Press; Washington, DC: 1991.
- Institute of Medicine (IOM). Seafood Choices: Balancing Benefits and Risks. National Academy Press; Washington, DC: 2006.
- Jacobson JL, Jacobson SW. Intellectual impairment in children exposed to polychlorinated biphenyls in utero. *N. Engl. J. Med.* 1996; 335:783–789. [PubMed: 8703183]
- Jardine CG. Development of a public participation and communication protocol for establishing fish consumption advisories. *Risk Anal.* 2003; 23:461–471. [PubMed: 12836839]
- Kamrin MA, Fischer LJ. Current status of sport fish consumption advisories for PCBs in the Great Lakes. *Regul. Toxicol. Pharmacol.* 1999; 29:175–181. [PubMed: 10341148]
- Knuth B. Fish consumption health advisories: who heeds the advice? *Great Lakes Res. Rev.* 1995; 1:36–40.
- Konig A, Bouzan C, Cohen JT, Connor WE, Kris-Etherton PM, Gray GM, Lawrence RS, Savitz DA, Teutsch SMA. A quantitative analysis of fish consumption and coronary heart disease mortality. *J. Prev. Med.* 2005; 29:335–346.
- Lange TR, Royals HE, Connor LL. Mercury accumulation in largemouth bass (*Micropterus salmoides*) in a Florida lake. *Arch. Environ. Contam. Toxicol.* 1994; 27:466–471. [PubMed: 7811106]
- Medscape. Medscape poll on seafood advice. 2006. <http://medscape.com/px/instantpollservlet/results?PollID=196>
- Marien K, Stern AH. An examination of the trade-offs in public health resulting from the use of default exposure assumptions in fish consumption advisories. *Environ. Res.* 2005; 98:258–267. [PubMed: 15820733]

- NRC (National Research Council). Toxicological Effects of Methylmercury. National Academy Press; Washington, DC: 2000.
- Patterson J. Introduction—comparative dietary risk: balance the risks and benefits of fish consumption. *Comments Toxicol.* 2002; 8:337–344.
- Pflugh KK, Lurig L, vonHagen LA, vonHagen S, Burger J. Urban angler's perceptions of risk from contaminated fish. *Sci. Total Environ.* 1999; 228:203–218. [PubMed: 10371054]
- Prevention Magazine. Which fish are safe for kids?. *Prevention Magazine*; Jan. 2002 p. 44
- Ramos AM, Crain EF. Potential health risks of recreational fishing in New York City. *Ambul. Pediatr.* 2001; 1:252–255. [PubMed: 11888410]
- Reinert RE, Knuth BA, Kamrin MA, Stober QJ. Risk assessment, risk management, and fish consumption advisories in the United States. *Fish.* 1991; 16:5–12.
- Roe, S.; Hawthorne, M. Toxic risk on your plate. *Chicago Tribune*; Dec. 2005
- Schantz SL. Developmental neurotoxicity of PCBs in humans: what do we know and where do we go from here? *Neurotoxicol. Teratol.* 1996; 18:217–227. [PubMed: 8725628]
- Sparks P, Shepherd R. Public perceptions of the potential hazards associated with food production: an empirical study. *Risk Anal.* 1994; 14:799–808. [PubMed: 7800864]
- Statistical Analysis System (SAS). SAS Users' Guide. Statistical Institute; Cary, NC: 1995.
- Stern AH. Re-evaluation of the reference dose for methylmercury and assessment of current exposure levels. *Risk Anal.* 1993; 13:355–364. [PubMed: 8341810]
- Tilden J, Hanrahan L, Anderson H, Palit C, Olson J, MacKenzie W, The Great Lakes Sport Fish Consortium. Health advisories for consumers of Great Lakes sport fish: is the message being received? *Environ. Health Perspect.* 1997; 105:1360–1365. [PubMed: 9405330]
- Toth JF Jr, Brown RB. Racial and gender meanings of why people participate in recreational fishing. *Leis. Sci.* 1997; 19:129–146.
- US Census Bureau. New Jersey quick facts. 2004. <http://quickfacts.census.gov/qfd/states/34000.html>
- Velicer CM, Knuth BA. Communicating contaminant risks from sport-caught fish: the importance of target audience assessment. *Risk Anal.* 1994; 14:833–841.
- Willett WC. Balancing health risks and benefits. *Am. J. Prev. Med.* 2005; 29:320–321. [PubMed: 16242596]

Fig. 1. Temporal changes in awareness of benefits and risks from fish consumption, and about specific warnings or advisories. Shown are the percent of respondents in 2004 and 2007 who said they were aware.

Fig. 2. Temporal changes in awareness of the benefits and risks of fish consumption as a function of ethnicity. Shown are percent that had heard of the benefits or the risks.

Table 1

Demographics of New Jersey study population (2007)

	Percent	Income (thousands of dollars)	Age	Gender (% women)
Overall		35.0±2.02, 0–300	29.6±0.62, 10–83	55
Education				
Less than high school	3	28.7±13.3, 0–150	24.3±5.6, 10–78	67
High school graduate	12	39.3±3.7, 0–150	43.1±2.3, 17–83	46
Currently enrolled in college	50	22.8±2.4, 0–200	22.3±0.4, 18–59	64
College graduate	20	50.1 ±5.2, 0–300	33.2±1.2, 20–67	47
Graduate level education	15	53.7±6.2, 0–300	38.8±1.5, 17–61	44
χ^2 (everyone)		62.4 (< 0.0001)	205 (< 0.0001)	
χ^2 (excluding those currently in college)		6.9 (0.07)	26.9 (< 0.0001)	

Given are means±standard error and range for age and income ($N = 460$).

Table 2Demographic information by self-identified ethnicity of people interviewed ($N = 460$) in 2007

	White ($N = 207$)	Black ($N = 49$)	Hispanic ($N = 40$)	Chinese, Korean, Thai, Filipino ($N = 93$)	Indian, Pakistani, Israeli, Lebanese, Iranian, Middle Eastern ($N = 66$) ^a	χ^2
Age (year)	30.6±1.0	27.5±1.5	33.7±2.6	27.2±1.1	29.2±1.6	7.5 (NS)
Income (thousands of dollars)	33.9±3.1	22.6±3.0	41.4±6.0	36.4±4.7	42.3±6.2	9.2 (NS)
Income (excluding those currently in college)	47.1±4.9	32.4±4.3	48.1±7.0	52.1±8.2	53.3±7.8	5.01 (NS)
Women (%)	52	61	63	53	62	3.8 (NS)
Education						
Less than high school (%)	4	2	2	0	3	3.8 (NS)
High school graduate (%)	15	17	25	9	1	13.5 (0.009)
Currently in college (%)	47	45	40	60	52	4.0 (NS)
College graduate (%)	20	23	23	18	23	0.6 (NS)
Graduate level education (%)	14	13	10	13	21	2.7 (NS)

NS: not significant.

^a 67% were Indian and 17% were Pakistani.

Table 3

Fishing and consumption behavior of people surveyed in central New Jersey by gender (2007)

	Overall (N = 460)	Male (N = 205)	Female (N = 255)	χ^2
Fishing				
That fish (%)	30	42	20	28.3 (< 0.0001)
Number of times fish per year ^a	10.3±1.2	9.5±1.2	11.7±2.6	0.25 (NS)
Fish in saltwater (%)	17	27	8	7.6 (0.006)
Eat fish from any source (%)	85	89	83	0.7 (NS)
Monthly consumption (for everyone)				
Total number of meals of fish	5.9±0.3	6.4±0.5	5.6±0.4	2.4 (NS)
Number of meals of self-caught fish	0.5±0.1	0.7±0.2	0.3±0.1	14.6 (< 0.0001)
Number of meals of fish in restaurants	2.0±0.1	2.2±0.2	1.9±0.2	2.7 (NS)
Number of meals of store-bought fish	3.7±0.2	3.9±0.4	3.6±0.3	0.07 (NS)
Monthly consumption (for those who eat fish)				
Total number of meals of fish	7.2±0.4	7.2±0.4	6.7±0.4	0.5 (NS)
Number of meals of self-caught fish	0.8±0.1	0.8±0.2	0.3±0.1	12.7 (0.0004)
Number of meals of fish in restaurants	2.4±0.1	2.4±0.2	2.3±0.2	0.5 (NS)
Number of meals of store-bought fish	4.4±0.3	4.3±0.4	4.4±0.3	0.7 (NS)

Given are means±standard error. NS: not significant.

^aOnly for those who fish.

Table 4

Fishing and consumption behavior of people surveyed in New Jersey by ethnicity (2007)

	White (N = 207)	Black (N = 49)	Hispanic (N = 40)	Asian (N = 93)	Indian/Middle Eastern (N = 66)	χ^2
Fishing						
That fish (%)	37.0	20.0	23.0	26.0	20.0	12.5 (0.01)
Number of times fish per year ^a	10.2±1.7	17.1±5.4	13.1±7.0	10.2±2.8	5.3±1.9	5.6 (NS)
Fish in saltwater (%)	22.0	16.0	15.0	13.0	6.0	10.9 (0.03)
Eat fish from any source (%)	85.0	92.0	95.0	85.0	79.0	7.1 (NS)
Monthly consumption (for everyone)						
Total number of meals of fish	5.2±0.3	6.5±0.8	5.4±0.6	6.1±0.6	6.6±1.2	4.1 (NS)
Number of meals of self-caught fish	0.5±0.1	0.3±0.2	0.2±0.1	0.2±0.1	0.5±0.3	3.6 (NS)
Number of meals of fish in restaurants	2.0±0.2	1.6±0.2	1.4±0.3	2.5±0.3	1.9±0.3	10.9 (0.03)
Number of meals of store-bought fish	3.1±0.3	4.6±0.6	3.9±0.6	3.8±0.5	4.2±0.9	9.6 (0.05)
Monthly consumption (for those who eat fish)						
Total number of meals of fish	6.1±0.4	7.0±0.8	5.7±0.6	7.2±0.6	8.4±1.4	5.8 (NS)
Number of meals of self-caught fish	0.6±0.2	0.4±0.2	0.2±0.1	0.2±0.1	0.6±0.4	4.4 (NS)
Number of meals of fish in restaurants	2.4±0.2	1.7±0.3	1.5±0.4	2.9±0.3	2.4±0.4	19.7 (0.0006)
Number of meals of store-bought fish	3.7±0.3	5.0±0.6	4.1±0.6	4.5±0.5	5.4±1.1	6.5 (NS)

Given are means±standard error. NS: not significant.

^a Only for those who fish.

Table 5

Fishing and consumption behavior of people surveyed in New Jersey by age (2007)

	<u>Age</u>			χ^2
	<22	23–35	36–83	
Fishing	<i>N</i> = 217	<i>N</i> = 131	<i>N</i> = 112	
That fish (%)	24.0	43.5	25.0	16.5 (0.0003)
Number of times fish per year ^a	10.8±1.79	7.4±1.4	15.4±4.0	5.8 (0.05)
Fish in saltwater (%)	14.3	23.7	13.4	6.3 (0.04)
Eat fish from any source (%)	80.7	88.6	91.1	7.9 (0.02)
Monthly consumption (for everyone)				
Total number of meals of fish	4.94±0.32	5.47±0.44	8.36±0.99	17.3 (0.0002)
Number of meals of self-caught fish	0.29±0.09	0.41±0.11	0.88±0.35	3.2 (NS)
Number of meals of fish in restaurants	2±0.18	2.02±0.19	2.08±0.23	2.1 (NS)
Number of meals of store-bought fish	3.04±0.25	3.1±0.29	5.82±0.71	22.3 (< 0.0001)
Monthly consumption (for those who eat fish)	<i>N</i> = 175	<i>N</i> = 116	<i>N</i> = 102	
Total number of meals of fish	6.11±0.34	6.17±0.45	9.18±1.05	12.5 (0.002)
Number of meals of self-caught fish	0.36±0.11	0.47±0.12	0.96±0.39	2.0 (NS)
Number of meals of fish in restaurants	2.48±0.21	2.28±0.21	2.28±0.24	0.2 (NS)
Number of meals of store-bought fish	3.77±0.29	3.50±0.31	6.39±0.76	17.7 (0.0001)

Given are means±standard error. NS: not significant.

^a Only for those who fish.

Table 6

Fishing and consumption behavior of people surveyed in New Jersey by education (2007)

	Less than high school (N = 12)	High school graduate (N = 57)	Currently enrolled in college (N = 228)	College graduate (N = 94)	Graduate level education (N = 68)	χ^2
Fishing						
That fish (%)	16.7	28.1	28.5	33.0	32.4	1.9 (NS)
Number of times fish per year ^a	22.0±2.0	9.8±2.8	10.3±1.6	7.9±1.8	13.5±5.0	3.8 (NS)
Fish in saltwater (%)	8.3	15.8	19.3	18.1	16.2	1.2 (NS)
Eat fish from any source (%)	66.6	84.2	82.4	90.0	92.6	9.8 (0.04)
Monthly consumption (for everyone)						
Total number of meals of fish	3.58±1.23	5.4±0.68	5.23±0.32	6.5±0.86	8.22±1.26	11.4 (0.02)
Number of meals of self-caught fish	0.25±0.18	0.3±0.21	0.31±0.09	0.71±0.27	0.85±0.46	5.8 (NS)
Number of meals of fish in restaurants	0.92±0.36	1.69±0.29	2.18±0.18	2.02±0.25	1.99±0.23	5.2 (NS)
Number of meals of store-bought fish	2.42±1.15	3.41±0.55	3.15±0.24	4.04±0.63	5.71±0.86	14 (0.008)
Monthly consumption (for those who eat fish)						
Total number of meals of fish	5.38±1.48	6.42±0.71	6.33±0.34	7.19±0.92	8.87±1.32	4.9 (NS)
Number of meals of self-caught fish	0.38±0.26	0.35±0.25	0.38±0.11	0.79±0.3	0.92±0.5	4.7 (NS)
Number of meals of fish in restaurants	1.38±0.46	2.01±0.33	2.64±0.2	2.24±0.27	2.14±0.24	3.5 (NS)
Number of meals of store-bought fish	3.63±1.58	4.05±0.61	3.82±0.27	4.47±0.68	6.16±0.9	8.2 (0.08)

Given are means ± standard error. NS: not significant.

^a Only for those who fish.

Table 7

Understanding of fish consumption advisories by gender (2007)

	Overall (N = 460)	Male (N = 205)	Female (N = 255)	χ^2
Have you heard about				
Benefits of eating fish (%)	92.2	91.0	93.2	0.3 (NS)
Risks from eating fish (%)	78.4	81.0	76.2	1.7 (NS)
Risks from freshwater fish (%)	44.1	46.5	42.3	0.6 (NS)
Risks from saltwater fish (%)	50.8	54.5	48.0	1.8 (NS)
Warnings from NJDEP (%)	24.7	29.0	21.4	3.2 (0.07)
Warnings from FDA (%)	44.8	46.8	43.2	0.6 (NS)
Do you believe the warnings (%)	74.6	73.2	75.7	0.4 (NS)
Who would you trust for information on health benefits or risks from consuming fish (1 = not at all; 5 = totally trust)				
Doctor	4.3±0.04	4.1±0.06	4.3±0.05	5.7 (0.02)
Professor	3.4±0.05	3.4±0.08	3.4±0.07	0.006 (NS)
Family	3.3±0.05	3.2±0.08	3.4±0.07	2.4 (NS)
State official	3.3±0.06	3.1±0.09	3.3±0.07	2.7 (NS)
Federal official	3.2±0.05	3.1±0.08	3.3±0.07	1.0 (NS)
Fishermen	2.8±0.06	2.8±0.09	2.8±0.08	0.3 (NS)
Friend	2.6±0.05	2.5±0.08	2.7±0.07	1.5 (NS)

Table 8

Understanding of fish consumption advisories by ethnicity (2007)

	White (N = 207)	Black (N = 49)	Hispanic (N = 40)	Asian (N = 93)	Indian/Middle Eastern (N = 66)	χ^2
Have you heard about						
Benefits of eating fish (%)	91.3	95.9	92.5	95.7	84.9	7.4 (NS)
Risks from eating fish (%)	76.8	71.4	75.0	85.0	72.7	5.0 (NS)
Risks from freshwater fish (%)	50.5	38.8	40.0	47.3	21.2	18.6 (0.0009)
Risks from saltwater fish (%)	61.2	38.8	45.0	45.2	31.8	22.7 (0.0001)
Warnings from NJDEP (%)	31.6	30.6	12.5	17.2	15.2	15.5 (0.004)
Warnings from FDA (%)	50.2	40.8	37.5	41.9	31.8	8.3 (0.08)
Do you believe the warnings (%)	77.9	72.7	71.8	75.0	66.7	3.4 (NS)
Who would you trust for information on health benefits or risks from consuming fish (1 = not at all; 5 = totally trust)						
Doctor	4.2±0.06	4.1±0.14	4.3±0.17	4.4±0.07	4.4±0.11	4.9 (NS)
Professor	3.3±0.08	3.3±0.16	3.5±0.2	3.4±0.1	3.8±0.12	7.2 (NS)
Family	3.2±0.08	3.1±0.18	3.3±0.21	3.5±0.11	3.5±0.14	6.6 (NS)
State official	3.2±0.09	3.0±0.19	3.6±0.19	3.4±0.1	3.3±0.15	7.0 (NS)
Federal official	3.2±0.08	3.0±0.17	3.6±0.19	3.3±0.1	3.2±0.15	5.6 (NS)
Fishermen	2.7±0.09	2.4±0.18	3.2±0.21	2.9±0.13	3.0±0.16	11.9 (0.02)
Friend	2.7±0.07	2.3±0.16	2.4±0.18	2.7±0.12	2.6±0.14	8.5 (0.07)

Table 9

Understanding of fish consumption advisories by age (2007)

	<u>Age</u>			χ^2
	<22 (N = 217)	23–35 (N = 131)	36–83 (N = 112)	
Have you heard about				
Benefits of eating fish (%)	88.6	95.4	95.4	7.2 (0.03)
Risks from eating fish (%)	79.1	81.4	73.4	2.4 (NS)
Risks from freshwater fish (%)	43.8	42.6	46.8	0.4 (ns)
Risks from saltwater fish (%)	48.1	55.0	51.4	1.5 (NS)
Warnings from NJDEP (%)	21.4	23.3	33.0	5.4 (0.07)
Warnings from FDA (%)	45.7	39.5	48.6	2.2 (NS)
Do you believe the warnings (%)	76.9	74.4	70.2	1.6 (NS)
Who would you trust for information on health benefits or risks from consuming fish (1 = not at all; 5 = totally trust)				
Doctor	4.3±0.06	4.3±0.08	4.3±0.09	0.6 (NS)
Professor	3.5±0.07	3.3±0.1	3.3±0.12	2.6 (NS)
Family	3.3±0.08	3.2±0.1	3.3±0.11	0.7 (NS)
State official	3.3±0.08	3.2±0.11	3.3±0.12	1.2 (NS)
Federal official	3.2±0.08	3.2±0.1	3.3±0.12	0.5 (NS)
Fishermen	2.8±0.09	2.8±0.12	2.9±0.13	0.4 (NS)
Friend	2.5±0.07	2.6±0.1	2.7±0.1	3.1 (NS)

Table 10

Understanding of fish consumption advisories by education (2007)

	Less than high school (N = 12)	High school graduate (N = 57)	Currently enrolled in college (N = 228)	College graduate (N = 94)	Graduate level education (N = 68)	χ^2
Have you heard about						
Benefits of eating fish (%)	83.3	89.5	90.8	93.6	97.1	4.8 (NS)
Risks from eating fish (%)	58.3	59.7	81.1	77.7	80.9	14.9 (0.005)
Risks from freshwater fish (%)	33.3	31.6	45.2	41.5	52.2	6.3 (NS)
Risks from saltwater fish (%)	16.7	42.1	51.8	51.1	55.2	7.8 (NS)
Warnings from NJDEP (%)	0.0	17.5	23.3	21.3	43.3	18.9 (0.0008)
Warnings from FDA (%)	8.3	29.8	47.4	37.2	58.2	19.1 (0.0007)
Do you believe the warnings (%)	70.0	64.7	79.8	67.4	74.6	8.2 (0.08)
Who would you trust for information on health benefits or risks from consuming fish (1 = not at all; 5 = totally trust)						
Doctor	4.1±0.31	4.3±0.13	4.2±0.06	4.4±0.08	4.2±0.11	5.6 (NS)
Professor	4.0±0.28	2.9±0.18	3.6±0.07	3.1±0.11	3.6±0.13	26.5 (< 0.0001)
Family	3.4±0.42	3.3±0.18	3.4±0.07	3.2±0.1	3.3±0.15	2.7 (NS)
State official	2.8±0.35	3.3±0.18	3.3±0.08	3.4±0.12	3.0±0.14	6.1 (NS)
Federal official	3.5±0.38	3.3±0.17	3.2±0.08	3.2±0.12	3.1±0.13	2.0 (NS)
Fishermen	3.1±0.43	2.6±0.17	2.8±0.08	3.1±0.13	2.4±0.15	13.8 (0.008)
Friend	2.2±0.32	2.6±0.15	2.6±0.07	2.6±0.12	2.7±0.13	2.8 (NS)