

An Assessment Of Awareness Of Fish Consumption Advisories Concerning
Mercury Among Women Of Childbearing Age

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of Philosophy at George Mason University

By

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DEDICATION

This is dedicated to my extremely loving husband Therman Jr. who supported me throughout this entire endeavor, my wonderful son Therman III. I thank my family for giving me the inspiration to write this Dissertation. Without their continuous support this would not have been possible.

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ABSTRACT

AN ASSESSMENT OF AWARENESS OF FISH CONSUMPTION ADVISORIES CONCERNING MERCURY AMONG WOMEN OF CHILDBEARING AGE

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George Mason University, 2009

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This dissertation describes the results of a survey that was administered to 300 undergraduate and graduate females (ages 18-40) enrolled in courses in the College of Science at a large mid-Atlantic university and 309 females (18-40) within the general public at local supermarkets in a mid-Atlantic State. The survey revealed that older women of childbearing age are more aware of the fish consumption advisories concerning mercury than are younger women, that of the ethnic groups surveyed, Hispanic women were the least aware of the fish consumption advisories concerning mercury, that mothers were more aware of these advisories than non-mothers, and that level of education was a predictor of awareness.

In addition, mothers were more likely to report reducing their fish intake due to concerns about mercury than were non-mothers. Furthermore, mothers were more likely than non-mothers to alter their fish intake because of their awareness of the advisories, though not

always in recommended ways. For example, there is some evidence that some were eliminating fish, an important source of protein, from their diet. Finally, results showed that women with more than 2 years of college were more likely to be aware of fish consumption advisories than were women with less than 2 years of college. These findings suggest that factors such as motherhood encourage alertness to fish consumption advisories and that more needs to be done to encourage awareness of the risks associated with mercury in fish by taking steps such as encouraging mothers and older females to talk about mercury in fish with younger women and targeting Hispanic and younger women with information about this health threat using social media and other channels they monitor.

Finally, the study also reports interviews that were conducted with experts from the National Fisheries Institute, the US Environmental Protection Agency, and the US Food and Drug Administration. The interviews focused on the importance of risk assessment, perception, and management. In the opinion of these experts, the US Environmental Protection Agency and the US Food and Drug Administration should continue to use fish consumption advisories concerning mercury to protect human health. However, the communication methods used need to be constantly evaluated and improved, and innovative methods of communication are needed.

Chapter 1
Mercury in Fish:
The Scientific and Communication Challenges

Introduction

Mercury is a naturally-occurring chemical that is released into the environment through the erosion of metal-rich rocks and through mining operations. It is also released by the burning of fossil fuels, gold mining, smelting, and municipal waste incineration (World Health Organization, 1990). Small amounts of metallic mercury are even released as a vapor during dental fillings (Dorea, 2004). Mercury is also used in lamps, thermostats, and the production of cement (World Health Organization, 1990).

Mercury in the environment can be found as an inorganic form that can be deposited on land or in water (Jackson, 1997). Sulfate-reducing bacteria that are found in water and soil can cause inorganic mercury to form an organic mercury compound, methylmercury, which accumulates in aquatic organisms (Jackson, 1997). Its toxicity can increase by a process known as bioaccumulation which starts with organisms at the bottom of the aquatic food chain and continues to the top of the food chain where it is more toxic and is contained in large fish that are consumed by humans. The top level of the food chain includes large predatory fish or larger marine mammals. Larger fish or marine mammals contain higher levels of methylmercury because the fish or mammals have lived longer and methylmercury had more time to accumulate in them. Methylmercury is mostly contained in fish that is consumed by humans.

In humans, mercury in the form of methylmercury is absorbed in the gastrointestinal tract and enters the bloodstream (World Health Organization, 1990). The mercury is then distributed to all tissues and organs, including the brain, in about 4 days (World Health Organization, 1990). In pregnant women, methylmercury passes through the placenta to the developing fetus (World Health Organization, 1990).

Mercury is a potent neurotoxin that can severely harm the brain and nervous system of developing fetuses and young children (Cohen et al., 2005; Pianin, 2003). Exposure to mercury by eating fish containing bioaccumulated mercury can result in neurological problems such as learning and attention disabilities and mental retardation (Pianin, 2003). Children that had a high exposure during *in utero* are reported to have severe sensory impairment, paralysis, hyperactive reflexes, cerebral palsy, and impaired mental development (Pianin, 2003). In pregnant women, consuming seafood is beneficial to their health when dietary intake of mercury is low (Mozaffarian & Rimm, 2006; Sunderland, 2007).

Mercury is measured in the blood and hair concentrations to determine the magnitude of exposure (Mahaffey, 2009; Sunderland, 2007). The half-life of mercury is about 50 days in the blood that is measured in blood and hair samples in humans. It is about 70-80 days in the entire body (National Research Council, 2000; Park & Johnson, 2006). In humans, most of the mercury is quickly absorbed after ingestion and spread throughout the body (Park & Johnson, 2006).

In 2009, the United States government drafted an international treaty to decrease mercury pollution in Nairobi, Kenya. This will hopefully lead to a reduction in mercury

exposure and other countries around the world will also commit to reducing mercury in the environment (Maliti, 2009).

In 1995, the United States Environmental Protection Agency (US EPA) established a reasonably safe reference dose (RfD) to be used to estimate human health effects. It is 0.1 ug mercury per 1 kg body weight per day (0.1 ug/kg/day). It is based largely on a mercury poisoning incident in Iraq in the 1970's (US EPA, 1989). This incident involved acute exposure of individuals who consumed mercury-treated flour that was ground from grain intended for planting.

At the present time, 0.1 ug/kg/day is still the dose below which these adverse health effects probably do not occur in most people (Rice, Shoeny, Mahaffey, 2003). In 1997, the US EPA was mandated by Congress to determine whether the RfD established in 1995 was scientifically justifiable (Rice et al., 2003), and Congress funded a review in 1999 by the National Research Council (NRC). The NRC concluded that the RfD was scientifically justifiable but recommended that the US EPA should conduct a risk assessment of mercury based on new epidemiological studies that had been conducted since the US EPA's decision in 1995 (Rice et al., 2003).

In 2001, the US EPA completed a risk assessment for mercury based primarily on recent epidemiological studies (Rice et al., 2003) in the Seychelles Islands, the Faroe Islands, and New Zealand. The results of the Faroe study concluded that there were significant neurodevelopmental deficits in children at birth and into their school years. At similar mercury levels, children in the Seychelles study did not show any deficits (Ginsberg & Toal, 2009; Axelrad et al., 2007). Following this, the US EPA declared that their RfD

should apply to the general public, and not just for nursing mothers, pregnant women, or women who are thinking of becoming pregnant. The US EPA retained the opinion that the reasonably safe RfD for mercury is 0.1 ug/kg/day.

Because it has been concluded that a higher sensitivity for mercury occurs in the fetus than in adults, and based on epidemiological studies, the US Food and Drug Administration (US FDA) issued an advisory to protect the fetus based on a suspected higher sensitivity to adverse health effects from mercury. In 2000, the US FDA consulted with the US EPA, reevaluated its advisory, and now the US FDA uses the same RfD for mercury (0.1 ug/kg/day) as the US EPA.

In the 1970s, the US FDA set an action level of 1 ppm (part per million) for mercury in fish. An action level for mercury is the amount of unavoidable mercury residues that are permitted in fish and shellfish. “Unavoidable mercury residues” are permissible levels of mercury-containing poisonous or deleterious substances. This action level can be revised according to the Code of Federal Regulations (21 CFR Parts 109 and 509). The action level for mercury was based on studies of two Japanese poisoning events (individuals consumed highly contaminated fish) and the poisoning incident that occurred in Iraq in the 1970s (US Food and Drug Administration, 1995).

On January 12, 2001, the US EPA and the US FDA issued fish consumption advisories to the public about consuming commercially available fish that were possibly contaminated with mercury. Now it is known that large predatory fish that people eat, such as king mackerel, shark, swordfish, pike, and bass, usually contain high levels of mercury in their tissue (US EPA, 2003).

In December 2003, the US EPA and the US FDA issued a joint draft advisory to the public warning pregnant women, nursing mothers, women who might become pregnant, and young children about the dangers of eating more than twelve ounces a week of tuna and other fish and shellfish or about two to three meals containing fish per week. The advisory noted that these special populations should not consume shark, swordfish, king mackerel, or tilefish because they contain high levels of mercury. Also, the US EPA and US FDA are now advising the public not to consume the same kind of fish or shellfish more than once a week (i.e., that is, people should mix the types of fish that are consumed), as part of a larger effort by the Federal Government to warn the public against the dangers of consuming mercury that is contained in tuna, in other fish, and in shellfish (Pianin, 2003). On March 19, 2004, a joint advisory was issued that mentions 5 fish that contain low levels of mercury (shrimp, canned light tuna, salmon, pollock, and catfish).

However, a range of information about seafood is communicated. For example, on October 4, 2007, the “National Healthy Mothers, Healthy Babies Coalition”, a non-profit organization, in partnership with top professors of obstetrics and doctors of nutrition and federal agencies, released recommendations for seafood consumption during pregnancy. The Coalition is an organization dedicated to improving maternal and child health that is comprised of more than one hundred and fifty local, state, and national organizations including the American Academy of Pediatrics, March of Dimes, National Institute of Child Health and Human Development, and the Centers for Disease Control and Prevention. The Coalition recommends that pregnant and nursing women should eat at

least twelve ounces a week of fish such as salmon, tuna, sardines, or mackerel in addition to other seafood (Squires, 2007).

These Coalition recommendations are in direct conflict with the fish consumption advisory concerning mercury that was issued in 2004 by the US FDA and the US EPA that warns women who might become pregnant, pregnant women, and nursing mothers against eating more than twelve ounces a week of tuna and other fish and shellfish. A representative with the US FDA said that the agency will study the recommendations but has not changed its advice (Squires, 2007). This conflict exists because fish contains omega-3 fatty acids which are essential nutrients for the brain and nervous systems in developing fetuses, infants, and young children. In 2007, a study was conducted at the Medical University of South Carolina that concluded that fifty-six percent of pregnant women had unfortunately reduced their fish intake to levels that are below the amount that is beneficial to a developing fetus and infant (Squires, 2007).

Still another source of confusion is that several bodies can issue advisories. For example, when a commercial fishing ban is issued, it is because high levels of contamination have been found in fish caught for commercial purposes. In a ban, the commercial harvesting and sales of particular fish, shellfish, and/or wildlife from specific water bodies, are prohibited. A statewide advisory, issued by a State, is designed to alert the public about health risks that could be caused by chemical contamination in lakes, rivers, or coastal waters. A State can issue one advisory for a water body or a type of water body if more than one fish or chemical contaminant has been detected (US EPA, 2003).

If high concentrations of mercury or the other primary chemical contaminants are found in local fish, it is the position of the federal government that the primary responsibility to issue fish consumption advisories, and fact sheets, rests with local and State governments. Materials are to be distributed through media releases and brochures to targeted audiences (Connelly & Knuth, 1998).

Most States issue four different types of fish consumption advisories and bans to protect the public and to target specific populations such as pregnant women, nursing mothers, and children:

- (a) The no-consumption advisory for the public is issued when levels of chemical contamination in fish or wildlife pose a human health risk.
- (b) The no-consumption advisory for sensitive subpopulations is issued when contaminant levels pose a human health risk to sensitive subpopulations such as pregnant women, nursing mothers, and children.
- (c) The restricted-consumption advisory for the public is issued when contaminant levels in fish or wildlife pose a human health risk if the general public consumes too much fish or wildlife.
- (d) The restricted consumption advisory for sensitive subpopulations is issued to sensitive subpopulations when contaminant levels in fish or wildlife could pose a human health risk if the subpopulations consume too much fish or wildlife (US EPA, 2003).

Communication Challenges Associated with Fish Consumption Advisories

There are a number of challenges associated with making fish consumption advisories effective vehicles for sharing risk information with key stakeholders. First, fish consumption advisories recommend specific limits on the amount of sport fish consumed, but sport and subsistence anglers often decide for themselves whether or not to eat certain fish, where to fish, and how much they should eat. These anglers are at a greater risk than the general public because they often consume large amounts of fish (Reinert et al, 1996).

Second, the protection of human health is sometimes poorly done. For example, it has been noted that sometimes fish consumption advisories are written in a vague manner, which makes individuals confused and contributes to their misunderstanding of the importance of the information (Burger, 2000). Connelly and Knuth (1998) have recommended that such materials be written in a manner that the public can more easily read and understand.

A third source of confusion occurs when adjoining States, which share the same water body, issue different advisories. In this situation, it is difficult for the public to know which advisory to follow (Burger, 2000). Even federal and state agencies that are located within the same State sometimes do not send the same risk messages to the public (Fisher, 1991).

A fundamental problem is that all States do not use the same criteria to determine the most appropriate time to issue fish consumption restrictions and what type of advisory to issue. The States sometimes differ on how they report advisory information and the criteria that they use to determine the need for issuing and rescinding fish consumption

advisories. The states do agree that these decisions must be made carefully, because once a fish consumption advisory or a ban is issued, it may stay in effect for several years.

Unfortunately, some advisories have remained in effect for too long because it was difficult for the states to determine when the public is no longer at risk (Cunningham et al., 1994).

This brief discussion of difficulties establishes the importance of learning what steps government agencies can take to identify the extent to which advisories are reaching their intended audiences. Little has been published on the effectiveness of these fish consumption advisories (Fisher, 1996). One study suggests that most of the time the public is aware of the advisories, and that instead of following the advisories, they usually choose to continue eating the contaminated fish because they consider the risk to be small (Reinert et al., 1991). It is known that the public's responsiveness to fish consumption advisories depends on the way they receive risk information, on whether or not it is helpful to them, and on their understanding of the risk of consuming the fish (Reinert et al., 1991). Kahlor, Dunwoody, Griffin, Neuwirth, and Giese have also studied fish advisories for the Great Lakes. They found that it is very important to consider the public's perceived and real information when risk messages are developed (Kahlor et al., 2003). People vary in the extent to which they perceive they are at risk and the degree to which they believe they need more information about a risk.

Numerous federal agencies and national advocacy groups study the degree of harm posed by mercury in fish as well as the benefits of fish consumption. The objective of the present study was to determine awareness of fish consumption advisories among members of the public, particularly among vulnerable groups such as women in their childbearing

years and members of ethnic or socio-economic groups especially likely to consume significant amounts of fish as part of their regular diet. Awareness and ability to act on warnings is affected by the landscape of messages people encounter about the health benefits and harms associated with fish.

Risk Communication Challenges

By definition, all communication is impacted by the universal components of communication situations: sources, receivers, channels, and topic or content (Rowan et al., 2009). Therefore one can expect that many risk communication situations will be plagued by tensions indexed by the CAUSE Model (Rowan, 1991; Rowan et al., 2009). The C in Cause stands for lack of *confidence in sources* or messengers; the A for lack of *awareness* about a hazard such as mercury in fish; the U for lack of *understanding*—one may be able to say the word, mercury, but have little understanding of why mercury is harmful; the S in CAUSE stands for lack of *satisfaction* or agreement with the recommended solutions, and the E for lack of *enactment* or willingness to move from agreement to behavior change (e.g., believing one should reduce fish consumption during pregnancy but not acting on this belief).

Following this model, it is important to consider first the messengers who are sending the public information about fish and health, the extent to which these message sources are apt to earn or not earn the public's confidence, the nature of the messages being sent, and the clarity and understandability of these messages. Therefore, the first step taken in this dissertation was a series of interviews with experts at the US FDA, the US EPA and the National Fisheries Institute (NFI) on the messages each of these organizations send key

publics, the obstacles they perceive to effective communication, and the steps they have taken to address these challenges. Consequently, this study begins by describing the positions and activities of federal agencies and a key national advocacy group concerning fish as a source of health risks and benefits for humans and communication activities undertaken to share research findings and their health implications with the public.

Views of Federal Regulator and Fish Consumption Advocates on the Healthfulness of Fish

Several individuals from various organizations were interviewed to determine what federal government officials and key stakeholders are currently doing to address risk assessment and communication about fish consumption advisories concerning mercury within the United States.

- 1) Dr. Marjorie Davidson, Education Team Leader, Center for Food Safety and Applied Nutrition, US Food and Drug Administration. Dr. Davidson is responsible for providing non-formal education on various issues such as nutrition and food safety issues to the general public, farm workers, and public health professionals.
- 2) Dr. Steven Bradbard, Supervisory Consumer Studies Specialist, Center for Food Safety and Applied Nutrition, US Food and Drug Administration. Dr. Bradbard is responsible for overseeing a team of multi-disciplinary scientists such as agricultural economists, sociologists, psychologists, and public health analysts who conduct qualitative and quantitative research on nutrition and labeling issues for food and drug cosmetic products regulated by the US FDA.

- 3) Philip Spiller, Special Assistant for Special Projects, Center for Food Safety and Applied Nutrition, US Food and Drug Administration. Mr. Spiller is responsible for the ongoing risk assessment for methylmercury in commercial fish.
- 4) Jeff Bigler, National Program Manager, Office of Water, US Environmental Protection Agency. Mr. Bigler is responsible for providing states, tribes, and federal government agencies with the risks and benefits of fish consumption of non-commercial fish and commercial fish including recreational fish.
- 5) Randi Thomas, Vice President, Tuna, National Fisheries Institute. Mrs. Thomas is responsible for food safety issues dealing with tuna conservation and management.
- 6) Stacey Viera, Vice President, Public Affairs, National Fisheries Institute. Mrs. Viera is responsible for communicating with the public about the importance of including at least two fish meals a week in a balanced diet.

The Center for Food Safety and Applied Nutrition, US Food and Drug Administration, is responsible for protecting the public's health by ensuring that the nation's food supply is safe, sanitary, and properly labeled, and that cosmetic products are safe and properly labeled. The US EPA is responsible for ensuring that the public's health and the environment are protected. The National Fisheries Institute is a large advocacy organization that is dedicated to representing the seafood industry to ensure that seafood is a part of a healthy diet for the general public.

Based on the information that was collected from my interviews I conclude that the results from my interviews support certain actions such as, at a minimum, that the US EPA and the US FDA should continue to communicate with the public about fish consumption

advisories concerning mercury to protect their health. Innovative new methods of communication are needed that include actively seeking input from the public. Methods used need to be constantly evaluated and updated to be current with rapidly changing modes of communication. The National Fisheries Institute could provide key input and support, but first they would want their position about fish benefits recognized and then it appears that they might support statements targeted at particularly susceptible populations that moderate fish consumption is warranted where levels are particularly high. A mechanism is needed to ensure that the public is always consulted to determine the effectiveness of warnings and advisories before their distribution.

Differing Perspectives on Risk Associated with Fish Consumption

I concluded from my interview with the US EPA and FDA representatives that both the US EPA and the US FDA agree that fish pose a risk, at least to susceptible groups such as pregnant women. However, the National Fisheries Institute would not agree, arguing instead that even among the most susceptible groups, the benefits of fish consumption outweighed the risks. However, even the NFI representatives did not specify there was no risk to pregnant women with high consumption of the type of fish that had the highest levels of methylmercury. The absence of agreement by this key stakeholder with the US FDA and the US EPA on any type of warning is a serious shortcoming and could be a significant factor preventing good risk communication. Perhaps, the three organizations could be pressured to agree on a specific labeling statement that would be required for selected fish of concern that is sold in the United States.

According to the US FDA and the US EPA representatives, mercury is a neurotoxin at high levels of exposure. The fetus can be more sensitive to the effects of methylmercury than adults. It is not known whether, or the extent to which, methylmercury may be causing adverse health effects at low levels of exposure as are generally experienced in the United States. Debate about this issue continues. Due to the possible or potential risk to the developing fetus and young children, the US FDA issued an advisory in 2001 and the US EPA along with the US FDA issued a joint fish consumption advisory concerning methylmercury in fish in 2004. A new risk assessment of methylmercury in commercial fish is planned by the US FDA and may be completed in the next few years. However, the US FDA representatives did not say what this new assessment might show or how it might affect the current fish consumption advisories concerning mercury.

According to the US FDA representatives, the US FDA reported that it will not consider any changes to its fish consumption advisory concerning methylmercury until its risk assessment process is complete. The US FDA is hoping to complete its risk assessment process within the next few years. The US FDA is studying the impact that the information that is contained in the fish consumption advisory concerning mercury is having on the public, to what degree the recommendations contained in the fish consumption advisory concerning mercury is known to the public, and to understand what individuals are doing behaviorally with that information.

For contrast, the National Fisheries Institute representatives stated that the US FDA fish consumption advisory concerning mercury is targeted toward pregnant women, women that are thinking about becoming pregnant and nursing mothers. Individuals that are not a

woman of child-bearing age such as middle-age men, teenagers, and the elderly are misinterpreting the information that is contained in the fish consumption advisory concerning mercury and using it as a guide for themselves. As a result, these individuals may be consuming less fish than they normally would. For example the article, “Decline in Fish Consumption Among Pregnant Women After a National Mercury Advisory” (Oken et al., 2003) suggested there is a spill-over effect that causes individuals to consume less fish because of exposure to fish consumption advisories. Fish is beneficial to everyone’s diet because of its positive effects on cognition especially to the very young and the elderly. In particular, the omega-3 fatty acids that are contained in seafood can be of a great benefit to an elderly individual that is suffering from the Alzheimer’s disease or heart disease.

The National Fisheries Institute representatives recommended more information on the positive benefits of fish consumption citing specific studies that they feel support their point of view. According to the National Fisheries Institute representatives, the risk to human health from exposure to mercury can not be considered without looking at the benefits of consuming fish. The benefits of consuming fish far outweigh the risk to exposure to mercury that is contained in fish. These representatives said there is a perception amongst the public that mercury poisoning is a problem when in fact it has been proven that it is not a problem. The NFI representatives says the Center for Disease Control and Prevention and the US FDA have never documented a case of mercury poisoning in the United States. The National Fisheries Institute is concerned that the messages about the benefits of consuming fish can be muddied when the issue is discussed in the media and electronic outlets. The National Fisheries Institute recommends that

pregnant women that are concerned about what they are consuming that they should consult with the US FDA and follow the fish consumption advisory concerning mercury.

Communication Activities of US Government and Advocacy Groups Concerning Fish Consumption Advisories

I concluded from my interview with the US EPA and FDA representatives that both the US FDA and the US EPA were able to cite extensive efforts to make the public aware of the risks of mercury in fish. The number of organizations involved and brochures distributed were impressive and follow-up to determine the effectiveness of these considerable efforts was done. The US FDA agreed that they would like to know the effectiveness of their current efforts for reaching the public.

According to the US FDA representatives, the US EPA and the US FDA planned a detailed public educational campaign that is aimed toward pregnant women, nursing mothers, women who might become pregnant, and parents of young children. The campaign was developed after the release of the fish consumption advisory concerning mercury in March 2004. Initially, information about the fish consumption advisory concerning mercury was sent to more than 9,000 print and electronic media outlets including web sites. The media outlets that specialized in reaching women were targeted. The media outreach was repeated every two years to bring public attention to the importance of following the government's fish consumption advice concerning mercury.

According to the US FDA representatives, the US FDA conducted eight focus groups in Calverton, Maryland, San Diego, Boston, and Miami with pregnant women and women of childbearing age to determine how understandable they found the seafood consumption information to be included in the 2004 joint advisory. The same moderator

was used with the 8 focus groups. The two objectives of the focus groups were to fine tune the format and content of the advisory to best convey the consumption recommendations and to determine based on their self-report how the women would make decisions about what seafood to eat and what to feed their young children. One focus group in each city included pregnant women and another group included women of childbearing age (nursing mothers and mothers who had children that were less than 7 years old). Some of the groups included women that had a higher education degree and other groups included women that had two years of college or less. This was done to determine whether there were any differences among the women based on their education level. In each of the focus groups, the women read the draft of a one-page fish consumption advisory concerning mercury and they were then asked by the moderator to comment on it. Next, the women read a draft of frequently asked questions one at a time and were asked to comment on the questions and answers.

According to the US FDA representatives, some of the key findings from the focus groups were that a large number of pregnant women stated that they would reduce the amount of fish that they would eat while they are pregnant and other pregnant women stated that they would completely eliminate fish from their diets to prevent any possible harm from mercury to their unborn child. Most of the women understood the content of the information that would be used for the 2004 fish consumption advisory concerning mercury.

In order to evaluate the effectiveness of fish consumption advisories concerning mercury, the US FDA representatives said that FDA staff administered a survey to about

1500 pregnant women called the Infant Feeding Practices Survey which surveyed women at 7 months pregnant and every month after birth regarding changes in their eating habits and their own nutrition and awareness of fish consumption advisories concerning mercury and other pathogens such as listeria and dioxins (S. Bradbard, personal communication, June 8, 2007). Another survey that the US FDA administered every few years to the general public is called the Food Safety Survey that dates back to the 1980s about food safety issues and information about the fish consumption advisories concerning mercury that was added to this survey starting after the 2001. The survey was administered by random-digit dialing telephone to about 4,000 individuals within the general public (US FDA, 2002). One of the US FDA representatives spoke at the 9th Annual National Forum on Contaminants and Fish to discuss the results of the surveys which included samples of pregnant women, women of child-bearing age, and adults within the general public. The meeting was co-sponsored by the US EPA and the Maine Center for Disease Control and Prevention in Maine on July 23-26, 2007. The survey results will not be released to the public until the results are published in the future.

The National Fisheries Institute representatives said their organization actively provides science-based information about seafood to media nationwide, third-party groups, and for consumers through www.AboutSeafood.com. As part of this outreach, NFI emails a free newsletter, The Dish On Fish, to subscribers on the first day of every month. The newsletter offers recipes, cooking tips and beneficial health information about seafood. The National Fisheries Institute Media Room site contains current and archived press releases, fact sheets, op eds, frequently asked questions, position papers, facts and statistics,

top 10 United States consumption by species chart, glossary of seafood terminology, and various other topics related to seafood that is available to the media. The National Fisheries Institute has a page on their website, *Expecting Moms: Important News About Seafood and Health*. The page offers a link to the fish consumption advisory concerning mercury that was issued in March 2004 by the US EPA and the US FDA.

The National Fisheries Institute representatives said that the US FDA conducted focus groups in March 2005 to determine whether the information that is contained in the fish consumption advisory concerning mercury was understandable to pregnant women and women of child-bearing age. The results of the focus groups concluded that negative consequences can occur if a message is not clearly stated. “Many pregnant women said that they were inclined to reduce the amounts of fish that they would eat during their pregnancy, and some said they would eliminate fish altogether from their diets, in order to avoid any potential risk from methylmercury.” According to the National Fisheries Institute, the information that is distributed to pregnant women should be re-evaluated based on the feedback that the US FDA received from the focus groups that they conducted. The issuance of the fish consumption advisory concerning mercury is misinterpreted to mean all fish – whether or not they contain mercury - pose a risk without a full understanding of the positive benefit of fish consumption.

Summary

Since a National Academy Study Committee (Institute of Medicine, 2006) found that fish consumption advisories and bans concerning mercury are scientifically supportable for vulnerable populations, this study assumed that fish consumption

advisories and bans for certain populations are reasonably good risk management tools, and that they should be used to inform the public about advisory restrictions due to high concentrations of mercury and other toxic pollutants. Given that these management tools are warranted, we need to know how to make them more effective. Currently, relatively little is known about the effectiveness of the advisories.

The CAUSE model (Rowan et al., 2009) argues that any message about a physical hazard could fail because of lack of confidence in message sources, lack of awareness that a warning has been issued, lack of understanding of a warning, lack of agreement, or failure to convert agreement to action, i.e., enactment. The first three of these potential failures would harm the effectiveness of any risk communication program. Therefore, this dissertation sought to test awareness of fish consumption advisories among college students and shoppers. The expectation was that if there were awareness of fish consumption advisories, particularly among women of childbearing age, then this evidence would offer some indication that the advisories are effective. Additionally, this dissertation sought to determine awareness of fish consumption advisories among members of ethnic groups living in the United States that are known to consume fish as a larger portion of their diets than most U. S. residents.

The specific objectives for this study were to test the following hypotheses:

- The 1st hypothesis is that 18-40 year old female undergraduate and graduate students enrolled in College of Science courses at a large mid-Atlantic university are not aware of fish consumption advisories concerning mercury.

- The 2nd hypothesis is that there is no difference between age groups (18-21), (22-30), and (31-40) of female undergraduate and graduate students enrolled in College of Science courses concerning their awareness of fish consumption advisories concerning mercury.
- The 3rd hypothesis is that there is no difference between African-American, Asian or Pacific Islander, American Indian or Alaskan Native, Hispanic, White, or members of other ethnicities and their awareness of fish consumption advisories concerning mercury.
- The 4th hypothesis is that there is no difference between college-educated and non-college educated individuals and their awareness of fish consumption advisories concerning mercury.
- The 5th hypothesis is that there is no difference in awareness of fish consumption advisories concerning mercury between 18-40 year old mothers and non-mothers enrolled in the University and Three County Study.
- The 6th hypothesis is that there is no difference in whether the females reduced their fish intake between 18-40 year old mothers and non-mothers enrolled in the University and Three County Study.
- The 7th hypothesis is that there is no difference in whether the females excluded certain fish or seafood between 18-40 year old mothers and non-mothers enrolled in the University and Three County Study.
- The 8th hypothesis is that there is no difference in whether the 18-40 year old mothers and non-mothers in the University and Three County studies answered

that they thought the health problems which mercury in fish can cause in young infants were do not know, negligible, minor, moderate, or major.

- The 9th hypothesis is that there is no difference in awareness of fish consumption advisories concerning mercury between college-educated females with 2 years of college or more and females with less than 2 years of college enrolled in the University and Three County Study.

The next chapter presents the methods used to test these hypotheses.

Chapter 2

Method

This chapter reports the methods for three studies: a pilot study, a survey of women attending a mid-Atlantic university, and a survey of women in three counties within a mid-Atlantic state.

Pilot Study

Participants

During Fall 2006, a pilot survey was administered to approximately 100 students in a human anatomy and physiology class at a large mid-Atlantic university. Written permission was obtained from the professor teaching the students in the class.

The Office of Sponsored Programs (OSP) at the university is responsible for reviewing all human subject research. A form for review of research with human subjects was submitted by the investigator to OSP for this research. A protocol, the informed consent document, all instruments such as questionnaires and recruitment materials were approved.

Materials

The pilot study was designed to investigate awareness of fish consumption advisories concerning mercury among 100 females at a large mid-Atlantic University.

The survey instrument assessed their attitudes with respect to the advisories and their knowledge about the fish consumption advisories concerning mercury.

An 18-item survey (Appendix B) was administered to collect demographic information such as age, race/ethnicity, estimations of the number of fish meals eaten in a week during the previous 12 months, and how many times a month during the previous 12 months. The survey took less than ten minutes to complete. (Appendix B)

Design and Procedure

Prior to administering the survey, the participants were informed that the study was being conducted by a doctoral candidate in the Environmental Science and Public Policy Program at the university. They were told the purpose of the survey, and that their participation was voluntary.

The pre-test survey was designed to see if the survey questions were interpreted correctly and were not misleading, confusing, or offensive and that the full range of relevant answers was provided as alternatives. It was concluded that the survey did not need to be modified based on comments received from respondents.

Completed surveys were reviewed to verify that each question was properly answered by the students. All the information that was collected in the survey was entered into a JMP file. This file was used to produce descriptive data about the age, race/ethnicity, and student status of participants. The main goal was to determine the number of women aware of fish consumption advisories concerning mercury.

The survey questions were developed based on some of the principles of tailored design discussed by Dillman (2000). Steps were taken to ensure that questions were easy

to understand, bias was avoided, words were specific, and that the survey was easy to complete, and unoffensive (Appendix B). Some of the questions were designed to be skipped by the participant if it did not apply and a response was not needed. Participants were asked for their advice to help provide a sense of reward to them. Response categories in the survey are mutually exclusive. The survey was printed on 8 ½ x 11 inch sheets of paper with a staple in the upper left hand corner.

University Study

Participants

During the Fall 2006, the same survey instrument was administered to 300 university female undergraduate and graduate students at the same large mid-Atlantic university. The surveys were administered to students enrolled in Introductory Biology, Human Anatomy and Physiology, Ecology, Introduction to Modern Chemistry, and Ecosphere: Environmental Science courses in the College of Science. Several of these classes meet the natural science requirements for non-science students. The sample included participants whose knowledge of science ranged from low to high. That is, one of these courses is a junior-level course, so it can be inferred that students in that course possessed a greater knowledge of science than other respondents; the other courses were freshmen-level classes. The Office of Sponsored Programs approved the research.

Materials

The study investigated awareness of fish consumption advisories concerning mercury among 200 18- to 40-year old females, again focusing on their attitudes toward advisories and their knowledge of fish consumption advisories concerning mercury. The

18-item survey (Appendix B) was administered to collect responses from women of varying age, race/ethnicity, and science knowledge. The survey also tapped respondents' estimates of the number of fish meals they had eaten in a week during the previous 12 months and how many times a month during the previous 12 months they had eaten fish.

Design and Procedure

Prior to administering the questionnaire, the investigator informed participants that the survey was being done by a doctoral candidate in the Environmental Science and Policy Program at the university. They were told the purpose of the survey and were informed that their participation was voluntary.

Three County Study

Participants

To explore knowledge, attitude, and behavior associated with fish consumption, a third set of data was collected. During 2007, the survey was administered to 309 females between 18 and 40 years old within the general public at several local supermarkets in three counties with differing socio-economic profiles in a mid-Atlantic state. The survey instrument was the same instrument used in the other two studies. Procedures for gathering data from shoppers at grocery stores in the three counties were approved by the university's Office of Sponsored Programs.

Materials

The study investigated the awareness of fish consumption advisories concerning mercury among 309 18 to 40 year old females, again focusing on their attitudes toward advisories and their knowledge of fish consumption advisories concerning mercury, at

several local supermarkets located within three counties in a mid-Atlantic state by assessing their behavioral attitudes with respect to the advisories and their knowledge about the fish consumption advisories concerning mercury.

An 18-item survey (Appendix B) was administered to collect responses from women of varying age, race/ethnicity, and science knowledge. The survey also tapped respondents' estimates of the number of fish meals they had eaten in a week during the previous 12 months and how many times a month during the previous 12 months they had eaten fish. The survey took less than ten minutes to complete.

Design and Procedure

Prior to administering the survey, the participants were informed that the study was conducted by a doctoral candidate in the Environmental Science and Public Policy Program at a large mid-Atlantic university. They were told the purpose of the survey, and that their participation was voluntary.

The investigator stood at the local supermarkets in order to select female shoppers from the general public as they walked by to fill out the survey. The investigator asked the females to participate in the survey on the same days and times of the week. The times were at 8:00 AM, 1:00 PM, and 6:00 PM on Monday, Friday, Saturday, and Sunday. The investigator chose the local supermarkets within a mid-Atlantic state from a telephone book that listed all the local grocery stores in each of the counties. This was done to be sure that shoppers were captured in the morning, afternoon, and evening on different shopping days and from a diverse mix of stores at different locations within the three counties. The purpose was to avoid introducing bias that might be due to the type of shopper that only

shops at one time during the day or on a particular day of the week and to avoid any one type of grocery store or type of location within the three counties. So within the convenience sample, selected times, days, and stores were chosen in a stratified sampling format to reduce some of the potential sources of bias.

Chapter 3

Results

This chapter reports the results for the 9 hypotheses that were tested for two studies: a survey of women attending a large mid-Atlantic university (University Study) and a survey of women in three counties within a large mid-Atlantic state (Three County Study).

University Study

Female Students By Class Enrollment

Of the 300 female undergraduate and graduate females in the study, 46 students were enrolled in Introductory Biology (BIOL 103), 146 students were enrolled in Human Anatomy and Physiology (BIOL 124), 44 students were enrolled in Ecology (BIOL 307), 34 students were enrolled in Introduction to Modern Chemistry (CHEM 101), and 30 students were enrolled in Ecosphere: Environmental Science (EVPP 110) (Table 1).

Table 1

Female Students By Class Enrollment

Response	Number	Percentage
Introductory Biology (BIOL 103)	46	15.3
Human Anatomy & Physiology (BIOL-124)	146	48.7
Ecology (BIOL-307)	44	14.7
Introduction to Modern Chemistry (CHEM 101)	34	11.3
Ecosphere: Environmental Science (EVPP 110)	30	10.0
Total	300	100

Race/Ethnicity

It was found that 32 of the students were African American, 57 were Asian or Pacific Islander, 2 were American Indian or Alaskan Native, 25 were Hispanic, 159 were White, and 25 were Other (Table 2).

Table 2

Race/Ethnicity Of Females In University And Three County Study

Race/Ethnicity	<u>University Study</u>		<u>Three County Study</u>	
	Number	Percentage	Number	Percentage
African American	32	10.6	202	65.4
Asian or Pacific Islander	57	19.0	14	4.5
American Indian or Alaskan Native	2	0.7	1	0.32
Hispanic	25	8.3	22	7.1
White	159	53.0	53	17.2
Other	25	8.3	17	5.5
Total	300		309	

Age

It was found that 109 were 18 years old, 62 were 19 years old, 38 were 20 years old, 23 were 21 years old, 20 were 22 years old, 15 were 23 years old, 11 were 24 years old, 4 were 25 years old, 3 were 26 years old, 5 were 27 years old, 1 was 28 years old, 2 were 29 years old, 1 was 30 years old, 2 were 31 years old, 1 was 32 years old, 1 was 33 years old, 1 was 34 years old, and 1 was 40 years old (Table 3).

Table 3

Ages Of Females In University and Three County Study

Age	<u>University Study</u>		<u>Three County Study</u>	
	Number	Percentage	Number	Percentage
18	109	36.3	34	11.0
19	62	20.7	31	10.0
20	38	12.7	32	10.4
21	23	7.7	27	8.7
22	20	6.7	15	4.9
23	15	5.0	13	4.2
24	11	3.7	7	2.3
25	4	1.3	7	2.3
26	3	1.0	10	3.2
27	5	1.7	9	2.9
28	1	0.3	6	1.9
29	2	0.6	15	4.9
30	1	0.3	9	2.9
31	2	0.7	12	3.9
32	1	0.3	10	3.2
33	1	0.3	10	3.2
34	1	0.3	10	3.2
35	0	0.0	10	3.2
36	0	0.0	7	2.3

Age	<u>University Study</u>		<u>Three County Study</u>	
	Number	Percentage	Number	Percentage
37	0	0.0	8	2.6
38	0	0.0	5	1.6
39	0	0.0	8	2.6
40	1	0.3	14	4.5
Total	300		309	

Number Of Children

It was found that 288 of the students do not have children, 7 had 1 child, 2 had 2 children, 1 had 3 children, and 2 had 4 children (Table 4).

Table 4

Number Of Children Of Female Students In University Study

<u>Response</u>	<u>Number</u>	<u>Percentage</u>
No Children	288	96.0
1 Child	7	2.3
2 Children	2	0.7
3 Children	1	0.3
4 Children	2	0.7
Total	300	100

Student Status

It was found that 113 were 1st year students, 83 were 2nd year students, 49 were 3rd year students, 29 were 4th year students, 14 were >4th year students, 2 were MS students. There were no PhD students, 2 were nondegree high school graduates, 6 were BA or BS graduates, and 2 were nondegree other students (Table 5).

Table 5

Student Status Of Female Students In University Study

<u>Response</u>	<u>Number</u>	<u>Percentage</u>
Undergraduate 1 st Year	113	37.7
Undergraduate 2 nd Year	83	27.7
Undergraduate 3 rd Year	49	16.3
Undergraduate 4 th Year	29	9.7
Undergraduate > 4 th Year	14	4.7
MS	2	0.7
PhD	0	0.0
Nondegree: High School	2	0.7
Nondegree: BA or BS	6	2.0
Nondegree: Other	2	0.7
<u>Total</u>	<u>300</u>	<u>100</u>

Read/Heard About Advisory

185 had read or heard about fish consumption advisories concerning mercury while 115 had not (Table 6).

Table 6

Number Of Females That Read/Heard About Advisory In University And Three County Study

Response	<u>University Study</u>		<u>Three County Study</u>	
	Number	Percentage	Number	Percentage
Yes	185	61.7	202	65.4
No	115	38.3	107	34.6
Total	300		309	

Students That Did/Did Not Reduce Their Fish Intake

Of those who had learned about the risk of mercury in fish, 34 had reduced their fish intake, but 263 had not reduced their fish intake (Table 7).

Table 7

Female Participants That Reduced Their Fish Intake In University And Three County Study

Response	<u>University Study</u>		<u>Three County Study</u>	
	Number	Percentage	Number	Percentage
Yes	34	11.3	68	22.0
No	263	87.7	240	77.7
No Response	1	0.33	1	0.32
Not Applicable	2	0.7	-	-
Total	300		309	

Whether Students Eat Fish

It was found that 45 students never eat fish, 54 almost never eat fish, 105 eat fish once a month, 64 eat fish once a week, 31 eat fish 2 or more times a week, and 1 of the students eats fish one or more times a day (Table 8).

Table 8

Whether Female Students Eat Fish In University Study

Response	Number	Percentage
Never Eats Fish	45	15.0
Almost Never Eats Fish	54	18.0
Eats Fish Once A Month	105	35.0
Eats Fish Once A Week	64	21.3
Eats Fish 2 Or More Times A Week	31	10.3
Eats Fish 1 Or More Times A Day	1	0.3
Total	300	100

Vegetarians/Nonvegetarians

It was found that 15 students were vegetarians and 285 were not vegetarians (Table 9).

Table 9

Number Of Female Students That Are Vegetarians In University Study

<u>Response</u>	<u>Number</u>	<u>Percentage</u>
No	285	95.0
Yes	15	5.0
<u>Total</u>	<u>300</u>	<u>100</u>

Students That Did/Did Not Exclude Fish Or Seafood

While 36 of the students did exclude fish or seafood from their diet because of their concern about mercury levels, most (263) of the 300 students did not exclude fish or seafood from their diet because of their concern about mercury levels (Table 10).

Table 10

The Number Of Females That Excluded Fish or Seafood from Their Diet In University And Three County Study

<u>Response</u>	<u>University Study</u>		<u>Three County Study</u>	
	<u>Number</u>	<u>Percentage</u>	<u>Number</u>	<u>Percentage</u>
Yes	36	12.0	71	23.0
No	263	87.7	237	76.7
No Response	1	0.33	1	0.32
<u>Total</u>	<u>300</u>		<u>309</u>	

Health Problems That Mercury In Fish Can Cause In Young Infants

Only 25 of the 300 students answered that they thought the health problems which mercury in fish can cause in young infants are negligible, and 66 students answered that the health problems are minor. The survey found that 101 of the students answered that the health problems that mercury in fish can cause in young infants are of moderate concern, and 92 answered that the health problems are major concerns (Table 11).

Table 11

Number Of Female Students That Responded About Health Problems That Mercury In Fish Can Cause In Young Infants In University Study

Response	Number	Percentage
No Response	14	4.7
Negligible	25	8.3
Minor	66	22.0
Moderate	101	33.7
Major	92	30.7
Do Not Know	2	0.7
Total	300	100

Know What Agency Issues Advisories

Of the 300 students, 48 answered that the federal government issues fish consumption advisories concerning mercury, 14 answered that the state government issues fish consumption advisories concerning mercury, 223 answered that they did not know

who issued fish consumption advisories concerning mercury, and 13 answered that both the federal and state government issues fish consumption advisories concerning mercury (Table 12).

Table 12

Number Of Female Students That Know What Agency Issues Advisories In University Study

Response	Number	Percentage
No Response	2	0.7
Federal Government	48	16.0
State Government	14	4.7
Do Not Know	223	74.3
Both Federal and State Government	13	4.3
Total	300	100

Where Student Became Familiar With Advisories

Only 30 students answered that they read or heard about the fish consumption advisory concerning mercury on the television, 2 answered that they read or heard about the fish consumption advisory concerning mercury on the radio, 7 answered that they read or heard about the fish consumption advisory concerning mercury in the newspaper, and 5 answered that they read or heard about the fish consumption advisory concerning mercury in magazines or other print media (leaflets, pamphlets, flyers). While none of the students answered that they read or heard about the fish consumption advisory concerning mercury

on posted signs or billboards, 9 answered that they read or heard about the fish consumption advisory concerning mercury on the World Wide Web/Internet, 23 answered that they read or heard about the fish consumption advisory concerning mercury from some other source. The largest group (103) of students answered that they read or heard about the fish consumption advisory concerning mercury on any combination of television, radio, newspaper, magazines or other print media (leaflets, pamphlets, flyers), World Wide Web/Internet and from some other source (Table 13).

Table 13

Source Of Female Students Becoming Aware Of Advisories In University Study

Response	Number	Percentage
No Response	121	40.3
Television	30	10.0
Radio	2	0.7
Newspaper	7	2.3
Magazine Or Other Print Media (Leaflets, Pamphlets, Flyers)	5	1.7
Posted Signs Or Billboards	0	0.0
World Wide Web/Internet	9	3.0
Other	23	7.7
Any Combination Of 1 to 7	103	34.3
Total	300	100

Quality Of Information In Advisories

Few (only 28 out of the 300) students answered that the information contained in the fish consumption advisories concerning mercury was very clear but 101 answered that the information contained in the fish consumption advisories concerning mercury was clear. Some (46) of the students answered that the information contained in the fish consumption advisories was not clear, 2 answered that the information was not clear at all, and 6 answered that they did not know whether the information contained in the fish consumption was very clear, clear, not clear, or not clear at all (Table 14).

Table 14

Females Responses To The Quality of Information Contained in Advisories In University Study and Three County Study

Response	<u>University Study</u>		<u>Three County Study</u>	
	Number	Percentage	Number	Percentage
No Response	117	39.0	105	34.0
Very Clear	28	9.3	40	12.9
Clear	101	33.7	109	35.3
Not Clear	46	15.3	36	11.7
Not Clear at All	2	0.7	6	1.9
Do Not Know	6	2.0	13	4.2
Total	300		309	

The Three County Study

Race/Ethnicity

In the Three County study, it was found that 202 of the females were African American, 14 were Asian or Pacific Islander, 1 was American Indian or Alaskan Native, 22 were Hispanic, 53 were White, and 17 were Other (Table 2, 15).

Table 15

Race/Ethnicity Of Females In Three County Study

Race/Ethnicity	Number	Percentage
African American	202	65.4
Asian or Pacific Islander	14	4.5
American Indian or Alaskan Native	1	0.3
Hispanic	22	7.1
White	53	17.2
Other	17	5.5
Total	309	100

Age

It was found that 34 were 18 years old, 31 were 19 years old, 32 were 20 years old, 27 were 21 years old, 15 were 22 years old, 13 were 23 years old, 7 were 24 years old, 7 were 25 years old, 10 were 26 years old, 9 were 27 years old, 6 were 28 years old, 15 were 29 years old, 9 were 30 years old, 12 were 31 years old, 10 were 32 years old, 10 were 33 years old, 10 were 34 years old, 10 were 35 years old, 7 were 36 years old, 8 were 37 years old, 5 were 38 years old, 8 were 39 years old, and 14 were 40 years old.

Number Of Children

It was found that 227 of the females surveyed did not have children, 48 had 1 child, 24 had 2 children, 8 had 3 children, and 2 had 4 children (Table 16).

Table 16

Number Of Children Of Females In Three County Study

Response	Number	Percentage
No Children	227	73.5
1 Child	48	15.5
2 Children	24	7.8
3 Children	8	2.6
4 Children	2	0.7
Total	309	100

Student Status

It was found that 59 were 1st year students, 33 were 2nd year students, 31 were 3rd year students, 20 were 4th year students, 9 were >4th year students, 34 were MS students. There were 6 PhD students, 31 were nondegree high school graduates, 46 were BA or BS graduates, and there were no nondegree other students (Table 17).

Table 17

Student Status Of Females In Three County Study

Response	Number	Percentage
Undergraduate 1 st Year	59	19.1
Undergraduate 2 nd Year	33	10.7
Undergraduate 3 rd Year	31	10.0
Undergraduate 4 th Year	20	6.5
Undergraduate >4 th Year	9	2.9
Mature Student/Other Undergraduate/Graduate Degree	40	13.0
MS	34	11.0
PhD	6	1.9
Nondegree: High School	31	10.0
Nondegree: BA or BS	46	14.9
Nondegree: Other	0	0.00
Total	309	100

Whether Females Eat Fish

It was found that 49 females within the Three County study never eat fish, 45 almost never eat fish, 110 eat fish once a month, 71 eat fish once a week, 28 eat fish 2 or more times a week, and 4 of the students eat fish one or more times a day (Table 18).

Table 18

Whether Females Eat Fish In Three County Study

Response	Number	Percentage
No Response	2	0.7
Never Eats Fish	49	15.9
Almost Never Eats Fish	45	14.6
Eats Fish Once A Month	110	35.6
Eats Fish Once A Week	71	23.0
Eats Fish 2 Or More Times A Week	28	9.1
Eats Fish 1 Or More Times A Day	4	1.3
Total	309	100

Vegetarians/Nonvegetarians

It was found that 17 females within the public were vegetarians and 292 were not vegetarians (Table 19).

Table 19

Number Of Females That Are Vegetarians In Three County Study

Response	Number	Percentage
No	292	94.5
Yes	17	5.5
Total	309	100

Read/Heard About Advisories

There were 202 who had read or heard about fish consumption advisories concerning mercury while 107 had not (Table 20).

Table 20

Number Of Females That Read/Heard About Advisories In Three County Study

Response	Number	Percentage
No	107	34.6
Yes	202	65.4
Total	309	100

Females That Did/Did Not Reduce Their Fish Intake

In the Three County study, of those who had learned about the risk of mercury in fish, 68 had reduced their fish intake, but 240 had not reduced their fish intake (Table 21).

Table 21

*Number Of Females That Reduced Their Fish Intake
In Three County Study*

Response	Number	Percentage
No Response	1	0.3
No	240	77.7
Yes	68	22.0
Total	309	100

Females That Did/Did Not Exclude Fish Or Seafood

While 71 of the females within the public did exclude fish or seafood from their diet because of their concern about mercury levels, most (237) of the 309 females did not exclude fish or seafood from their diet because of their concern about mercury levels (Table 22).

Table 22

Number Of Females That Excluded Fish Or Seafood From Their Diet In Three County Study

Response	Number	Percentage
No Response	1	0.3
No	237	76.7
Yes	71	23.0
Total	309	100

Health Problems That Mercury In Fish Can Cause In Young Infants

Only 32 of the 309 females within the public answered that they thought the health problems which mercury in fish can cause in young infants are negligible, and 69 females answered that the health problems are minor. The survey found that 99 of the females within the public answered that the health problems that mercury in fish can cause in young infants are of moderate concern, and 92 answered that the health problems are major concerns (Table 23).

Table 23

Number Of Females That Responded About Health Problems That Mercury In Fish Can Cause In Young Infants In Three County Study

Response	Number	Percentage
No Response	17	5.5
Negligible	32	10.4
Minor	69	22.3
Moderate	99	32.0
Major	92	30.0
Total	309	100

Knows What Agency Issues Advisories

Of the 309 females within the public, 82 answered that the federal government issues fish consumption advisories concerning mercury, 24 answered that the state government issues fish consumption advisories concerning mercury, 179 answered that they did not know who issued fish consumption advisories concerning mercury, and 23 answered that both the federal and state government issues fish consumption advisories concerning mercury (Table 24).

Table 24

*Number Of Females That Know What Agency Issues Advisories
In Three County Study*

Response	Number	Percentage
No Response	1	0.3
Federal Government	82	26.5
State Government	24	7.8
Do Not Know	179	57.9
Both State and Federal Government	23	7.4
Total	309	100

Where Females Became Familiar With Advisories

Only 35 females within the public answered that they read or heard about the fish consumption advisory concerning mercury on the television, 6 answered that they read or heard about the fish consumption advisory concerning mercury on the radio, 6 answered that they read or heard about the fish consumption advisory concerning mercury in the newspaper, and 16 answered that they read or heard about the fish consumption advisory concerning mercury in magazines or other print media (leaflets, pamphlets, flyers). While 1 of the females within the public answered that they read or heard about the fish consumption advisory concerning mercury on posted signs or billboards, 7 answered that they read or heard about the fish consumption advisory concerning mercury on the World Wide Web/Internet, 21 answered that they read or heard about the fish consumption advisory concerning mercury from some other source. The largest group (109) of the

females within the public answered that they read or heard about the fish consumption advisory concerning mercury on any combination of television, radio, newspaper, magazines or other print media (leaflets, pamphlets, flyers), World Wide Web/Internet and from some other source (Table 25).

Table 25

*Source Of Females Becoming Aware Of Advisories
In Three County Study*

Response	Number	Percentage
No Response	108	35.0
1= Television	35	11.3
2= Radio	6	1.9
3= Newspaper	6	1.9
4= Magazines Or Other Print Media (Leaflets, Pamphlets, Flyers)	16	5.2
5= Posted Signs Or Billboards	1	0.3
6= World Wide Web/Internet	7	2.3
7= Other	21	6.8
Any Combination Of 1 to 7	109	35.3
Total	309	100

Quality Of Information In Advisories

Few (only 40 out of the 309) females within the public answered that the information contained in the fish consumption advisories concerning mercury was very clear but 109 answered that the information contained in the fish consumption advisories concerning mercury was clear. Some (36) of the females within the public answered that the information contained in the fish consumption advisories was not clear, 6 answered that the information was not clear at all, and 13 answered that they did not know whether the information contained in the fish consumption was very clear, clear, not clear, or not clear at all (Table 26).

Table 26

Females Responses To The Quality Of Information Contained In Advisories In Three County Study

Response	Number	Percentage
No Response	105	34.0
Very Clear	40	12.9
Clear	109	35.3
Not Clear	36	11.7
Not Clear At All	6	1.9
Do Not Know	13	4.2
Total	309	100

The statistical software used to analyze the data that I collected from the surveys is JMP. JMP offers statistical analyses such as performing univariate statistics, analysis of variance and multiple regression, nonlinear fitting, multivariate analysis, and nonparametric tests. Point estimates such as the percentage of females that are aware of the fish consumption advisories concerning mercury were calculated.

Results

Test of Hypotheses

The first hypothesis states that 18-40 year old females enrolled in the University Study are not aware of fish consumption advisories concerning mercury. To test this hypothesis, the proportion of “yes” (subject is aware of the fish consumption advisories concerning mercury) found in the survey was compared with the null hypothesis that no proportion (0%) is aware of the fish consumption advisories concerning mercury.

Table 27

Number Of Females That Read/Heard About Advisory In University Study

Response	Number	Percentage
No	115	38.3
Yes	185	61.7
Total	300	100

Table 28

Test Probabilities - Number Of Females That Read/Heard About Advisory In University Study

Response	Estimated Probability	Hypothesized Probability
No	0.38333	100.0
Yes	0.61667	00.00

Table 29

Likelihood Ratio Test – Number Of Females That Read/Heard About Advisory In University Study

Test	ChiSquare	DF	Probability>Chi-Square
Likelihood Ratio	.	1	.

A likelihood-ratio test shows that the p value is < 0.0000 which means the null hypothesis can be rejected. So, the test shows that 18-40 year old female undergraduate and graduate students enrolled in College of Science courses at a large mid-Atlantic University are well aware of fish consumption advisories concerning mercury.

Given the large proportion of students aware of the fish consumption advisories concerning mercury, a second test was conducted to test if more than 50% of the female students are aware of the fish consumption advisories concerning mercury. Again, a likelihood-ratio to test proportions was conducted.

Table 30

Number Of Females That Read/Heard About Advisory In University Study

Response	Number	Percentage
No	115	38.3
Yes	185	61.7
Total	300	100

Table 31

Test Probabilities – Number Of Females That Read/Heard About Advisory In University Study

Response	Estimated Probability	Hypothesized Probability
No	0.38333	.50000
Yes	0.61667	.50000

Table 32

Likelihood Ratio Test – Number Of Females That Read/Heard About Advisory In University Study

Test	Chi-Square	DF	Probability>Chi-Square
Likelihood Ratio	16.4849	1	<.0001

Table 33

Confidence Intervals – Number Of Females That Read/Heard About Advisory In University Study

Response	Number	Percentage	Lower CI	Upper CI	1-Alpha
No	115	38.333	0.33012	0.439497	0.950
Yes	185	61.667	0.560503	0.66988	
Total	300				

The p value of this test is less than 0.0001, which means the null hypothesis can be rejected. So not only are the female students aware of the fish consumption advisories concerning mercury but more than 50% of the students are aware of the advisories. In fact, the survey shows that 61.6% are aware of the fish consumption advisories concerning mercury; this is with a 0.95 confidence level of (56% to 67%). Therefore, I am 95% certain that the real percentage of the female students that are aware of the fish consumption advisories concerning mercury is between 56% to 67%.

The second hypothesis states that there is no difference in the awareness of fish consumption advisories concerning mercury between female age groups (18-21), (22-30), and (31-40) enrolled in the University Study.

Three groups were formed and the distribution by ages is:

Group A = 18 – 21 years old

Group B = 22 – 30 years old

Group C = 31 – 40 years old

Table 34

Ages Of Female Students In University Study

<u>Level</u>	<u>Number</u>	<u>Percentage</u>
A	232	77.3
B	62	20.7
C	6	2.0
<u>Total</u>	<u>300</u>	<u>100</u>

A contingency table analysis below shows the statistical difference among the various age groups. The percentages are:

Group A (18 to 21 years old) = 77%

Group B (22 to 30 years old) = 21%

Group C (31 to 40 years old) = 2%

Table 35

Contingency Table – Ages Of Females That Read/Heard About Advisory In University Study

Number	No	Yes	Total
Total Percentage			
Column Percentage			
Row Percentage			
A= 18 -21	94	138	232
Total Percentage	31.33	46.00	77.33
Column Percentage	81.74	74.59	
Row Percentage	40.52	59.48	
B= 22-30	21	41	62
Total Percentage	7.00	13.67	20.67
Column Percentage	18.26	22.16	
Row Percentage	33.87	66.13	
C= 31-40	0	6	6
Total Percentage	0.00	2.00	2.00
Column Percentage	0.00	3.24	
Row Percentage	0.00	100.00	
Total	115	185	300
	38.33	61.67	

Table 36

Tests – Ages Of Females That Read/Heard About Advisory In University Study

Source	DF	-LogLike	RSquare (U)
Model	2	3.39846	0.0170
Error	297	196.30326	
C. Total	299	199.70172	
N	300		

Table 37

Likelihood Ratio Test – Ages Of Females That Read/Heard About Advisory In University Study

Test	ChiSquare	Probability>ChiSquare
Likelihood Ratio	6.797	0.0334

A likelihood ratio test shows that the p value is less than .05 (0.0334) and it suggests that the null hypothesis can be rejected. So, the test shows that there is a difference in the awareness of fish consumption advisories concerning mercury between age groups (18-21), (22-30), and (31-40). Therefore, older students (i.e., 22 to 40 years old) are more aware of the advisories than younger students.

The third hypothesis states that there is no difference concerning African-American, Asian or Pacific Islander, American Indian, or Alaskan Native, Hispanic, White, or Other enrolled in the University Study and Three County Study.

A contingency table analysis demonstrates the statistical difference among the racial/ethnicity groups.

Table 38

Contingency Table – Race/Ethnicity Of Females That Read /Heard About Advisory In University And Three County Study

Number			
Total Percentage			
Column Percentage			
Row Percentage	No	Yes	Total
1= African American	83	151	234
Total Percentage	13.63	24.79	38.42
Column Percentage	37.39	39.02	
Row Percentage	35.47	64.53	
2= Asian or Pacific Islander	29	42	71
Total Percentage	4.76	6.90	11.66
Column Percentage	13.06	10.85	
Row Percentage	40.85	59.15	
3= American Indian or Alaskan	0	3	3
Native (Total Percentage)	0.00	0.49	0.49
Column Percentage	0.00	0.78	
Row Percentage	0.00	100.00	
4= Hispanic	24	23	47
Total Percentage	3.94	3.78	7.72
Column Percentage	10.81	5.94	
Row Percentage	51.06	48.94	
5= White	67	145	212
Total Percentage	11.00	23.81	34.81
Column Percentage	30.18	37.47	
Row Percentage	31.60	68.40	
6= Other	19	23	42
Total Percentage	3.12	3.78	6.90
Column Percentage	8.56	5.94	
Row Percentage	45.24	54.76	
	222	387	609
	36.45	63.55	

Table 39

Tests – Race/Ethnicity Of Females That Read /Heard About Advisory In University And Three County Study

Source	DF	-LogLike	RSquare (U)
Model	5	5.55972	0.0139
Error	603	393.93287	
C. Total	608	399.49259	
N	609		

Table 40

Likelihood Ratio Test – Race/Ethnicity Of Females That Read /Heard About Advisory In University And Three County Study

Test	ChiSquare	Probability>ChiSquare
Likelihood Ratio	11.119	0.0491

A likelihood ratio test shows that the p value is less than 0.05 (0.0491) which means the null hypothesis can be rejected. Therefore, there are significant differences among the ethnic groups and their awareness about the fish consumption advisories concerning mercury.

Test results show a difference in Race/Ethnicity in reference to the fish consumption advisory concerning mercury. The White females (Group 5) at 68.4% have a higher proportion of “Yes” (females that read or heard about fish consumption advisories

concerning mercury than any other racial/ethnic group. Group 3 (American Indian or Alaskan Native) has a 100% of awareness but the sample size is too small for a conclusive result. Group 4 (Hispanics) has a 48.9% awareness, and therefore has the least awareness about the fish consumption advisories concerning mercury.

The fourth hypothesis states that there is no difference in awareness of fish consumption advisories concerning mercury between college-educated and non-college educated individuals enrolled in the University Study and Three County Study. A comparison was conducted of the proportion of “yes” (subject is aware of the fish consumption advisories concerning mercury) for educated college group vs. the non college educated group found in the Three County survey. This step was taken to test the Null hypothesis that there is no difference in the “Yes” proportions.

A contingency table analysis demonstrates that there is no significant difference among the college-educated and non-college educated individuals. College students have an awareness (responded “Yes” to reading the mercury advisory) of 63.32% while non-college individuals have an awareness of 67%.

Table 41

Contingency Table – Educational Status Of Females That Read/Heard About Advisory In University And Three County Study

Number	No	Yes	Total
Total Percentage			
Column Percentage			
Row Percentage			
College	212	366	578
Total Percentage	34.81	60.10	94.91
Column Percentage	95.50	94.57	
Row Percentage	36.68	63.32	
Non College	10	21	31
Total Percentage	1.64	3.45	5.09
Column Percentage	4.50	5.43	
Row Percentage	32.26	67.74	
	222	387	609
	36.45	63.55	

Table 42

Tests – Educational Status Of Females That Read/Heard About Advisories In University And Three County Study

Source	DF	-LogLike	RSquare (U)
Model	1	0.12620	0.0003
Error	607	399.36639	
C. Total	608	399.49259	
N	609		

Table 43

Likelihood Ratio Test – Educational Status Of Females That Read/Heard About Advisory In University and Three County Study

Test	ChiSquare	Probability>ChiSquare
Likelihood Ratio	0.252	0.6154

The likelihood ratio test shows that the p-value is greater than .05 (0.6154) so the null hypothesis cannot be rejected. Therefore, among the participants in these studies, there are no significant differences between the level of education and awareness of the fish consumption advisories concerning mercury.

The fifth hypothesis states that there is no difference in awareness of fish consumption advisories concerning mercury between 18-40 year old mothers and non-mothers enrolled in the University and Three County Study.

Table 44

Number Of Mothers And Non-Mothers That Read/Heard About Advisories In University And Three County Study

Response	Number	Percentage
No	515	85.0
Yes	94	15.4
Total	609	100

Table 45

Contingency Table – Number Of Mothers And Non-Mothers That Read/Hear About Advisories In University And Three County Study

Number	Aware? No	Aware? Yes	
Total Percentage			
Column Percentage			
Row Percentage			
Non-Mothers	199	316	515
	32.68	51.89	84.56
	89.64	81.65	
	38.64	61.36	
Mothers	23	71	94
	3.78	11.66	15.44
	10.36	18.35	
	24.47	75.53	
	222	387	609
	36.45	63.55	

A contingency table analysis demonstrates the statistical difference among the mothers and non-mothers.

Table 46

Tests – Number Of Mothers And Non-Mothers That Read/Heard About Advisories In University And Three County Study

Source	DF	-LogLike	R-Square (U)
Model	1	3.62576	0.0091
Error	607	395.86683	
C. Total	608	399.49259	
N	609		

Table 47

Likelihood Ratio Test – Number Of Mothers And Non-Mothers That Read/Heard About Advisories In University And Three County Study

Test	Chi-Square	Probability>Chi-Square
Likelihood Ratio	7.252	0.0071

A likelihood ratio test shows that the p value is less than .05 (0.0071) which means the null hypothesis can be rejected. The test shows that 18-40 year old mothers in the University and Three County Study are more aware of fish consumption advisories concerning mercury than non-mothers. Seventy-five percent of the mothers were aware and 61% of the non-mothers were aware.

The sixth hypothesis states that there is no difference in whether females reduced their fish intake between 18-40 year old mothers and non-mothers enrolled in the University and Three County Study.

Table 48

Contingency Table – Number Of Mothers And Non-Mothers That Reduced Their Fish Intake In University And Three County Study

Number	Reduced Fish Consumption?		Reduced Fish Consumption?	
Total Percentage	No	Not Applicable	Yes	
Column Percentage				
Row Percentage				
Non-Mothers	440	4	71	515
	72.25	0.66	11.66	84.56
	87.48	100.00	69.61	
	85.44	0.78	13.79	
Mothers	63	0	31	94
	10.34	0.00	5.09	15.44
	12.52	0.00	30.39	
	67.02	0.00	32.98	
	503	4	102	609
	82.59	0.66	16.75	

Table 49

Tests – Number Of Mothers And Non-Mothers That Reduced Their Fish Intake In University And Three County Study

Source	DF	-LogLike	R-Square (U)
Model	2	9.57982	0.0321
Error	605	288.96824	
C. Total	607	298.54807	
N	609		

Table 50

*Likelihood Ratio Test – Number Of Mothers And Non-Mothers
That Reduced Their Fish Intake In University And Three County Study*

Test	Chi-Square	Probability>Chi-Square
Likelihood Ratio	19.160	<.0001

A likelihood ratio test shows that the p value is less than .05 (.0001) which means the null hypothesis can be rejected. So, the test shows that 18-40 year old mothers are more inclined than non-mothers to reduce fish intake in the University and Three County Study. However, this finding should be viewed with caution since 20 percent of the cells in this chi square analysis have a count of fewer than 5.

The seventh hypothesis states that there is no difference in whether the females excluded certain fish or seafood between 18-40 year old mothers and non-mothers enrolled in the University and Three County Study.

Table 51

Contingency Table – Number Of Mothers And Non-Mothers That Excluded Fish Or Seafood From Their Diet In University And Three County Study

Number	Fish Exclusion		
Total Percentage	No	Yes	
Col Percentage	Fish Exclusion		
Row Percentage	No	Yes	
Non-Mothers	444	71	515
	72.91	11.66	84.56
	88.45	66.36	
	86.21	13.79	
Mothers	58	36	94
	9.52	5.91	15.44
	11.55	33.64	
	61.70	38.30	
	502	107	609
	82.43	17.57	

Table 52

Tests – Number Of Mothers And Non-Mothers That Excluded Fish Or Seafood From Their Diet In University And Three County Study

Source	DF	-LogLike	R-Square (U)
Model	1	13.96047	0.0493
Error	607	269.10691	
C. Total	608	283.06738	
N	609		

Table 53

Likelihood Ratio Test – Number Of Mothers And Non-Mothers That Excluded Fish Or Seafood From Their Diet In University And Three County Study

Test	ChiSquare	Probability>ChiSquare
Likelihood Ratio	27.921	<.0001

The likelihood ratio test shows that the p value is less than .05 (.0001) and it suggests that the null hypothesis can be rejected. So, the test shows that there is a difference in whether the females excluded certain fish or seafood between mothers and non-mothers. Therefore, mothers are more willing to exclude certain fish or seafood than the non-mothers.

The eighth hypothesis states that there is no difference in whether the 18-40 year old mothers and non-mothers in the University and Three County studies answered that they thought the health problems which mercury in fish can cause in young infants were do not know, negligible, minor, moderate, or major.

Table 54

Contingency Table – Number Of Mothers And Non-Mothers That Responded About Health Problems That Mercury In Fish Can Cause In Young Infants In University And Three County Study

Number	Health Problems?					
Total Percentage	Do not know	Major	Minor	Moderate	Negligible	
Column Percentage						
Row Percentage						
Non-Mothers	25	148	116	173	52	514
	4.11	24.34	19.08	28.45	8.55	84.54
	83.33	79.57	85.93	86.50	91.23	
	4.86	28.79	22.57	33.66	10.12	
Mothers	5	38	19	27	5	94
	0.82	6.25	3.13	4.44	0.82	15.46
	16.67	20.43	14.07	13.50	8.77	
	5.32	40.43	20.21	28.72	5.32	
	30	186	135	200	57	608
	4.93	30.59	22.20	32.89	9.38	

Table 55

Tests – Number Of Mothers And Non-Mothers That Responded About Health Problems That Mercury In Fish Can Cause In Young Infants In University And Three County Study

Source	DF	-LogLike	RSquare (U)
Model	4	3.17405	0.0036
Error	600	867.85799	
C. Total	604	871.03203	
N	608		

Table 56

Likelihood Ratio Test – Number Of Mothers And Non-Mothers That Responded About Health Problems That Mercury In Fish Can Cause In Young Infants In University And Three County Study

Test	ChiSquare	Probability>Chi-Square
Likelihood Ratio	6.348	0.1746

A likelihood ratio test shows that the p value is greater than .05 (0.1746) and it suggests that the null hypothesis cannot be rejected. Therefore, there are no statistical differences between mothers and non-mothers in relation to their perceptions of the health effects caused by mercury in fish in young infants. However, the general trend in the table above is that mothers are more predisposed to perceive mercury in fish as a serious hazard in children i.e., 40% for mothers and 29% non-mothers perceived mercury in fish as a major health effect in young infants.

The ninth hypothesis states there is no difference in awareness of fish consumption advisories concerning mercury between college-educated females with 2 years of college or more and females with less than 2 years of college enrolled in the University and Three County Study.

Table 57

*Educational Status Of Females That Read/Heard
About Advisory In University And Three County Study*

Response	Number	Percentage
Higher	286	47.0
Lower	323	53.0
Total	609	100

Table 58

*Contingency Table – Educational Status Of Females
That Read/Heard About Advisory In University And Three County Study*

Number	Aware?		Total
	No	Yes	
Higher Education	74	212	286
Column Percentage	12.15	34.81	46.96
Row Percentage	33.33	54.78	
Lower Education	25.87	74.13	
	148	175	323
Column Percentage	24.30	28.74	53.04
Row Percentage	66.67	45.22	
	45.82	54.18	
Total	222	387	609
Column Percentage	36.45	63.55	

Table 59

Tests – Educational Status Of Females That Read/Heard About Advisory In University And Three County Study

Source	DF	-LogLike	RSquare (U)
Model	1	13.21930	0.0331
Error	607	386.27329	
C. Total	608	399.49259	
N	609		

Table 60

Likelihood Ratio Test – Educational Status Of Females That Read/Heard About Advisory In University And Three County Study

Test	ChiSquare	Probability>ChiSquare
Likelihood Ratio	26.439	<.0001

The likelihood ratio test shows that the p value is less than .05 (0.0001) so the null hypothesis can be rejected. Therefore, there are significant differences in awareness of fish consumption advisories concerning mercury between those women with 2 or more years of college and those with fewer than 2 years of college among the participants in these studies. The proportion of awareness in the more highly educated females is significantly higher than in the less educated females: 74% compared to 54%.

Additional Findings

In the Three County Study the participants included a large number of African American females. The study included 202 African American females out a total of 309 participants, which is 65% of the sample (Table 15).

In the University Study, the average age of the females is 20 years old and the median age is 19 years old. In the Three County Study, the average age is 26 years old and the median age is 24 years old. Therefore, the average age of the females in the Three County Study is 6 years older than the females in the University Study (Table 3).

In the University Study, some (46 or 15%) of the students answered that the information contained in the fish consumption advisories was not clear (Table 14). One hundred and one (34%) of the females answered that the information was clear (Table 14). In the Three County Study, some (36 or 12%) of the females answered that the information contained in the fish consumption advisories was not clear (Table 26). In the Three County Study, 109 (35%) students answered that the information was clear (Table 26).

Of the 300 students in the University Study, 223 (74.3%) answered that they did not know who issued fish consumption advisories concerning mercury (Table 12). Of the 309 females in the Three County Study, 179 (57.9%) answered they did not know who issued the advisories (Table 24).

Of the 300 students in the University Study, 92 (30.6%) answered that they thought the health problems which mercury in fish can cause in young infants are major concerns (Table 11). Of the 309 females in the Three County Study, 92 (29.8%) answered that they

thought the health problems which mercury in fish can cause in young infants are major concerns (Table 23).

Of the 300 students in the University Study, 103 (34.3%) answered that they read or heard about the fish consumption advisories concerning mercury on any combination of television, radio, newspaper, magazines or other print media (leaflets, pamphlets, flyers), World Wide Web/Internet and from some other source (Table 13). Of the 309 females in the Three County Study, 109 (35.2%) answered that they read or heard about the fish consumption advisories concerning mercury on any combination of television, radio, newspaper, magazines or other print media (leaflets, pamphlets, flyers), World Wide Web/Internet and from some other source (Table 25).

Chapter 4

Discussion

Deciding whether to eat fish and how much fish to eat are not easy decisions. There are a number of challenges associated with making fish consumption advisories effective vehicles for sharing risk information with key stakeholders. Mercury content in fish is dangerous to human health, and yet consumption of a certain amount of some fish each week is part of a healthful diet (Institute of Medicine, 2006). A difficulty is that those most likely to receive information about mercury in fish are individuals who frequently scan scientific, medical, and mainstream reports due to their own interests or social pressure to be informed (Kahlor et al., 2006). Many individuals, especially minorities, are not frequent consumers of such news.

In this chapter, I first highlight main findings and their implications. Next, I discuss the implications of my findings through the lens of risk perception and communication theories, particularly theories designed to identify obstacles to behavior change and research-guided ways of creating campaigns or conditions that encourage healthful fish consumption. Lastly, I discuss strengths and limitations of this study and my conclusions.

Main Findings

This dissertation identifies some intriguing and unanticipated results and important new information that can be used to further advance public health. The age of females, motherhood, and educational status were all found to be predictors of awareness of the fish consumption advisories concerning mercury. Furthermore, some evidence shows that these predictors were associated with self-reported behavior changes such as changing fish intake or reducing fish consumption.

First, age predicted awareness of fish consumption advisories. Older women were more likely to be aware of the advisories about mercury in fish than were younger women. There are a number of reasons why this may be the case. One reason is that increasing age gives individuals a greater opportunity to be exposed to information. Another reason may be that, with age, comes increasing reasons to be interested in and emotionally affected by the potential harm associated with mercury in seafood. Research in risk perception by Slovic (Slovic et al., 2004) and others (Loewenstein et al., 2001; Alhakami et al., 1994; Weber, 2006) shows that people must feel a risk before they address it. That is, when risk information is encountered in a report, but the personal relevance of the information is not obvious or not salient, people may have difficulty appreciating its impact on them and their lives. Slovic (Slovic et al., 2004) and others studying risk perception have found this pattern in a number of contexts (Loewenstein et al., 2001; Alhakami et al., 1994; Weber, 2006).

Support for this second interpretation of my findings may be found in a second finding. My findings show that mothers were more aware than non-mothers of the advisories in the University and Three County Study. Seventy-five percent of the mothers

were aware of the fish consumption advisories concerning mercury compared to 61% of the non-mothers. If a female was not planning to have a child soon, then she may not pay as much attention to the advisories as would women planning to have children soon. Being a mother may cause females to be more alert to threats that may harm their children and therefore pay more attention to the advisories than non-mothers. More females are waiting to have their first child due to education and career. In 2000, the mean average age of a mother with their first born child in the United States was 27.2 years old (US Department of Health and Human Services, 2002). In the Three County Study, the average age of the females was 26 years old. These findings suggest that campaigns aimed at increasing awareness of mercury in fish should target young women in their early 20s and young mothers. More mothers need to be targeted to become more aware of this issue prior to their becoming pregnant with their first child.

A third important finding in this dissertation is that mothers may be altering their intake of fish in ways that are less than ideal. According to the survey of the total 609 females who were either students enrolled in the University Study or participants in the Three County Study, 33% of the mothers and 14% of the non-mothers that had read or heard about fish consumption advisories concerning mercury reduced their intake of fish based on what they learned about the risk of mercury in fish. Among these individuals, those who were mothers reported being more willing to exclude certain fish or seafood from their diet because of their concerns about mercury levels than did non-mothers. Mothers were also more likely to perceive mercury in fish as a major health problem in young infants more than were non-mothers.

Unfortunately, while these findings show that the participants were alert to the mercury hazard, they also suggest that some participants were reducing consumption of all fish and seafood regardless of mercury content, which is a problem. According to the Institute of Medicine (2006), seafood contains high-quality protein, a low level of saturated fat, and a large amount of vitamins and minerals. This means that some mothers are likely missing out on the protein, vitamins, and minerals that are contained in fish and seafood. These females should be educated as to the health consequences of reducing fish consumption without addressing the need for appropriate dietary supplements.

A fourth finding is that ethnicity predicted awareness of fish consumption advisories. My findings show that Hispanic women were the least aware of the fish consumption advisories in the University and Three County Study. About 49% of them were aware of the fish consumption advisories compared to 100% of American Indian or Alaskan Native women, 68% of White women, 65% of African-American women, 59% of Asian or Pacific Islander women, and 55% of other women.

Fortunately, there is also some evidence that efforts to educate about the harm of mercury are having some positive effects. Specifically, education beyond two years of college was a predictor of awareness of fish consumption advisories. Highly educated females (2 years of college and above) were more aware of the advisories than were less educated females (fewer than 2 years of college). This finding, coupled with the finding that motherhood was a predictor of awareness of fish consumption advisories can inform public health campaigns. Consequently, I next analyze my findings through the lens of a

risk communication model that identifies factors that prevent or encourage awareness and response to health risks.

A Risk Communication Model

The findings from this dissertation identify possible reasons why at-risk groups may not benefit from government-issued fish advisories. This situation is not unique. Risk communication research shows that for nearly all physical hazards, there are predictable obstacles to ensuring that affected audiences detect, interpret, and respond to warnings and information in ways that protect them (Pidgeon et al., 2003; Slovic, 2000). One approach to overcoming risk communication challenges associated with risk communication is Rowan's CAUSE model of risk communication (Rowan, 1991, 1994; Rowan et al., 2009). The CAUSE Model identifies reasons why vulnerable groups may not respond to a warning as issuers hope. In addition, the model indexes large bodies of social science research on overcoming each obstacle. Each letter in the model stands for obstacles to communication and strategies for addressing these obstacles. The C suggests reasons why audiences may distrust message senders and research-supported ways to establish credibility and build trust. The A stands for reasons why audiences may not detect, interpret, or confirm efforts to create awareness of a hazard, and ways to increase the chances that audiences see, interpret, and confirm a warning. The U stands for understanding and indexes sources of likely confusion. Even if an intended audience detects a warning, they may not fully comprehend its message. The model directs users to research about ways to overcome likely obstacles, particularly confusions that arise when audiences are being exposed to scientific information. The S stands for satisfaction with

solutions. Audiences may understand a risk, but disagree with recommended solutions such as limiting fish intake. The model identifies research on persuasion and social influence that describes ways to gain agreement or satisfaction with a recommendation. The last letter is E is for enactment. Often people may agree that they should take some steps such as not eating certain fish, but fail to follow through or take the steps needed to, for example, vary the kinds of fish they eat. Research on encouraging enactment or causing behavioral change provides some direction for encouraging audiences to change habits (e.g., Booth-Butterfield, 2003).

Using the CAUSE model, I describe next steps in research and outreach that could be used to communicate with audiences who may not be aware of fish consumption advisories.

Earning Confidence, the C in the CAUSE Model. Research on credibility shows that people are unlikely to heed warnings if they question the motives or competence of the message source (O'Keefe, 2002). My findings show that younger women and Hispanic women of childbearing age were less likely to be aware of fish-consumption advisories than were older and non-Hispanic women. Therefore, research is needed to understand how to earn the confidence of women in these population groups concerning fish consumption advisories. In order to learn how to earn confidence among minorities about advisories, I would interview Hispanics and other minorities to determine how they would prefer receiving information. Health literacy research concludes that minorities may prefer letting others know how they wish to be reached rather than not being given a choice (Kreps, 2005, 2006).

Face-to-face interviews and focus groups can be conducted to discuss sources they trust. Unsolicited advice can sometimes be irritating and annoying to some individuals (MacGeorge et al., 2006). Interviews and focus groups may suggest preferred sources of health communication and ways of encouraging audiences to seek information rather than having it sent to them. To locate and interview focus group participants, I would contact community organizations and religious groups that deal with various ethnic groups in the local area. I would identify African American churches, Hispanic churches, Asian churches, Vietnamese churches, Bureau of Indian Affairs, Catholic churches, and mosques, so that their leaders can put me in touch with persons to interview. A large number of these organizations are well-organized and would be able to identify responsive people. Conducting focus groups would allow me to discuss these challenges in-depth with a group and understand some of their reactions. I would ensure that a large number of lower-income individuals were involved in the process.

My findings show that young women do not know as much about the fish consumption advisories as older women. There may be ways to better reach younger women. Older family members such as older peers, sorority sisters, co-workers, aunts, mothers, and religious leaders that are more familiar with the advisories could be encouraged to talk with younger women. Mothers might be encouraged to talk with young women who are planning a pregnancy about this risk.

Minorities may be more apt to pay attention to a health message if it comes from a member of their own community. Local television and radio stations could be contacted for each of the various racial/ethnic groups to cover the issue. The main goal is to listen to

minority individuals to bring a fresh perspective to the understanding of this issue so that these individuals in turn will be more receptive to the message and willingly share it with others. This listening process may suggest that the confidence of minority women will be earned if local opinion leaders whom they respect urge them to learn more about healthful consumption of fish. This approach to earning confidence is strongly supported by research on ways in which opinion leaders can cause change in their communities (Maibach & Parrott, 1995). Combining the most effective media, strategies, and messages will lead to substantial involvement of more young and minority populations (Kreps, 2005, 2006). Perhaps, text messages on cellular telephones could evolve as a routine means to get public health messages such as information about the advisory to young people and the general public.

The program could serve as a model that could be duplicated. Grants by foundations and other organizations could be made available to duplicate this effort. There is considerable work on effective public health campaigns in the public health literature (Maibach & Parrott, 1995), but there is also evidence that current methods of communicating health threats should be more effective. The model would have impact throughout the United States and therefore could potentially impact the entire nation.

Creating Awareness Among Young Individuals, the A in the CAUSE Model. It is critical that mothers who are nursing or might become pregnant and young children become more aware of the fish consumption advisory concerning mercury. As a second step to overcoming communication barriers about this health issue I would consider the letter “A” in the CAUSE Model and work on enhancing awareness by increasing the

number of females within the United States that are aware of fish consumption advisories concerning mercury (Rowan et al., 2003).

As noted earlier, my results show that in these studies, older women of childbearing age are more aware of the advisories than younger women. In my study, “older” women are those aged 22 to 40, women who are in their childbearing years. Perhaps these women are more health-conscious than 18 to 21 year-olds and therefore pay more attention to health messages. Younger women may also be more focused on networking and socializing more than older women who may have greater experience at scanning for health warnings, particularly warnings that affect the health of their families. Younger women may be more apt to listen to their friends and family about the advisories. Research shows that when people detect warnings, they do not simply respond to them. Instead they talk about these warnings with friends and family, or they may be more apt to hear about a warning from a family member or friend than from mainstream media or health professionals (e.g., Perry, 1988; Perry & Mushkatel, 1984; Southwell & Yzer, 2007). These findings should be taken into account in developing health communication strategies, so that limited resources can be applied where they will be most effective. The fact that people talk to one another when they learn about a warning can be used to amplify the effects of fish advisories.

Because they are a vulnerable group, younger females attending college or about to attend college should be targeted to increase their awareness of fish consumption advisories concerning mercury. Educational and information materials can be distributed on college campuses through religious organizations, health clinics, and health fairs. The information

can also be broadcast through college radio stations and television stations. This will hopefully result in more young females becoming aware of fish consumption advisories concerning mercury.

In my interviews and focus groups I would also attempt to learn what media young individuals use the most frequently. Since Hispanic women and other minority women are least aware of fish consumption advisories concerning mercury, they should be targeted along with the younger population to improve their understanding about the issue. One of the reasons that Hispanics are not as aware could be related to the fact that English is not their primary language. Therefore, the information in the advisory must be provided in a format that is fully comprehensible. One way to reach more Hispanics is through Hispanic radio and television stations such as *Telemundo* and *Univision*. Hispanics and other minorities typically trust their friends, family members, co-workers, churches, and are more apt to discuss health issues such as this among themselves. This information should be taken into consideration when health risk messages are crafted for these populations. One set of channels that the focus groups could explore are social media that young women monitor.

My Space.com, Craig's List, and blogs are major communication tools that are constantly being used by young people where they post information about themselves and then communicate with each other. This population can be targeted about the importance of following the recommendations in the advisory. My Space.com and blogs can be created about fish consumption advisories concerning mercury where mostly young people and the general public can respond to the discussion database. It is possible that some

blogs may function as oral communication does to amplify, extend, and increase the impact of a health message somewhat in the same way that interpersonal communication functions in health campaigns (Southwell & Yzer, 2007). The blogs would allow information to be transmitted to large numbers of young people and an even wider audience at a relatively low cost. Once blogs are set-up, I could comment on articles, write my own blog, and share photographs. Readers can read comments about my article, recommend the article to others, print the article, and e-mail the article to others. As a member I can post in forums and join discussion groups that will lead to further discussion on the issue. I can also join the discussion forum on health and healing in Maryland and Virginia that is available on Craig's List. I can also use this forum to write an article about the issue and post it in the forum. Hopefully a lot of discussion can be generated on the issue and major news media can cover a story about it. Young people that participate in blogs can be further directed to various websites for more information about the advisory.

In order to target more mothers, brochures about the fish consumption advisories could be placed on display at or near the front door of day care centers and doors of every classroom. Information containing the issue could be emailed to the mothers of the children in March as part of an Advisory Awareness Day and discussed in the day care center newsletters. Brochures and other educational materials can be distributed at free health clinics and emergency rooms in hospitals located in low-income and minority communities. Expectant mothers who do not have health insurance are more likely to receive pre-natal treatment at these clinics. These clients could receive an Advisory Package when they depart the emergency rooms as part of the check-out process.

Information can also be distributed to female shoppers at grocery stores located in low-income and minority neighborhoods where they typically shop. Public libraries can also display posters and brochures so that females that do not have access to the Internet or receive the daily newspaper have the opportunity to receive the information. Social service agencies and women's homeless shelters can display the information for their clients. Nurse practitioners that work in stores such as Target, Walmart, Walgreens, and CVS can distribute the information to female shoppers and females that they treat.

Deepening Understanding, the U in the CAUSE Model. Discussion that takes place among family and friends about various health risks is one way information can indirectly influence comprehension of an issue (Powell et al., 2007). Some of the females in the University and Three County study may have learned about the fish consumption advisories from family members and friends. Interpersonal discussion of health issues may have greater impact on those who participate in these discussions than would communication that exists solely in mass media. On the other hand, the opportunity for mixed and confusing messages increases in interpersonal channels. One way to increase the chances that there is both interpersonal communication about fish consumption advisories and that this information is correct, is to also launch efforts to educate target populations.

In order to target the young population, efforts could focus on elementary, middle, and high schools at the local level and in minority neighborhoods. Efforts should include young children because the message fits readily into their school curriculum, provides indirect access to the child's parents or guardians, and will likely stay with them when they

become adults. For example, the program could include a Poster Competition on Fish Consumption Advisories Concerning Mercury which would be held at local schools, churches, and community centers. Awards could be given for the best poster that would be judged on content, presentation, and comprehensiveness for first, second, and third place. Public health professionals and various community members from the local areas could serve as judges. Participation by these individuals conveys a strong sense of community support and interest in the students' education and well being. The earlier that children are involved in this issue, the easier for them to establish a pattern of following the recommendations in the fish consumption advisories (Booth-Butterfield, 2003). Raising children's awareness about the issue will likely lead to more parents, especially mothers, becoming more aware.

The Poster Session could be held in conjunction with an Advisory Awareness Day each year at the local schools. The winning poster can be highlighted at the Advisory Awareness Day. This will hopefully generate excitement, and the winning poster could be posted in the lobby or elsewhere around the winning school. Also, competition will be sparked among students at other participating schools that did not win but want to win the next year. Public health professionals would be invited to participate and lecture on the issue and other pertinent health issues for children. Federal, local, and state government agencies, and non-profit representatives should be invited to staff booths and informally talk with the students about the advisories. Brochures and pamphlets can be distributed to the students about the issue. Buttons, magnets, t-shirts, hats, bumper stickers, and

bookmarks would be distributed to the students that would serve as constant reminders to them.-

The advisory could also be part of an annual Health Fair at a local school, community center, or church during the month of March when the latest advisory was issued. The health fair would include exhibits, workshops, demonstrations, raffles, and door prizes. Posters and flyers would be designed and distributed in the local community at churches, supermarkets, schools, and recreation centers to inform the public about the health fair and to attract participation from as many individuals as possible. Free testing on a variety of health issues could be used to gain greater attendance. Various organizations could be contacted to find out if they would be interested in participating in the health fair. Diverse representation from these organizations would be solicited. Some of the organizations that I contact may want to donate products to be distributed at the health fair or provide financial or other support in return for favorable publicity acknowledging their community support.

Quizzes about fish consumption advisories concerning mercury would be administered to the participants at the Health Fair and prizes could be given to the individuals that answered the most questions correctly. Local media could be contacted so that they can advertise the health fair through the radio, cable television, and the newspaper. A planning committee would be needed to recruit volunteers to work at the registration table or to work with exhibitors, sponsors, and the media. Opportunities to participate in the Fish Consumption Advisory Health Fair will improve education and communication with communities about the issue.

I also suggest sending home brochures and videos about the fish consumption advisories in children's backpacks during the beginning, middle, and end of the school year to reinforce the issue in elementary, middle, and high schools. Teachers could send follow-up emails to mothers/guardians about a week or two after the information is sent home with the children. The issue could also be discussed with mothers at Parent Teacher Association meetings held throughout the school year. Obstetricians and gynecologists could display brochures in their offices and play videos about the issue while clients are in their waiting rooms. These are all informal ways to share information about the health consequences of mercury in fish that will lead to increased awareness about this serious health hazard.

S is gaining satisfaction with solutions, the S in the CAUSE Model. Just because some of the women may understand an issue and official recommendations to limit fish intake and vary the type of fish eaten, does not mean they will be satisfied with it. In my focus groups and face-to-face interviews I would also explore satisfaction with several possible methods to gain their agreement with recommended ways to eat fish healthfully. For example, I could ask the participants to view sample warning labels on fish and their opinions about school curricula about good choices when eating fish. A specific labeling statement could be required for selected fish of concern sold in the United States. The label could state "If you are a pregnant woman, a woman that is thinking about becoming pregnant, a nursing woman, or a young child, do not eat shark, swordfish, king mackerel, or tilefish because they contain high levels of mercury." This statement would help communicate one of the recommendations that was jointly issued in the fish consumption

advisory concerning mercury in 2004 by the US EPA and the US FDA among females within the general public.

Better Enactment, the E in the CAUSE Model. The fifth and final obstacle is moving people from agreeing to adopting and maintaining new habits. My findings showed that the fish advisories may be having some effect on fish consumption patterns. Among the participants in my study, mothers were more likely to alter their fish consumption patterns or stop eating fish entirely. However, my results should be viewed cautiously because they are self reported data and while my findings were statistically significant, the information about participants' behavior changes came from fairly small samples of individuals. Nevertheless, my findings, coupled with theory, can give direction to health campaigns designed to help people eat fish healthfully.

Theory that is particularly relevant to encouraging behavior change is summarized in the CAUSE Model. That model suggests Booth -Butterfield (2003) Embedded Behaviors model is a framework for determining factors that prevent or cause behaviors to become routine (Booth-Butterfield, 2003). Internal influences include psychological and biological factors that need to be taken into consideration. Biological factors include age and genetics. Psychological factors include personality traits and attitude. External influences include family and friends, cultural and religious beliefs, and timing. These internal and external factors influence whether or not a change in an individual's behavior will or will not occur. New or novel behaviors are less embedded in an individual than a familiar behavior and are easier to change. Behaviors that are not complicated are also easier to change (Booth-Butterfield, 2003).

For example, findings from adolescent tobacco projects about peer influence and similar factors can be used to encourage healthful patterns of fish consumption in young people's lives. Peer influence among young people can be used so that more of them accept the idea that it is cool to be health-conscious. This will hopefully also lead to their feeling more pressure to keep up with what their friends know about this health issue (Booth-Butterfield, 2003).

To illustrate, among some people eating sport caught fish is a highly embedded, frequent source of protein and family activity. To change that behavior, we need to learn why the current behavior occurs, how frequent it is, what benefit the behavior is to individuals, whether the behavior allows them to eat under economic challenges, or whether there are locations where some individuals fish as a way of relaxing and socializing. Once data are gathered on these issues, and it is determined how embedded unhealthy fish consumption patterns are embedded in some individuals, it would be more clear what could be done in order for them to change from unhealthy to more healthy consumption of fish.

Strengths/Limitations

Mercury content in fish is a health hazard to women of child-bearing age, developing fetuses, and young children. An important strength of this project is that women in this vulnerable group were surveyed about their awareness of fish consumption advisories concerning mercury. The three county study included 309 females between 18 and 40 years old within the general public with differing socio-economic profiles in a mid-Atlantic state. The university study included 300 undergraduate and graduate females

between 18 and 40 years old enrolled in courses in the College of Science at a large mid-Atlantic university. This project benefits from the survey of 609 females, a large sample size.

An important limitation of the research is that the survey results in this dissertation apply only to undergraduate and graduate females enrolled in courses in the College of Science at a large mid-Atlantic University between 18 and 40 years old and females within the general public in three counties with differing socio-economic profiles in a mid-Atlantic state between 18 and 40 years old. The reason for the study limitations is that the sample was a convenience sample as opposed to a random sample. Further research should be based on a random sampling and extrapolating these results to females within the general public on a national level.

Conclusions

This study tested nine hypotheses about fish consumption advisories concerning mercury among women of childbearing years. The first hypothesis said that 18 to 40 year old females are not aware of fish consumption advisories in the university study. It was found that the women enrolled in the College of Science courses are aware of fish consumption advisories. The second hypothesis said there is no difference in the awareness of fish consumption advisories concerning mercury between female age groups (18-21), (22-30), and (31-40) in the university study. It was found that the older women (22 to 40 years old) are more aware of fish consumption advisories than are younger women (18 to 21 years old). The third hypothesis tested states that there is no difference concerning African American, Asian or Pacific Islander, or Alaskan Native, Hispanic,

White, or other in the university study and the three county study. It was found that Hispanic women were less aware of fish consumption advisories than members of other ethnic groups. The fourth hypothesis said there is no difference in the awareness of fish consumption advisories concerning mercury between college-educated and non-educated individuals in the university and the three county study. It was found that college-educated women were not more aware of fish consumption advisories than non-college educated women. The fifth hypothesis said there is no difference in the awareness of fish consumption advisories concerning mercury between mothers and non-mothers in the university and the three county study. It was found that mothers were more aware of fish consumption advisories than non-mothers. The sixth hypothesis said there is no difference in whether females reduced their fish intake between mothers and non-mothers in the university and three county study. It was found that mothers were more likely than non-mothers to reduce their fish intake due to concerns about mercury. The seventh hypothesis said there is no difference in whether females excluded certain fish or seafood between mothers and non-mothers in the university and three county study. It was found that mothers were more likely than non-mothers to exclude certain fish or seafood from their diet due to concerns about mercury. The eighth hypothesis said there is no difference in participants' perceptions of the health problems which mercury in fish can cause in young infants between mothers and non-mothers in the university and three county study. It was found that mothers were not more likely than non-mothers to perceive that mercury in fish can cause serious health problems in young infants. However, mothers were more predisposed to perceive mercury in fish as a major health effect in young infants than non-

mothers. The ninth hypothesis said there is no difference in awareness of fish consumption advisories concerning mercury between females with 2 or more years of college and females with less than 2 years of college in the university and three county study. It was found that women with more than 2 years of college were more likely to be aware of fish consumption advisories than women with less than 2 years of college.

These results were tested in two studies. The first involved participants enrolled at a large mid-Atlantic university, specifically, 300 females between 18 and 40 years old. The second study involved 309 females who were shopping at grocery stores in three mid-Atlantic counties. These individuals included members of many ethnic populations. For example, 202 of the females were African American, 14 were Asian or Pacific Islander, 1 was American Indian or Alaskan Native, 22 were Hispanic, 53 were White, and 17 were other.

This study's findings suggest that risk communication efforts need to reach young college women, pregnant women that may or may not have completed high school and did not attend college, and women that become pregnant in high school. According to the surveys, women between the ages of 22 and 40 are more aware of fish consumption advisories concerning mercury than younger female students between 18 and 21. This means that encouraging mothers and women in their mid- to late 20s to talk about this risk with younger women may be an effective public health intervention. College campuses are an excellent context for reaching younger women of childbearing age about fish consumption advisories concerning mercury. Food safety for Moms-to-be and videos that are distributed by the US FDA and brochures about the issue could be distributed to all incoming

freshman female college students. Brochures and other educational materials could be distributed to members and visitors at churches and health clinics that are located on or near college campuses. Health fairs conducted on college campuses would provide another avenue for imparting this information. Retail outlets that frequently target populations and that require waiting (e.g., barber and beauty shops, automotive services, Department of Motor Vehicles, grocery check-out counters, etc.) are good places for brochures, posters, etc. College radio and television stations can also be used as a mechanism to broadcast important information about the fish consumption advisories concerning mercury.

As suggested by this research, minorities and young children may have special barriers that limit awareness of health communications or prevent the implementation of behavioral change once a health message is received. Further research is recommended to evaluate which of these barriers is most significant and which strategies, including the ones suggested above, are most likely to overcome these barriers. The survey instrument used in this study could be adapted to a pre-test/post-test measure of the success of the different strategies proposed earlier.

Various community groups and media that provide an avenue for health communications need to be evaluated in controlled studies. Such studies, for example, might compare use of similar materials providing the same message but comparing effectiveness of different venues such as churches, supermarkets, schools, and recreation centers. This research could determine which venue was most effective for different age groups and specific minorities like African Americans and Hispanics. Alternatively, future work might focus on a single at-risk group and compare the content of the message or a

vehicle for transmitting it (e.g., health fairs, schools, community centers, churches and various media such as radio, television, and internet) to determine which media and message works best with a particular target group.

In the future, whenever fish consumption advisories concerning mercury are issued a survey should always be conducted among females within the general public including those with different ethnic, racial, and socioeconomic backgrounds. Stakeholders, including those who will be targeted and surveyed, should always be included in the process to assist with the effective implementation of fish advisories.

**APPENDIX A: AN ASSESSMENT OF THE AWARENESS OF FISH
CONSUMPTION ADVISORIES CONCERNING MERCURY AMONG FEMALE
COLLEGE STUDENTS AT GEORGE MASON UNIVERSITY**

Monica Hawkins, PhD Candidate, George Mason University, ESP Program

INFORMED CONSENT FORM

This research is being conducted to determine the ratio of females between 18-40 years old that is aware of fish consumption advisories concerning mercury. The study subjects will be 18-40 year old undergraduate and graduate female students at George Mason University (GMU) and females within the general public. The study will involve about 300 female GMU students and 300 females from the general public at a local supermarket within Maryland. The project will involve a survey that should not take more than fifteen minutes to complete. The survey will be administered to collect demographic characteristics such as age, classification of the students, and estimations of the number of fish meals eaten in a week during the previous 12 months and how many times a month.

If you agree to participate, you will be asked to fill-out a 19-item survey that should not take more than 10-15 minutes to complete.

RISKS

There are no foreseeable risks for participating in this research.

BENEFITS

There are no direct benefits to you for participating in the research.

CONFIDENTIALITY

The data in this study will be confidential. Since the surveys are anonymous, names and other identifiers will not be placed on surveys or other research data. Your data will be aggregated with data from other participants and used in various statistical analyses.

PARTICIPATION

Your participation is voluntary, and you may withdraw from the study at any time and for any reason. If you decide not to participate or if you withdraw from the study, there is no penalty or loss of benefits to which you are otherwise entitled. There are no costs to you or any other party.

CONTACT

This research is being conducted by Monica Hawkins of the Environmental Science and Policy Program at George Mason University. She may be reached at (301)890-0939 for questions or to report a research-related problem. You may also contact Dr. Douglas Mose, Faculty Advisor of Monica Hawkins, of the Department of Chemistry at George Mason University at (703)993-1068. You may contact the George Mason University Office of Research Subject Protections at 703-993-4121 if you have questions or comments regarding your rights as a participant in the research.

CONSENT

I have had the opportunity to read this form and agree to participate in this study. I am 18 years old or older.

Name

Date of Signature

APPENDIX B: SAMPLE SURVEY INSTRUMENT

The following is a survey that will be used to determine the ratio of undergraduate and graduate GMU females and from the general public between 18 and 40 years old that are aware of fish consumption advisories concerning mercury. Questions such as these will be the primary tool used to extract data from the participants.

1. PLEASE INDICATE YOUR RACE AND ETHNICITY:

African-American _____
Asian or Pacific Islander _____
American Indian or Alaskan Native _____
Hispanic _____
White _____
Other - please specify _____

2. WHAT IS YOUR CURRENT AGE: _____

3. HOW MANY CHILDREN DO YOU HAVE:

0 _____ 1 _____ 2 _____ 3+ _____

4. WHAT IS YOUR STUDENT STATUS:

Undergraduate: 1st _____ 2nd _____ 3rd _____ 4th _____ >4th _____
MS _____
PhD _____
Nondegree: HS graduate _____ BA graduate _____

5. WHAT IS YOUR MAJOR: _____

Undecided _____

6. IF YOU ARE A MATURE STUDENT, WHAT IS YOUR OCCUPATION:

7. WHAT IS YOUR PARENT'S OCCUPATION: _____

8. IN THE PAST 12 MONTHS HOW MANY TIMES A WEEK DID YOU EAT FISH:

Never _____ Almost Never _____ Once a month _____ Once a week _____
2 or more times a week _____ 1 or more times a day _____

9. IF YOU DON'T EAT FISH WHY NOT: _____

10. ARE YOU A VEGETARIAN? Yes _____ No _____

11. HAVE YOU EVER READ OR HEARD ABOUT FISH CONSUMPTION ADVISORIES CONCERNING MERCURY:

Yes _____ No _____

12. HAVE YOU REDUCED FISH INTAKE BASED ON WHAT YOU LEARNED ABOUT THE RISK OF MERCURY IN FISH:

Yes _____ No _____

13. DO YOU EXCLUDE CERTAIN FISH OR SEAFOOD FROM YOUR DIET BECAUSE OF YOUR CONCERN ABOUT MERCURY LEVELS:

Yes _____ No _____

14. HOW SERIOUS ARE THE HEALTH PROBLEMS THAT MERCURY IN FISH CAN CAUSE IN YOUNG INFANTS?

Negligible _____ Minor _____ Moderate _____ Major _____

15. DO YOU KNOW WHAT AGENCY ISSUES FISH CONSUMPTION ADVISORIES CONCERNING MERCURY? (check all that apply)

Federal Government _____ State Government _____ Don't know _____

16. IF THE ANSWER TO QUESTION Number 11 IS YES, WHERE DID YOU READ OR HEAR ABOUT THE FISH CONSUMPTION ADVISORY CONCERNING MERCURY: (check all that apply)

Television _____

Radio _____

Newspaper _____

Magazines or other print media (leaflets, pamphlets, flyers) _____

Posted signs or billboards _____

World Wide Web/Internet _____

Other _____

None _____

17. HOW CLEAR AND UNDERSTANDABLE WAS THE INFORMATION CONTAINED IN THE FISH CONSUMPTION ADVISORY CONCERNING MERCURY:

Very Clear _____

Clear _____

Not Clear _____

Not Clear At All _____

Do not know _____

18. IF SO, IN WHAT FORMAT:

Newspaper _____

Posted Signs _____

World Wide Web/Internet _____

Radio _____

Television _____

Magazines or other print media (leaflets, pamphlets, flyers) _____

19. HOW WOULD YOU IMPROVE FISH CONSUMPTION ADVISORIES CONCERNING MERCURY:

REFERENCES

REFERENCES

- Alhakami, A. S. & Slovic, P. (1994). A psychological study of the inverse relationship between perceived risk and perceived benefit. *Risk Analysis*, *14*, 1085-1096.
- Axelrad, D. A., Bellinger D. C., Ryan, L. M. & Woodruff, T. J. (2007). Dose-response relationship of prenatal mercury exposure and iq: an integrative analysis of epidemiologic data. *Environmental Health Perspectives*, *115*, 609-615.
- Booth-Butterfield, M. (2003). Embedded health behaviors from adolescence to adulthood: The impact of tobacco. *Health Communication*, *15*, 171-184.
- Burger, J. (2000). Consumption advisories and compliance: the fishing public and the deamplification of risk. *Journal of Environmental Planning and Management*, *43*, 471-488.
- Cohen, J. T., Bellinger, D. C., Connor, W. E., & Shaywitz, B. A. (2005). A quantitative analysis of prenatal intake of n-3 polyunsaturated fatty acids and cognitive development. *American Journal of Preventive Medicine*, *29*, 366-374.
- Connelly, N. A. & Knuth, B. A. (1998). Evaluating risk communication: examining target audience perception formats for fish consumption health advisory information. *Risk Analysis*, *10*, 649-659.
- Dillman, D. A. (2000). *Mail and internet surveys*. New York, NY: John Wiley & Sons, Inc.
- Dorea, J. G. (2004). Mercury and lead during breast-feeding. *British Journal of Nutrition*, *92*, 21-40.
- Fisher, A. 1991. Risk communication challenges. *Risk Analysis*, *11*, 173-179.
- Ginsberg, G. L. & Toal, B. F. (2009). Quantitative approach for incorporating methylmercury risks and omega-3 fatty acid benefits in developing species-specific fish consumption advice. *Environmental Health Perspectives*, *117*, 267-275.
- Institute of Medicine. (2006). *Seafood Choices: Balancing benefits and risks*. Washington, D.C., National Academy Press.

- Jackson, T. A. (1997). Long-range atmospheric transport of mercury to ecosystems, and the importance of anthropogenic emissions: A critical review and evaluation of the published evidence. *Environmental Reviews*, 5, 99-120.
- Kahlor, L., Dunwoody, S. Griffin, R. J., & Neuwirth, K. (2006). Seeking and processing information about impersonal risk. *Science Communication*, 28, 163-194.
- Kahlor, L., Dunwoody, S. Griffin, R. J., Neuwirth, K., & Giese, J. (2003). Studying heuristic-systematic processing of risk communication. *Risk Analysis*, 23, 355-368.
- Kreps, G. L. (2005). Communication and racial inequities in health care. *American Behavioral Scientist*, 49, 1-15.
- Kreps, G. L. (2006). One size does not fit all: Adapting communication to the needs and literacy levels of individuals. *Annals of Family Medicine*. Retrieved March 31, 2008 from <http://www.annfammed.org/cgi/eletters/4/3/2005>.
- Loewenstein, G. F., Hsee, C. K., Weber, E. U., Welch, N. (2001). Risk as feelings. *Psychological Bulletin*, 127, 267-286.
- MacGeorge, E.L., Feng, B., Butler, G. L., & Budarz, S. K. (2006). Understanding advice in supportive interactions: Beyond the face work and message evaluation paradigms. *Human Communication Research*, 30, 42-70.
- Mahaffey, K. R., Clickner, R. P., & Jeffries, R. A. (2009). Adult women's blood mercury concentrations vary regionally in the united states: association with patterns of fish consumption (NHANES 1999-2004). *Environmental Health Perspectives*, 117, 47-53.
- Maliti, T. (2009). US calls for treaty on mercury reduction. Retrieved March 25, 2009 from <http://www.wtop.com/?nid=387&sid=1602783>.
- Maibach, E. W. & Parrott, R. L. (Eds). (1995). *Designing health messages: Approaches from communication theory and public health practice*. Thousand Oaks, CA: Sage.
- Mozaffarian, D. & Rimm, E. B. (2009). Fish intake, contaminants, and human health: evaluating the risks and the benefits. *Journal of American Medical Association*, 296, 1885-1899.
- National Research Council. (2000). *Toxicological effects of methylmercury*. Washington, D. C.: National Academy Press.

- O'Keefe, D. J. (2002). *Persuasion: Theory and research* (2nd ed.). Thousand Oaks, CA: Sage.
- Oken, E., Kleinman, K. P., Berland, W. E., Simon, S. R., Rich-Edwards, J. W., Gillman, M. W. (2003). Decline in fish consumption among pregnant women after a national mercury advisory. *Obstetrics and Gynecology*, *102*, 346-351.
- Park, S. P., & Johnson, M.A. (2006). Awareness of fish advisories and mercury exposure in women of childbearing age. *Nutrition Reviews*, *64*, 250-256.
- Perry, R. W. (1979). Evacuation decision-making in natural disasters. *Mass Emergencies*, *4*, 25-38.
- Perry, R. W. (1988). *The communication of disaster warnings*. Paper presented at the Symposium on Science Communication. Sponsored by the U.S. Environmental Protection Agency and the Annenberg School of Communications. University of Southern California, Los Angeles, CA.
- Perry, R. W., & Mushkatel, A. H. (1984). *Disaster management: Warning response and community relocation*. Westport, CT: Quorum.
- Pidgeon, N. R., Kasperson, R., & Slovic, P. (Eds.). (2003). *The social amplification of risk*. Cambridge: Cambridge.
- Pianin, E. (2003, December 11). Federal warning on tuna planned. *The Washington Post*, p. A1.
- Powell, M., Dunwoody, S., Griffin, R., & Neuwirth, K. (2007). Exploring lay uncertainty about an environmental health risk. *Public Understanding of Science*, *16*, 323-343.
- Reinert, R.E., Knuth, M.A., Kamrin, M.A., & Stober, Q.J.. (1991). Risk assessment, risk management, and fish consumption advisories in the United States. *Fisheries*, *16*, 5-12.
- Reinert, R.E., Knuth, B.A., Kamrin, M.A., & Stober, Q.J. (1996). A review of basic principles and assumptions used to issue fish consumption advisories. *American Fisheries Society Symposium*, *16*, 98-108.
- Rice, D. C., Schoeny, R., & Mahaffey, K. (2003). Methods and rationale for derivation of a reference dose for methylmercury by the U.S. EPA. *Risk Analysis*, *23*, 107-115.
- Rowan, K. E. (1991). Goals, obstacles, and strategies in risk communication: A problem-solving approach to improving communication about risks. *Journal of Applied Communication Research*, *19*, 300-329.

- Rowan, K. E. (1994). Why rules for risk communication are not enough: a problem-solving approach to risk communication. *Risk Analysis*, 14, 365-374.
- Rowan, K. E., Sparks, L., Pecchioni, L., Villagran, M. (2003). The “CAUSE” model: A research-supported guide for physicians communicating cancer risk. *Health Communication*, 15, 239-252.
- Rowan, K. E., Kreps, G. L., Botan, C. H., Sparks, L., Samoilenko, S., & Bailey, C. (2008). Responding to terrorism: Risk communication, crisis communication, and the CAUSE Model. In D. O’Hair, R. L. Heath, K. J. Ayotte, & Gerald R. Ledlow. *Terrorism: Communication and rhetorical perspectives*. Cresskill, NJ: Hampton.
- Rowan, K. E., Botan, C. H., Kreps, G. L., Samoilenko, S. & Farnsworth, K. (2009). *Risk communication education for local emergency managers: using the CAUSE model for research, education, and outreach*. In R.L. Heath & O’Hair, H.D., *Handbook of Crisis and Risk Communication*. (p. 170-193). New York: Routledge.
- Slovic, P. (Ed.). (2000). *The perception of risk*. Sterling, VA: Earthscan.
- Slovic, P., Finucane, M. L., Peters, E., MacGregor, D. G. (2004). Risk as analysis and risk as feelings: some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, 24, 311-322.
- Southwell, B. G. & Yzer, M. C. (2007). The roles of interpersonal communication in mass media campaigns. In C. Beck (Ed.), *Communication yearbook 31* (p. 420-462). NY: Erlbaum.
- Squires, S. (2007, October 4). *Mothers again urged to eat fish*. The Washington Post p. A1.
- Sunderland, E. M. (2007). Mercury exposure from domestic and imported estuarine and marine fish in the U.S. seafood market. *Environmental Health Perspectives*, 115, 235-242.
- US Department of Health and Human Services. (2002). *Mean Age of Mother, 1970-2000*. National Vital Statistics Reports, Volume 51. Centers for Disease Control and Prevention, Hyattsville, Maryland.
- US Environmental Protection Agency. (1989). *Assessing human health risks from chemically contaminated fish and shellfish: a guidance manual*. (US Environmental Protection Agency Publication No. 503/8-89-002). Office of Marine and Estuarine Protection and Office of Water Regulation and Standards, Washington, DC: US Environmental Protection Agency.

- US Environmental Protection Agency. (2003). *Update: National listing of fish and wildlife advisories*. (US Environmental Protection Agency Publication No. 823-F-03-003). Washington, DC: US Environmental Protection Agency.
- US Food and Drug Administration. (1995). *Mercury in fish cause for concern*. (US Food and Drug Administration Publication No. 95-2285). Rockville, Maryland: Government Printing Office.
- US Food and Drug Administration. (2002). Food safety survey: summary of major trends in food handling practices and consumption of potentially risky foods. Retrieved from <http://www.cfsan.fda.gov/~dms/fssurvey.html>.
- Weber, E. U. (2006). Experience-based and description-based perceptions of long-term risk: why global warming does not scare us (yet). *Climate Change*, 77, 103-120.
- World Health Organization. (1990). *Methylmercury*. Environmental Health Criteria, Volume 101. World Health Organization, Geneva.
- Wright, P., Creighton, P., Thulfall, S. M. (1982). Some factors determining when instructions will be read. *Ergonomics*, 36, 172-181.

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