Econometric Analysis of Maine's Mercury Advisory

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Section 1

INTRODUCTION

1.1. Problem Background

Fish and shellfish are good sources of lean protein, essential nutrients, and Omega 3 fatty acids (U.S.E.P.A. and U.S.F.D.A., 2004) that deliver many health benefits to humans. A well balanced diet including a variety of fish can contribute to cardiovascular health (Mozaffarian and Rimm, 2006) and young children's proper neurological development (Hibbeln et al., 2007; Uauy and Dangour, 2006). Despite the multitude of positive health impacts associated with eating eat and shellfish (hereafter, fish), nearly all fish contain at least some methylmercury, MeHg. This contaminant is particularly concerning because it is distributed in the edible tissue (Davidson et al., 2004), making fish preparation methods ineffective in reducing exposure (U.S.F.D.A. and U.S.E.P.A., 2004; Mahaffey et al., 2004). Because methylmercury levels increase with fish consumption (Knobeloch et al., 2005; Johnsson et al., 2005) and eating fish is the primary mechanism of methylmercury exposure (Knobeloch et al., 2005), federal and state agencies have responded to inform the public about contaminated fish.

Although there are various options for responding to the issue of contaminated fish, the issuance of fish consumption advisories has been the favored response among federal and state agencies (e.g., see Anderson et al., 2004) since the 1970s. Unfortunately, this frequently used method is rarely evaluated for its effectiveness (U.S.E.P.A., 2011). This study examines the effectiveness of Maine Center for Disease Control and Prevention's (CDC) recently updated fish consumption advisory.

It is difficult to communicate both the risks of contaminated fish and the benefits of consuming low mercury fish (Anderson et al., 2004). In an effort to present a unified and consistent approach to mercury advisories, the Environmental Protection Agency (U.S.E.P.A.) and Food and Drug Administration (U.S.F.D.A) issued a Joint Federal Advisory for Mercury in Fish in 2004. The advisory recommends that local advisories be followed when consuming sport caught fish. Following this momentum, states have continued to implement various risk communication strategies to effectively provide technical information to the public.

Fish consumption advisories are continuously being updated based on tissue sampling and public health communication research. One of the key revisions in the 2004 Joint Federal Advisory for Mercury in Fish is an increased emphasis on positive benefits from eating fish and examples of commonly eaten fish that are low in mercury. Another important advancement of this advisory specifically addresses canned "light" tuna and canned "white" (albacore) tuna (U.S.E.P.A. and U.S.F.D.A., 2004). This differentiation is critical because tuna is the most commonly consumed fish in the United States and "white" tuna contains high levels of mercury, while "light" tuna does not (Burger and Gochfeld, 2006).

Encouraging a "switch" from high-mercury fish to low-mercury fish is ideal, but difficult (Cohen et al., 2005; Hughner et al., 2008; Park and Johnson, 2006). Although issuing advisories is the most frequent method of communication, there are disadvantages in its voluntary nature and in communicating such a complex message (Scherer et al. 2008; Knuth et al., 2003). Also, Jakus et al. and Halkeier (1998 and 1999) discuss the inherent difficulty in assuming people's behaviors act in line with new information. The following discussion outlines methods for

ameliorating these and other challenges when communicating information about safe fish consumption to the public.

1.2. Previous Methodological Studies and Applications

The literature suggests several key ideas to consider when implementing and updating fish consumption advisories at the state level. First off, consistent testing of methylmercury levels should be performed to confirm accuracy of advisories (Hughner et al., 2009; Shimshack et al., 2007). Regional factors such as fish availability, price and cultural attributes should be considered when making advisories to the public (Burger et al., 2005; Shimshack et al., 2007). Trust improves information effectiveness; thus, is a key determinant in implementing public health outreach strategies (Pieniak et al., 2007; Westphal et al., 2008; Burger et al., 2009).

1.2.1. Targeting

Previously, public health outreach associated with fish consumption was primarily directed at anglers and their families. Research suggests this message should instead be aimed toward the at-risk population to diminish the most sensitive population's damaging exposure to methylmercury (Sherer, 2008; Anderson et al., 2004). The at-risk population is women of childbearing age, pregnant women, nursing mothers and young children. This group is most at-risk because the developing nervous system of the fetus is more vulnerable to methylmercury than is the adult nervous system (U.S.E.P.A., 2012). Thus, the at-risk population should have access to information and the ability to assimilate information to elicit the appropriate advisory response in behavior change (Shimshack et al., 2007; Tilden, 1997).

Recent additions to the literature suggest communication of fish advisories should more effectively target at-risk subpopulations to not only reduce exposure but to also minimize negative spill-over effects on the general population (Cohen et al., 2005; Groth, 2010; Hughner et al., 2009). An overall reduction in fish consumption is not an ideal outcome. Better targeting could be achieved through point of purchase labeling to effectively communicate with the at-risk population when making fish consumption decisions (Roosen et al., 2009; Hughner et al., 2009). Other methods used to promote public awareness of fish consumption advisories include distributing brochures, fact sheets, posters, media campaigns, wallet cards and maps. Dispersal methods also vary widely; from physicians to mailings to fishing license holders. It is suggested that outreach strategies should continue to be further analyzed for their effectiveness (Gliori et al., 2006; Knobeloch et al., 2005).

Communicating such a complex message requires close examination of language being used. The literature suggests language barriers should be specifically considered when creating public health materials. Outreach materials should be presented in an appropriate literacy level and available in multiple languages depending on the region's demographics. Highly effective communication strategies include information about specific risks (e.g. Mercury) and benefits (e.g. Omega 3's); this might include a description of bioaccumulation, trophic level relationships and detailed benefits from safe fish consumption (Burger et al., 2009; Groth, 2010; Burger et al., 2006).

1.2.2. Messaging

A shift in the literature indicates an increased awareness of the benefits associated with fish consumption is critical to making healthy choices in the at-risk population (Karouna-Renier et al., 2008; Knuth et al., 2003; Verbeke et al., 2005). This awareness comes from the public health information provided through state agencies. As the EPA and FDA suggest, examples of safe fish should be presented alongside fish that should be avoided (Burger et al., 2009; U.S.E.P.A. and U.S.F.D.A., 2004).

Analogous to the literature suggestions, many states have recognized the importance of presenting specific nutritional benefits of fish consumption to the at-risk population as the focus of their advisories. Outlining the health benefits with fish meal size descriptions and preparation suggestions provide the at-risk population with more complete information to make healthy choices. Increasing awareness of fish consumption benefits ameliorates a portion of unnecessary fish consumption reduction behavior found in at-risk populations.

Although each state can choose to implement different mercury advisories and public health outreach strategies, the literature suggests consistent federal and state messaging as a practical approach to educating the public (Hughner et al., 2008; Groth, 2010; Knobeloch et al., 2005; Tilden, 1997). An example of this consistent message can be found in many states' advisories for commercial fish. A shifted public health focus from sport-caught fish to commercial fish is evident and important because more consumers are choosing to eat fish bought in stores and restaurants (Burger et al., 2005; Anderson et al., 2004). States' awareness

of increased commercial fish consumption has led many states to reference the EPA and FDA guidelines for commercial fish in their fish consumption advisories.

Overall, states have implemented many of the literature's suggestions for effectively providing technical information about mercury to the at-risk population. Using accurate data to provide complete risk and benefit information to the most sensitive populations in a clearly understood language is an appropriate starting point for state agencies. However, there is still room for improvement in reaching the target population and eliciting an appropriate knowledge and behavior change. Risk communication that effectively highlights the risk/benefit relationship of fish consumption should continue to be researched. Presenting advisories with specific details about benefits, risks and types of fish that are safe to eat and types that should be avoided provides the general public, anglers, and most importantly, the at-risk subpopulation with adequate information to make healthy fish consumption choices.

1.3. Maine's Approach

Maine's Mercury Advisory Program is run by the Maine Center for Disease Control and Prevention (Maine CDC). After a thorough investigation of the relevant body of literature, previous survey efforts, extensive focus group testing and changes in the federal advisories, the program was recently updated. The centerpiece of this program has been the distribution of a brochure that was developed with U.S.E.P.A. funding under a Cooperative Grant.

The brochure, Maine Family Fish Guide (hereafter, the brochure), is distributed to obstetricians across the state and is instructed to be given to pregnant women at the first prenatal doctor appointment. The brochure describes safe eating guidelines for commercial

and sport-caught fish. A greater emphasis was placed on benefits of fish consumption, including specific examples such as omega 3 fish oils. Following literature suggestions, the centerfold of the brochure depicts fish that are both high in omega 3 fish oils and low in mercury alongside fish to avoid while pregnant and breastfeeding. Recipes for healthy fish meals are described to encourage trying different kinds of fish. Analogous to the EPA and FDA Joint Advisory, the differences between "light" and "white" tuna are highlighted and pre-packaged salmon is encouraged as a substitute.

1.4. Research Questions

When evaluating a public health program, there are many questions that can be asked. Of most importance to the Maine CDC, is whether the brochure is *working*. More specifically, is the brochure being read, understood and influencing behavior in an appropriate way? An appropriate behavior change would be a specific switch from eating high-mercury fish to low-mercury fish, not an overall reduction in fish consumption. And before we determine if knowledge and behavior are being influenced, the factors that influence reading the brochure must be examined; as in, are the brochures being distributed, received and drawing enough attention to be read? We then concisely ask, "Does the Maine Center for Disease Control and Prevention's Family Fish Guide increase knowledge and appropriately change fish consumption behavior within the at-risk population?"

More specifically, we will examine long-term changes in behavior that will show whether women are making changes specific to their pregnancy or if the information has a lasting impact on their knowledge and behavior. Knowledge about specific species, benefits and risks will be assessed. Of critical importance to this research is the measurement of behavior

changes associated with pre-packaged fish like “white” tuna, “light” tuna and salmon. The next section will discuss the survey instrument used to measure knowledge and behavior changes.

Section 2

CONCEPTUAL FRAMEWORK

2.1. Economic Theory

As illustrated in the preceding literature review and problem background, consumers maximize their utility by choosing products that have attributes that align with their preferences. We assume that preferences encompass knowledge and experience regarding risks and benefits associated with fish consumption during pregnancy. The economic purpose of the Brochure is to provide information to the most at-risk consumers in order to reduce or even eliminate the negative externality of asymmetric information regarding specific product attributes. In its most basic sense, public health information regarding contaminated fish provides consumers with an important ability – differentiability of seemingly substitutable goods. The removal of information asymmetry is clearly beneficial to consumers because it minimizes uncertainty and subsequently, their choices can be more in line with their preferences.

Providing clarity of a good to the consumer is important in maximizing consumer utility. But what exactly is being made clearer? Very specific product attributes. Product attributes can be grouped into three categories: (1) *Search* characteristics that can be assessed prior to purchase, (2) *Experienc*e characteristics that can be assessed after the good is consumed, and (3) *Credence* characteristics are those that cannot reasonably be verified by consumers even after purchase and consumption (Caswell and Mojduszka, 1996; Bleda and Valente). Economists consider environmental attributes to be credence attributes. Information on

products' credence attributes is so asymmetrical that the market does not function properly (Bleda and Valente, 2008). Problems of adverse selection can occur where environmental attributes are credence in nature. Thus, price is not an appropriate signal of the product. This free-riding problem can be supplemented by trusted information distributed by state agencies.

Economic theory assumes that a consumer's indirect utility function gives the consumer's maximum utility when faced with a price level *p* and an income *w*. In general, this function represents the consumer's preferences over market conditions. The principle of rationality states that the choices households make are preferred to the choices they could have made with the same income constraint (Wetzstein, 2005). Because of an individual's rational desire to maximize utility given a budget constraint, the optimal level of utility obtainable will depend indirectly on the prices of the goods being bought and the individual's income. The indirect utility function *V* reflects this dependence and is presented below as Equation 1. This indirect approach can be used to study how changes in economic circumstances affect various outcomes, such as utility (Nicholson and Snyder, 2008).

We assume that women make choices that maximize their utility. These choices are a function of knowledge and demographic characteristics. Knowledge is assumed to be a function of information sources, including the brochure of interest, and experience. Experience is compiled of experience in the world, experience with pregnancy, experience with nutrition advice, and experience with consuming fish.

$$\boldsymbol{V = U(Knowledge(Info, Experience), Demographics)}$$

Eq (1)

We employ this utility framework to explain fish consumption decisions. Specifically, we assume that respondents make choices that maximize their utility as such:

$$\boldsymbol{V_1 = U(Knowledge, Demographics) > V_0 = U(Knowledge, Demographics)}$$

Eq (2)

Equation 2 states that respondents will choose good 1 over good 0 because the indirect utility obtained from good 1 is greater than the indirect utility obtained from good 0.

2.2. Motivation for Independent Variable Specification

Based on the previous conceptual framework, we have developed a list of variables that are likely to explain knowledge and behavior related to the brochure and fish consumption.

Independent Variables	Description
READ	Respondent received and read CDC's brochure
AGE	Age of respondent in years
EDU	Respondent's years of education
BF	Respondent's able and willing to breastfeed
FBABY	Respondent's first baby
COUPLE	Respondent is in a relationship
INC	Respondent's income
WIC	Respondent participates in WIC program
EMP	Respondent is employed part-time or full-time
INFO	Index of quantity of information sources
READFB	Interaction term (READ*FBABY)
WICREAD	Interaction term (WIC*READ)
EATB	Respondent ate fish before pregnancy
GOODME	Respondent thinks at least some fish and shellfish are good for them during pregnancy
GOODB	Respondent thinks at least some fish and shellfish are good for their baby during

	pregnancy
BADME	Respondent thinks at least some fish and shellfish are bad for them during pregnancy
BADB	Respondent thinks at least some fish and shellfish are bad for their baby during pregnancy

2.2.1. Read the Brochure (READ)

We hypothesize that women that read the brochure will have more general interest and knowledge about safe fish consumption. This will likely hold significant explanatory power in fish consumption and other nutritional behaviors. READ is our variable of interest that will explain the brochure's impact on those who received and read it. Section 4.1. will go into greater detail about the differences and similarities between women who read the brochure and those that did not.

2.2.2. Age at Child's Birth (AGE)

Analogous to conventional economic theory, demographic characteristics such as age have a significant impact on behavior. The age of respondents when responding to the survey is assumed to be the age of when they gave birth to their most recent child. This provides a measure of time spent absorbing the media and other information sources regarding general nutrition, seafood safety and pregnancy decisions. We hypothesize that age will have a positive effect on general knowledge.

2.2.3. Educational Attainment (EDU)

Education is commonly used as a crude proxy for intelligence. Because education is correlated with many other socioeconomic factors and intelligence is not, it is important to include these other factors in regressions to make education as best a proxy as possible.

2.2.4. Breastfeeding (BF)

We hypothesize that women who are able and willing to breastfeed are more likely to seek out information about nutrition both during and after pregnancy. Thus, it is important to control for this to try to clearly understand the impact of the Maine CDC's brochure on knowledge and behavior.

2.2.5. Respondent's First Baby (FBABY)

Based on previous work (see Teisl et al., 2011) it is important to control for women who responded regarding their first baby. These previous studies suggest that a woman's first experience with pregnancy elicits more information seeking behavior than repeated pregnancies. If a respondent has had a baby previously and receives the updated brochure, the respondent may not read it even though there is new information included. Thus, there may be a subset of women that read the old brochure for previous pregnancies and disregard the new information because they do not realize it is updated information.

2.2.6. Relationship Status (COUPLE)

We hypothesize that women who are in a relationship often have more time to devote to educating themselves about pregnancy than those who are single. This hypothesis originates

within the concept of a time constraint and the inherent tradeoffs associated with time. If a pregnant woman is single, she is also likely employed in order to support herself and her baby and has less time to spend elsewhere.

2.2.7. Annual Household Income (INC)

Analogous to conventional economic theory, income should be included to account for lifestyle differences. Women with higher levels of household income are likely to have more access to information and medical services. Higher levels of household income could also indicate that there are two income earners in the household. If the respondent is employed she may have less time available for seeking out information regarding nutrition during pregnancy.

2.2.8. Participant in WIC (WIC)

WIC stands for the Women, Infant and Children Program that provides nutrition advice and resources to pregnant, postpartum, and breastfeeding women, infants and children up to age 5 that meet income guidelines (WIC, 2012a). Intuitively, a researcher might suggest that women who have low levels of income would be more likely to not receive as much nutrition advice, especially as specific as the Maine Mercury Advisory details. Thus, women who participate in the WIC program would be less likely to read the brochure and be less likely to be knowledgeable about safe fish consumption.

However, the Maine WIC Program offers very specific and current nutrition advice. In fact, women that choose to exclusively breastfeed, receive extra food including canned fish. The WIC website states that “These are food benefits you can only get by breastfeeding! They

are meant to encourage you to offer your baby the best possible food, and to support you in staying strong and healthy" (WIC, 2012b). WIC only provides very specific canned fish: water packed light tuna, pink salmon and sardines. All three types of canned fish provided are low in mercury and high in omega 3 fish oils. Thus, we hypothesize that women who are participants in WIC are more likely to read the brochure (that is also provided at WIC) and are also more likely to engage in safe fish consumption behaviors. Because of WIC participants' increased access to sources of information, this variable will need to be controlled for.

2.2.9. Employment (EMP)

Like age and income, employment is often controlled for regression analysis. Specific to our research question, we hypothesize that women who are not employed have more time to seek out nutritional information regarding their pregnancy.

2.2.10. Other Information Sources (INFO)

It is hypothesized that women who read the brochure, planned to breastfeed, are more educated or who were preparing for their first child would be more likely to seek out information regarding their pregnancy. Thus, it is important to control for information seeking behaviors. The survey asked respondents to select from a list of information sources they utilized to gather information for their pregnancy. The list includes: books or magazines, healthcare provider, WIC program, friends or family, brochures, TV or radio, newspaper, internet, other, and received no information about keeping their baby healthy while pregnant. The variable, INFO, is an index of all the selections respondents made for this question. The index was constructed by summing the number of information sources selected.

2.2.11. Interaction Terms (READFB and WICREAD)

Following the logic of including FBABY and WIC in regression analysis, we interacted these two variables with the READ variable. It is hypothesized that women who responded regarding their first baby and women that participate in the WIC program are likely to have significantly different responses to the information provided in the brochure.

2.2.12. Prior Fish Consumption (EATB)

We hypothesize that women who ate fish before pregnancy are more likely to seek out information regarding safe fish consumption during pregnancy. This would likely impact the INFO and READ variables and needs to be accounted for in the model. If the respondent already ate fish and received the brochure, it is likely it would catch their attention more than a respondent that did not eat fish before they became pregnant. Thus, we constructed EATB as a binary variable that is coded 1 if the respondent stated they ate fish before they were pregnant.

2.2.13. Benefits associated with mother (GOODME) and baby (GOODB)

If the respondent believes that some fish and shellfish provide health benefits to the mother and/or the developing baby during pregnancy, their knowledge and behavior towards fish will likely be different than a respondent that does not believe this is true. Thus, we constructed GOODME and GOODB to control for this perspective. There were two questions in the survey that asked specifically about what they had heard or read while gathering information for their pregnancy. One of the questions asked respondents if they had "heard or read anything that states eating fish or shellfish **while** you are pregnant is <u>good</u> for **you or your**

baby?" Two dependent variables were created from the response choices for this question. GOODME is a binary variable that describes respondents that selected choice 1 (yes, some fish and shellfish are good for me) or choice 3 (yes, all fish and shellfish are good for me). GOODB is a binary variable that describes respondents that selected choice 2 (yes, some fish and shellfish are good for my baby) or choice 4 (yes, all fish and shellfish are good for my baby).

2.2.14. Risks associated with mother (BADME) and baby (BADB)

It is also important to account for respondents' perceptions of risks associated with eating fish during pregnancy. If the respondent believes that some fish and shellfish poses health risks to the mother and/or the baby during pregnancy, their knowledge and behavior towards fish will likely be different than a respondent that does not hold this belief. Thus, we constructed BADME and BADB to control for this perspective's influence.

As discussed above, there were two questions in the survey that asked specifically about what they had heard or read while gathering information for their pregnancy. The second question of interest asked respondents if they had "heard or read anything that states eating fish or shellfish **while** you are pregnant is bad for **you or your baby**?" Two dependent variables were created from the response choices for this question. BADME is a binary variable that describes respondents that selected choice 1 (yes, some fish and shellfish are bad for me) or choice 3 (yes, all fish and shellfish are bad for me). BADB is a binary variable that describes respondents that selected choice 2 (yes, some fish and shellfish are bad for my baby) or choice 4 (yes, all fish and shellfish are bad for my baby).

Section 3

DATA

3.1. Survey

3.1.1. Previous Brochure Evaluation

Before the updates to the mercury advisory, the previous brochure was evaluated using a mail survey between January and April of 2004 (see Teisl et al., 2011). The mail survey was administered to a random sample of 1,250 women that gave birth in the last three months with a response rate of 62%. The survey questionnaire consisted of 80 questions intended to assess awareness of Maine's mercury advisory, receipt of the brochure, and any changes in fish consumption behavior. Using econometric analysis, a series of models were estimated to examine whether reading the advisory significantly altered women's fish consumption knowledge and behaviors.

The hypotheses tested looked at overall fish consumption behaviors and knowledge of the advisory. One of the most important findings indicates the advisory induced appropriate switching behavior; women reading the advisory decreased their consumption of high-mercury fish and increased their consumption of low-mercury fish. Another key finding indicates an advisory-induced switching behavior from "white" tuna to "light" tuna.

Based on the hypotheses and findings from this study, the survey design was modified to include new hypotheses about the updated brochure. As previously discussed, we chose to investigate the potential for switching behavior between tuna and pre-packaged salmon. The

survey design was also informed by the research question: *why* are women decreasing their consumption of high-risk fish and increasing their consumption of low-risk fish?

3.1.2. Survey Design

To measure the effectiveness of Maine CDC's Family Fish Guide, we designed a mixed-mode survey following a modified Dillman approach (Dillman et al., 2009). Notification of a survey pretest was made publicly available at day care centers and the University of Maine. The draft survey was pre-tested by four women that were pregnant or recently had a baby. Of specific interest to the researchers was the style of the inclusion of the matrix style fish consumption questions. Three options were presented to the pre-testers and the unanimous selection was included in the survey. Literacy concerns and clarity were reviewed and modified as needed. The final survey consisted of 55 questions intended to assess awareness of the state's methylmercury advisory, receipt of the brochure, and any change in knowledge and fish consumption behavior.

Of critical importance to this study was measuring the change in knowledge and behavior after receiving the brochure. In order to measure this, the survey questionnaire was divided into three stages: before, during and after pregnancy. As previously described, healthcare providers are instructed to distribute the Maine CDC's brochure to women at their first prenatal visit. This snapshot in time falls within the "during" stage of pregnancy. Thus, we should be able to measure any changes that are associated with reading the brochure.

Within the three stages, there were a few repeating questions to capture brochure-induced changes. The repeating questions included a dichotomous choice question that elicits whether respondents ate any fish during that stage; for respondents that did not eat any fish, a follow-up question asked respondents *why* they didn't eat fish. Another repeating question was a matrix-response style that asked how many meals per month of different types of fish respondents ate. A repeating question about nutritional behaviors asked respondents to select the food and/or supplements they ate/took where the response choices focused on benefits received from fish (e.g. omega 3 fish oils, lean source of protein).

Knowledge was measured using a few different survey questions. Later in the questionnaire, there were many knowledge questions that asked about specific health attributes and risks associated with specific species. Analogous to literature suggestions, differentiation between consumption of "white" and "light" tuna was highlighted in the questionnaire to tease out detailed knowledge regarding prepackaged fish.

As with any survey effort, collecting information about the respondent's demographics and socioeconomic characteristics helps describe their choices. The last section in the survey questionnaire asked respondents these types of questions. There were also questions specifically about the brochure and its impact on respondents that were presented only to those that stated they received and read the brochure.

3.1.2.1. Online Questionnaire

The final questionnaire was transferred verbatim to an online survey system, Qualtrics©, to increase response rates in a cost-effective manner. After receiving comments

about the link being difficult to enter, the researchers used a free URL redirection service, Tiny URL.com, to create a link to the online survey that was significantly easier to enter. It was estimated that it took approximately 10 to 15 minutes for respondents to complete either version of the questionnaire.

3.1.3. Survey Administration

Between September and December of 2011 the mixed-mode survey was administered to 1,500 women (randomly drawn from Maine's Birth Certificate Registry) who had given birth in the previous three months (May, June and July of 2012). Due to Maine's relatively homogenous racial profile (96% of Maine citizens are Caucasian), targeting specific ethnic or racial groups was not a primary concern (U.S. Census, 2011). Selected mothers were contacted with a first-class letter informing them about the survey and providing a web-link to the survey online. The first-class mailing also included a one dollar cash incentive to encourage response rates. Non-respondents were sent three more mailings including a letter encouraging them to participate in the study, the web-link to the survey online, a paper questionnaire and a postage-paid return envelope. The three rounds that included the paper questionnaire did not include cash incentives to participate. Overall response rate is 42% to date.

3.2. Data Entry and Cleaning

The data was entered into two separate Access databases and cross checked for validity when the datasets were complete. Because a few respondents completed the both the paper and web versions of the survey, the second completed questionnaire was dropped from the analysis. A few respondents did not input their unique survey code into the web-based

questionnaire. We assume that due to the length of the survey and lack of incentive for purposely skewing the results that these individuals should be included in the analysis. They were given new survey identification numbers and were included in the dataset.

Section 4

ANALYSIS

Using the independent variables motivated in Section 2, the research questions will be investigated using econometric analysis in the following sections.

4.1. Variable of Interest: READ

It is important to first look at who is receiving the Maine CDC's brochure, who is actually reading it, and who is unaware of the mercury advisory. We first asked who is receiving the brochure but isn't reading it? The data indicates that only 17 respondents received the brochure and did not read it, of which 9 indicated they do not eat fish and 5 specified other various reasons.

Three paths of logic could explain such a small proportion of women receiving but not reading the materials. Perhaps healthcare providers are not handing out the brochure at prenatal visits. The problem then is determining which healthcare providers are disregarding the fish consumption advisory. A second and more likely scenario is that those who read the brochure also are more likely to remember receiving the brochure; thus, the number of women that stated they received the brochure could be massively underestimated. The problem with this communication method then is such: why hand something out that people are not noticing enough to read? Perhaps encouraging healthcare providers to go through the brochure with patients would increase likelihood of reading and/or understanding the material. The third explanation might be that women who do not eat fish are likely not considering this brochure

to be relevant to their diet and nutritional choices during pregnancy. Perhaps a suggestion might be made that fish consumption brochures focus more on ways to obtain benefits of fish (i.e. omega 3 fish oils) other than consuming fish. Regardless of the logic, the fact that the majority of the "nonreaders" are also "non-receivers" eliminates most of the potential for selection bias and endogeneity in the READ variable.

The question then becomes, why are women who most likely received the brochure choose to not read it, and consequently do not remember receiving it? We performed a two-sample chi-square test on readers and nonreaders. The results show that overall; readers are slightly older, more educated and more likely to breastfeed. This indicates that AGE, EDU, and BF are likely to be important explanatory variables for information seeking behavior, and general knowledge and behavior related to fish.

4.2. Econometric Analysis

4.2.1. General Functional Form

The following general regression is used in the upcoming sections to explain binary and continuous dependent variables. All regressions were specified in the statistical program SAS©.

$$\boldsymbol{DEP = \alpha + \beta_1 READ + \beta_2 AGE + \beta_3 EDU + \beta_4 BF + \beta_5 FBABY + \beta_6 COUPLE + \beta_7 INC + \beta_8 WIC + \beta_9 EMP + \beta_{10} INFO + \beta_{11} READ * FBABY + \beta_{12} WIC * READ + \beta_{13} EATB + + \beta_{14} GOODME + \beta_{15} GOODB + \beta_{16} BADME + \beta_{17} BADB + \varepsilon}$$

Eq (3)

4.2.2. Knowledge

Measuring changes in knowledge during pregnancy is critical to the objective of this research. More specifically, advisory-induced changes will be investigated in the following sections to measure the impact of the brochure's information on women's knowledge. We consider knowledge related to both risks and benefits critical to understanding the message of the brochure. Changes in both general and specific risks and benefits of fish consumption during pregnancy will be explored. Analogous to the literature and the brochure's objective, knowledge related to specific fish species will be teased out of the respondents as well. This type of knowledge is critical to making informed nutrition choices and is necessary to induce any behavior changes. Behavior changes will be explored in later sections.

4.2.2.1. Chi-Square Test of Knowledge Regarding Risks and Benefits

The survey asked four questions to determine the amount of knowledge respondents possessed about the risks and benefits of fish consumption. Two almost identical questions asked specifically about benefits differing only in who receives the benefits, the mother or the baby. Similarly, two knowledge questions asked about risks associated with eating fish, differing only in who receives the risks.

We performed a two-sample chi-square test on these knowledge questions to examine the differences among those who read the brochure and those who did not. For the question that asked about benefits the mother receives from eating some fish while pregnant, the results indicate that the readers were significantly more likely to get the question correct at the 1% level. Nonreaders were significantly more likely to select "Don't Know" at the 1% level.

These results show that readers were statistically more knowledgeable about specific benefits to the mother than nonreaders. For the question that asked about benefits to the developing fetus from the mother eating some fish while pregnant, the results indicate that the readers were statistically more likely to answer the question correctly at least at the 5% level. Again, nonreaders were significantly more likely to select "Don't Know" at the 1% level. It is interesting that the results for benefits to the fetus are very similar to the results for benefits to the mother. This tells us that women who read the brochure have some understanding about the connection between what they eat and its effects on not only their health, but their developing baby's health.

Overall, readers were statistically more knowledgeable about benefits accrued to both the mother and the developing baby. Across both groups, there is a larger knowledge base of the benefits accrued to the mother than benefits accrued to the developing baby. The "Don't Know" response choice is the only option that nonreaders were more likely to choose for the developing baby then the mother.

Then we performed a chi-square test to determine the differences in the knowledge of risks accrued to the mother and the developing baby between readers and nonreaders. The results for the question that asked about risks accrued to the mother indicate that readers were significantly more likely to know that some fish are high in mercury at the 5% level. Nonreaders were significantly more likely to select "Don't Know" than readers at the 1% level. For the question that asked about the risks the fetus receives from the mother eating some fish while

pregnant show that readers were significantly more aware of the risks associated with mercury during pregnancy than nonreaders at the 1% level.

Overall, readers were statistically more likely to understand mercury as a risk to the mother and developing baby than nonreaders. Consistent with knowledge about benefits, nonreaders were statistically more likely to answer "Don't Know" for questions about the mother and the baby. Both groups were more knowledgeable about mercury in fish than Omega 3 fish oils and were more likely to recognize risks to the baby and benefits to the mother. This shows an overall knowledge gap in this sensitive population about both benefits and risks associated with eating fish during pregnancy.

4.2.2.2. Chi-Square Test of Knowledge Regarding Fish Species

The survey asked three questions about specific species that are safe and not safe to eat during pregnancy. The first of these knowledge questions asked respondents about "white" and "light" tuna. The second of these questions asked respondents what species are low in mercury and thus, safe to eat during pregnancy. The last question of this series asked respondents which species are not safe to eat during pregnancy.

The first question we performed a chi-square test on was presented as a true/false question about tuna varieties that asked respondents to select the "true" answer choices. As discussed previously, knowledge related to "white" and "light" tuna is very important to this study because it is highlighted in the brochure; the two types differ in mercury levels and are commonly consumed. The results demonstrate a statistical increase in knowledge about different types of tuna between readers (who more often answered correctly) and nonreaders.

The second question we performed a chi-square test on asked respondents to select the fish that they thought were low in mercury. Readers were significantly more likely to select the fish that were truly low in mercury at least at the 5% level: fresh salmon, pre-packed salmon, fish sticks or sandwiches, atlantic mackerel and "light" pre-packed tuna. Almost 50% of nonreaders selected the "Don't Know" response choice. From these results, there is a clear and significant difference in knowledge of safe fish species between readers and nonreaders.

The next question we tested asked respondents to select which fish they thought should not be eaten during pregnancy or breastfeeding. Readers were significantly more likely to select the fish that were truly not safe to consume at the 1% level: shark, tilefish, swordfish, king mackerel. Again, 40% of nonreaders selected the "Don't Know" response option. These results show that readers were significantly more likely to know which fish were not safe to eat at all during pregnancy or breastfeeding.

In both knowledge sections, two consistent results are present. First, readers were significantly more likely to know general and specific information regarding risks and benefits of fish consumption. Secondly, nonreaders were significantly more likely to select "Don't Know" as their response. This consistent response selection indicates an overall confusion or unawareness of safe fish consumption practices among those who did not read the brochure.

4.2.2.3. Knowledge Regression Analysis

When examining advisory-induced knowledge changes, the researchers ran binary logit choice models for the responses of most importance to the research questions. The first two paragraphs discuss results from questions that asked about benefits of fish consumption during

pregnancy and that measure specific knowledge regarding Omega 3 fish oils. The second two paragraphs discuss results from regression analysis of questions that asked about risks of fish consumption during pregnancy and that measure specific knowledge regarding mercury. The last four paragraphs address other questions that asked about the differences of "light" and "white" tuna, which fish are low in mercury and which fish should be avoided during pregnancy and breastfeeding.

The survey asked respondents to select which response choices they thought were benefits accrued to them from eating some fish during pregnancy. We examined what factors contributed to respondents selecting "omega 3 fish oils" as a benefit. Independent variables with significant explanatory power include READ, AGE, EDU, BF, EMP and WICREAD. The variables that were significant at the 1% level include READ, AGE, EDU and WICREAD. It is an interesting finding that READ and WICREAD are this significant even when controlling for all these other factors.

The questionnaire asked respondents to select which response choices they thought were benefits accrued to their baby from them eating some fish during pregnancy. We examined what factors contributed to respondents selecting "omega 3 fish oils" as a benefit. Independent variables with significant explanatory power include READ, AGE, EDU, BF, EMP and WICREAD. The variables that were significant at the 1% level include READ, AGE and EDU. Again, reading the brochure holds a large amount of statistical significance in explaining knowledge of benefits related to Omega 3 fish oils.

To measure knowledge of risks, two questions asked respondents what they thought were risks associated with fish consumption during pregnancy. One of the questions asked respondents what risks they faced from consuming some fish. We examined what factors contributed to respondents selecting "mercury" as a risk. The regression analysis results indicate that INC and INFO are both significant explanatory variables at the 5% level.

Another risk-related question asked respondents what risks their developing baby faced when they consumed some fish during pregnancy. We examined what factors contributed to respondents selecting "mercury" as a risk to their baby. The binary logit results indicate that EDU, BF, INC and INFO are significant explanatory variables. INC was the only variable that was significant at the 1% level. It is not surprising that knowledge of mercury as a risk to the mother and the developing baby is not explained by reading the brochure. For years this was the only message consumers heard related to fish consumption during pregnancy.

In order to understand if there is knowledge regarding the health attributes of different varieties of tuna, we asked respondents a true/false question. The results of a binary logit regression on the "true" response choice "white tuna contains more mercury than light tuna" show that READ and BF are the only statistically significant variables. READ is significant at the 1% level and accounts for most of the explanatory power in the regression.

We are also interested in measuring knowledge of low-mercury fish. This knowledge is critical to encouraging a "switching" behavior from high-mercury fish to low-mercury fish. The questionnaire asked respondents to select which fish they thought were low in mercury. We are very interested in determining if the Maine CDC's brochure encouraged people to consider

pre-packaged salmon as a low-mercury substitute for “white” tuna. The regression results for the pre-packaged salmon response choice show that READ, BF and EDU are all significant at the 1% level. This result shows that women who read the brochure, chose to breastfeed and were more educated, were also more knowledgeable about pre-packaged salmon as a low-mercury fish.

This same question that asked respondents to select low-mercury fish provided us with another interesting dependent variable: “light” pre-packaged tuna. The regression results for respondents that selected “light” pre-packaged tuna as a low-mercury fish show that READ, EDU, BF, READFB and WICREAD are all significant independent variables. Breastfeeding was the only variable significant at the 1% level. It is interesting that READ, WICREAD and READFB all hold some explanatory power in measuring knowledge of “light” pre-packaged tuna as a low-mercury fish.

We are interested in understanding knowledge of high-mercury fish that have been described in the media for years as not safe for consumption during pregnancy or nursing. The questionnaire asked respondents to select fish that are high in mercury. The regression results for the selection of shark show that READ, EDU and BF are significant. READ is the only independent variable that is significant at the 1% level. The regression results for the selection of tilefish show that READ and INFO are significant variables. READ is the only variable significant at the 1% level. The regression results for the selection of swordfish show that READ is the only significant explanatory variable and it is significant at the 1% level. The regression

results for the selection of king mackerel show that READ and BF are significant. READ is the only variable significant at the 1% level.

The READ variable was by far the strongest and most consistent explanatory variable in modeling the responses to the knowledge questions. Other than common demographic variables, breastfeeding was the next most consistently significant explanatory variable in modeling the knowledge question responses. We hypothesize that breastfeeding is often planned during pregnancy and is a behavior that would induce seeking out more information.

4.2.3. Prior Fish Consumption Behavior

It is important to consider biases that might exist within studies. One bias to be discussed for this research is whether the pool of respondents is unbiased in regards to fish consumption. We make the conservative assumption that the women that chose to respond to this survey effort were more likely to eat fish than non-respondents.

When examining a change in fish consumption throughout the three stages of pregnancy highlighted, respondents that never ate fish should be removed from the analysis. We hypothesize that people tend to eat fish or they do not. It is more likely that women who do not eat fish and also read the brochure, are more likely to supplement with omega 3 fish oils; this type of behavior will be discussed in subsequent sections. Thus, if women that never ate fish were included in the analysis of the fish consumption questions, their responses would lead to underestimated changes in behavior.

4.2.4. Information Seeking Behavior

Knowledge is a function of experiences and information seeking behaviors. We can control for experience with fish, experience with pregnancy and experience with life using our survey data. In order to understand the effect of information sources on knowledge, we asked respondents to select what information sources they utilized to obtain information about their recent pregnancy. The table below presents the constructed independent variables and their associations with response choices.

Independent Variables	Description/Response Choice
BOOK	Books or Magazines, please specify
DOC	Doctor, Nurse, or other Healthcare Provider
WICINFO	WIC (Women, Infant, and Children) Program
FAM	Friends or Family
BRO	Brochures
TV	TV or Radio
NEWS	Newspaper
WEB	Internet, please specify
OTHERINFO	Other, please specify
NOINFO	I did not get this type of information

In order to understand the impact of information seeking behavior on knowledge of general benefits related to eating fish during pregnancy, we ran binary logit regressions with dependent variables GOODME and GOODB. The independent variables included READ and the information sources. The following table presents the results from these regressions.

GOODME	Sign	Significance	GOODB	Sign	Significance
Intercept	-	ns	**Intercept**	-	ns
READ	+	***	**READ**	+	***
BOOK	+	ns	**BOOK**	+	ns
DOC	+	***	**DOC**	+	**

WICINFO	-	**	**WICINFO**	-	**
FAM	-	ns	**FAM**	-	ns
BRO	+	**	**BRO**	+	***
TV	+	ns	**TV**	+	ns
NEWS	-	ns	**NEWS**	-	ns
WEB	+	ns	**WEB**	+	*
OTHERINFO	+	ns	**OTHERINFO**	+	ns
NOINFO	+	ns	**NOINFO**	+	ns

It is interesting that READ, DOC, WICINFO and BRO are all statistically significant for explaining knowledge about benefits to the mother and the developing baby. All four of these independent variables have a link to the brochure and its distribution.

We also wanted to understand knowledge of general risks related to fish consumption during pregnancy. In order to explain this type of knowledge, binary logistic regressions were ran with BADME and BADB as the dependent variables and we used READ and the information sources as the independent variables. The following table presents these regression results.

BADME	**Sign**	**Significance**	**BADB**	**Sign**	**Significance**
Intercept	-	ns	Intercept	-	*
READ	+	**	READ	+	***
BOOK	+	ns	BOOK	+	ns
DOC	+	ns	DOC	+	***
WICINFO	-	ns	WICINFO	-	ns
FAM	+	ns	FAM	+	*
BRO	+	*	BRO	-	ns
TV	-	ns	TV	+	ns
NEWS	+	ns	NEWS	-	ns
WEB	+	***	WEB	+	**
OTHERINFO	+	ns	OTHERINFO	-	ns
NOINFO	+	ns	NOINFO	+	ns

Based on these results, it is clear that reading the brochure increased knowledge about risks. It is interesting that receiving information from a healthcare provider was only significant for respondents hearing risk related information about their babies. Another interesting result is that reading information on the internet is highly statistically significant for explaining this type of knowledge but it is not for explaining knowledge related to benefits for the mother and baby.

4.2.5. Nutritional Behaviors

The survey asked a repeating question about supplemental behaviors explored before, during and after pregnancy. The response categories were created to reflect the benefits of eating fish as described by the brochure, such as omega 3 fish oils and lean protein. The response categories that pertained specifically to omega 3 fish oils or mercury were summed up to construct an index, HEALTHD to account for supplementary behaviors respondents participated in during pregnancy.

We hypothesize that women who did not eat fish before pregnancy and received information about the benefits of fish would likely choose to supplement their diet with low mercury fish or omega 3 supplements. However, the table of results below tells a different story. As discussed in previous sections, the EATB variable is binary and equal to 1 if the respondent ate fish before pregnancy and is equal to 0 if the respondent ate no fish during this time period.

HEALTHD	Sign	Significance
Intercept	-	ns
READ	+	**
AGE	+	ns
EDU	+	**
BF	+	**
FBABY	+	ns
COUPLE	+	ns
INC	+	ns
WIC	+	ns
EMP	-	ns
INFO	+	***
READFB	+	ns
WICREAD	-	*
EATB	+	***
GOODME	+	**
GOODB	+	***

The EATB variable proves to be statistically significant in the positive direction. In other words, women that ate fish before were more likely to consume low mercury fish during pregnancy and/or supplement their diet with omega 3 fish oils. This could be a result of general experience with fish that would likely include more general knowledge about the benefits of fish or an increased likelihood to seek out information and read the brochure. Knowledge of benefits to themselves and their babies also increased the likelihood of engaging in supplementary behaviors. Women that read the brochure, chose to breastfeed, were more educated and looked at many information sources were more likely to participate in supplementation as well.

The following table presents results from an OLS regression ran to explain changes in supplementing behaviors during pregnancy related specifically to omega 3 fish oils and mercury. The dependent variable, CHG_BD_HEALTH, was constructed as the difference in these behaviors from before pregnancy to during pregnancy.

CHG_BD_HEALTH	Sign	Significance
Intercept	-	*
READ	-	**
AGE	+	ns
EDU	+	ns
BF	-	ns
FBABY	-	*
COUPLE	-	ns
INC	-	ns
WIC	-	ns
EMP	-	ns
INFO	+	ns
READFB	+	ns
WICREAD	+	ns
EATB	+	ns
GOODME	-	ns
GOODB	-	**

Results from the table above show that READ is statistically significant in explaining an increase in omega 3 fish oil supplementation and mercury-avoidance behaviors. General knowledge about the benefits of fish for developing babies is also significant in explaining an increase in supplementary behaviors during pregnancy.

4.2.6. Fish Consumption Behaviors

As described previously, respondents that never ate fish are removed from the analysis of changes in fish consumption throughout the three highlighted stages of pregnancy. We created a new dataset that dropped all observations that did not eat any fish or shellfish before, during and after pregnancy. The following regression analysis uses this new dataset to tease out any changes in fish consumption behavior that were induced by reading the brochure.

4.2.6.1. Changes in Amounts of Fish

The survey asked respondents how the amount of fish they ate changed from before they were pregnant to during their pregnancy. The table below shows the binary logit regression results for respondents that answered that they ate more fish or shellfish while they were pregnant compared to before their pregnancy.

More During	Sign	Significance
Intercept	-	ns
READ	+	ns
AGE	+	ns
EDU	+	ns
BF	+	ns
FBABY	-	ns
COUPLE	-	ns
INC	-	ns
WIC	+	ns
EMP	-	ns
INFO	-	ns
READFB	+	ns
WICREAD	-	ns
EATB	-	***
GOODME	-	ns
GOODB	+	**
BADME	-	ns
BADB	-	**

These results indicate that women who ate fish before pregnancy and believe that some fish are bad for their babies' development were less likely to eat more fish during their pregnancy. Women who believe that some fish are good for their developing babies are more likely to increase their fish consumption during pregnancy.

The table below shows the binary logit regression results for respondents that answered that they ate the same amount of fish or shellfish while they were pregnant compared to before their pregnancy.

Same During	Sign	Significance
Intercept	-	ns
READ	+	ns
AGE	+	ns
EDU	-	ns
BF	-	ns
FBABY	-	**
COUPLE	+	**
INC	+	ns
WIC	+	ns
EMP	+	ns
INFO	+	ns
READFB	-	ns
WICREAD	-	ns
EATB	+	ns
GOODME	-	ns
GOODB	+	**
BADME	-	ns
BADB	-	ns

These results indicate that women who just had their first baby were less likely to consume the same amount of fish during pregnancy compared to before pregnancy. However, women who were in a relationship and believe that some fish are good for their developing babies were more likely to continue consuming the same amount of fish and shellfish during their pregnancy.

The table below shows the binary logit regression results for respondents that answered that they ate less fish or shellfish while they were pregnant compared to before their pregnancy.

Less During	Sign	Significance
Intercept	-	*
READ	-	ns
AGE	-	ns
EDU	+	ns
BF	-	ns
FBABY	+	**
COUPLE	-	*
INC	-	ns
WIC	-	ns
EMP	-	ns
INFO	-	ns
READFB	+	ns
WICREAD	+	ns
EATB	+	**
GOODME	+	ns
GOODB	-	***
BADME	+	*
BADB	+	**

These results show that women who are in a relationship and believe that some fish provide benefits to their developing babies are less likely to decrease their fish consumption during pregnancy. Women who just had their first baby, ate fish before their pregnancy and believe that fish pose risks to themselves and their developing babies were more likely to decrease fish consumption during pregnancy.

The survey also asked respondents how the amount of fish they ate changed from during pregnancy to after their pregnancy. The table below shows the binary logit regression

results for respondents that answered that they ate more fish after their pregnancy compared to during their pregnancy.

More After	Sign	Significance
Intercept	-	*
READ	-	**
AGE	+	ns
EDU	+	**
BF	+	ns
FBABY	+	ns
COUPLE	-	ns
INC	+	ns
WIC	+	ns
EMP	-	ns
INFO	+	ns
READFB	+	ns
WICREAD	+	*
EATB	-	ns
GOODME	-	ns
GOODB	-	ns
BADME	+	ns
BADB	+	ns

The results show that women that read the brochure were less likely to increase their fish consumption after pregnancy compared to during their pregnancy. Women who are more educated, participate in WIC and read the brochure were more likely to increase their consumption of fish after their pregnancy.

The table below shows the binary logit regression results for respondents that answered that they ate the amount of fish or shellfish after their pregnancy compared to during their pregnancy.

Same After	Sign	Significance
Intercept	+	ns
READ	+	*
AGE	+	ns
EDU	-	*
BF	-	ns
FBABY	-	ns
COUPLE	+	**
INC	-	ns
WIC	-	ns
EMP	+	ns
INFO	-	ns
READFB	-	ns
WICREAD	-	ns
EATB	+	ns
GOODME	+	*
GOODB	+	ns
BADME	-	ns
BADB	-	ns

These results indicate that women who are more educated are less likely to continue consuming the same amount of fish after their pregnancy as they did during their pregnancy. Women who read the brochure, were in a relationship and believe that some fish are good for them are more likely to continue to consume the same amount of fish that they ate during their pregnancy.

The table below shows the binary logit regression results for respondents that answered that they ate less fish or shellfish after their pregnancy compared to during their pregnancy.

Less After	Sign	Significance
Intercept	+	ns
READ	+	ns
AGE	-	ns
EDU	-	ns
BF	+	ns
FBABY	-	ns
COUPLE	-	*

INC	+	ns
WIC	+	*
EMP	+	ns
INFO	+	ns
READFB	-	ns
WICREAD	-	ns
EATB	-	ns
GOODME	-	ns
GOODB	+	ns
BADME	-	ns
BADB	-	ns

These results show that women who are in a relationship are less likely to decrease their fish consumption after pregnancy. Women that participate in WIC are more likely to decrease their fish consumption after pregnancy.

4.2.6.2. Changes in Types of Fish

We are interested in determining if respondents switched what types of fish they ate during pregnancy compared to before their pregnancy. Thus, the survey asked respondents if they ate different fish during their pregnancy. The table below presents results for the binary logit regression of this question.

Different During	Sign	Significance
Intercept	-	***
READ	-	ns
AGE	+	ns
EDU	+	**
BF	-	ns
FBABY	+	**
COUPLE	-	ns
INC	+	ns
WIC	-	ns
EMP	+	ns
INFO	+	ns

READFB	-	ns
WICREAD	+	ns
GOODME	+	ns
GOODB	+	***
BADME	-	ns
BADB	-	ns

These results show that women who are more educated, had their first baby and believe that fish are good for them are more likely to eat different types of fish during their pregnancy. We are also interested to see if respondents switched what types of fish they ate after they were pregnant. The table below presents these regression results.

Different After	Sign	Significance
Intercept	-	***
READ	+	ns
AGE	+	ns
EDU	+	ns
BF	-	ns
FBABY	+	***
COUPLE	-	ns
INC	+	ns
WIC	+	ns
EMP	-	ns
INFO	+	ns
READFB	-	ns
WICREAD	+	ns
GOODME	-	ns
GOODB	+	**
BADME	-	ns
BADB	-	ns

These results indicate that women who just had their first baby and believe that some fish are good for their developing baby are more likely to change what types of fish they consumed

after they were pregnant. This outcome could be explained by women switching to low-mercury fish during pregnancy and then returning to their before-pregnancy eating habits.

4.2.6.3. Meal Frequency Differences between Readers and Nonreaders

The survey questionnaire asked a repeating matrix-style question about fish consumption before, during and after pregnancy. Using a common metric in fish consumption advisories, the questions asked respondents to circle the number of meals per month of fish or shellfish they ate during a particular stage: before, during and after pregnancy. Based on previous survey efforts (see Teisl et al., 2011), the scale was determined to stop at "more than 5" per month. The fish included in the questions are all highlighted in the brochure as low mercury fish and shellfish, except for "white" tuna. This type of tuna is included to help explain the consumption of different varieties of tuna. First, it shows whether or not respondents *know* what type of tuna they are consuming. Secondly, it has the potential to show whether a switching behavior between "white" and "light" tuna occurred after reading the brochure and during pregnancy.

The table below shows the results of a t-test performed on meal frequencies for readers and nonreaders in the 12 months before they became pregnant.

Species (Before)	Sign	Significance
Cod, Haddock, Pollock, Hake, Flounder or Sole	+	***
"White" (Albacore) Tuna	-	***
"Light" Tuna	+	ns
Pre-Packaged Salmon	-	ns
Fresh Salmon	+	***
Shrimp	+	ns
Smelt or Atlantic Mackerel	-	*

Mussels	+	ns
Clams	+	ns
Other	+	ns

These results show that before pregnancy, readers ate significantly more cod, haddock, pollock, hake, flounder or sole (hereafter, white fish) and fresh salmon than nonreaders. Nonreaders ate significantly more "white" tuna and smelt or atlantic mackerel.

We also wanted to examine what types of fish readers and nonreaders were eating during pregnancy. The table below shows the results of a t-test for each species the survey presented.

Species (During)	Sign	Significance
Cod, Haddock, Pollock, Hake, Flounder or Sole	+	**
"White" (Albacore) Tuna	-	***
"Light" Tuna	+	ns
Pre-Packaged Salmon	+	*
Fresh Salmon	+	***
Shrimp	+	ns
Smelt or Atlantic Mackerel	-	ns
Mussels	+	ns
Clams	-	ns
Other	+	ns

The results show that readers ate significantly more white fish, pre-packaged salmon and fresh salmon during pregnancy than nonreaders. Nonreaders ate significantly more "white" tuna during pregnancy than readers.

Finally, we looked at meal frequencies after pregnancy. The table below shows the results of a t-test between readers and nonreaders.

Species (After)	Sign	Significance
Cod, Haddock, Pollock, Hake, Flounder or Sole	+	***
"White" (Albacore) Tuna	-	**
"Light" Tuna	+	ns
Pre-Packaged Salmon	+	ns
Fresh Salmon	+	***
Shrimp	+	**
Smelt or Atlantic Mackerel	+	ns
Mussels	+	**
Clams	+	ns
Other	-	ns

These results show that after pregnancy, readers ate significantly more white fish, fresh salmon, shrimp and mussels than nonreaders. Nonreaders ate significantly more "white" tuna after pregnancy than readers.

Overall, the fish consumption and nutrition behavior results show that knowledge of both benefits and risks is critical to making healthy nutrition decisions. Readers were more knowledgeable about risks and benefits of specific species and of the health attributes of fish. This knowledge is the basis for the significantly different fish consumption and nutrition behaviors exhibited between readers and nonreaders; the difference that readers consistently ate more low mercury fish and supplemented their diet with omega 3 fish oils than nonreaders.

Section 5

CONCLUSION

5.1. Discussion of Results

Public health messages can become sources of imperfect information if not communicated properly. Communication can be more effective when advisories are presented with balanced information regarding both risks and benefits to human health targeted directly at the most sensitive populations. These results indicate that the brochure is effectively educating at-risk groups about healthy fish consumption choices. Readers of the brochure were also more likely to supplement their diet with omega 3 fish oils or low mercury fish during pregnancy. We are currently continuing to work on measuring these changes in knowledge and behavior in order to enhance the Maine CDC's safe fish consumption outreach program.

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