Fish Consumption and Advisory Awareness Among Older Wisconsin Fishermen

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ABSTRACT

Objectives: The provision of fish consumption advice issued by the Wisconsin Department of Health Services (DHS) and Department of Natural Resources (DNR) has evolved over the past 40 years. In 2010, DHS received a US Environmental Protection Agency Great Lakes Restoration Initiative (GLRI) grant to evaluate existing advisory approaches, identify gaps, and adapt current communication approaches.

Methods: Previous research conducted by DHS found that older, male anglers eat more sport fish and have higher body burdens of persistent contaminants found in fish than other groups. As part of the GLRI, Wisconsin DHS and DNR aimed to engage this subpopulation and improve communication by using an Internet-based survey to collect information about fishing habits, consumption, and advisory awareness. At the end of the survey, participants were provided with answers to advisory questions and links to relevant online information. From fall 2011 through spring 2012, 827 men aged 50 and older completed this survey.

Results: Nearly all fishermen were aware of the existence of consumption advisories. Although awareness was high, penetration of traditional outreach materials was low with fewer than 35% having seen any of the pamphlets featured in the survey. Knowledge of the advisories was significantly higher among residents of counties along Lakes Michigan and Superior and among more frequent sport fish consumers. Men who were aware of these advisories were significantly more likely to have modified their consumption behavior.

Conclusion: Wisconsin's experience suggests general awareness among older male anglers. Participation in the online survey and responses to sources of advisory information supports the need to expand the current outreach program to reach and inform the fish-consuming public.

INTRODUCTION

The current goal of fish consumption advisories is to encourage people to eat fish that are high in nutrients and low in contaminants. Wisconsin began testing fish for contaminants in 1970 and the Wisconsin Department of Health Services (DHS) and Department of Natural Resources (DNR) first issued fish consumption advice in 1976 due to levels of polychlorinated biphenyls (PCBs) found in fish. The state began issuing mercury-based advisories in 1985 after DNR monitoring found higher levels of mercury in predator species of fish from northern lakes that were remote from any direct discharger or emitter of mercury. Based on mercury concentrations found in fish from certain waters and differences in vulnerability among populations, recommendations were provided for 2 demographic groups: (1) women of child-bearing age and children; and (2) men and older women.

In 2001, Wisconsin adopted a statewide advisory for mercury after the National Research Council and US Environmental Protection Agency (US EPA) determined there was a need to better protect fetuses and young children. Wisconsin's advice, for all fish consumers, is designed to prevent ingestion of mercury above levels that increase risk of adverse health effects based on health protection values determined appropriate by DHS. In addition, another goal of the statewide advice was to provide a simple message that frequent fish eaters could easily remember. The statewide advice differs by age and gender of the consumer and is supplemented with more stringent advice for particular waters where some species of fish have been found to have higher concentrations of contaminants. In 2012, there were 129 locations where levels of PCBs, mercury or other contaminants found in the fish required more restrictive advisories.

Prior to 1993, each state in the Great Lakes region had a different protocol for developing advisories and it was recognized that a common message from all states bordering the Great Lakes was needed to enhance public acceptance of the advice. Wisconsin participated as a member of the Great Lakes Sport Fish Consumption Advisory Task Force, which published a Uniform Advisory Protocol for PCBs in 1993.[1] A 2007 adden-

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Table 1. Sample Demographics.

Background Demographic	Number (%)
Age (in Years)	
50-60	455 (55)
61-70	282 (34)
71-80	83 (10)
80+	7 (1)
Ethnicity/Race	
Identification as non-Hispanic (n=803)	795 (99)
Identification as White only (n=802)	787 (98)
Years living and fishing in Wisconsin	
Lived less than 10 years in the state (n=806)	17 (2)
Fished WI waters for <10 years (not including Great Lakes) (n=825)	30 (4)
Never fished in any of the Great Lakes	143 (17)
Residence	
Lives in a county bordering Lakes Superior or Michigan (n=826)	195 (24)
Lives in another county (not bordering a Great Lake) (n=826)	631 (76)
Education	
High school or less	192 (23)
Some college or associate degree	308 (37)
College degree or greater	307 (37)
Not answered	20 (3)
Employment	
Working (full or part-time, or self-employed)	405 (49)
Retired (including semi-retired)	349 (42)
Other or not answered	73 (9)
Household income (n=779)	
<$15,000	27 (3)
$15,000 to $24,999	42 (5)
$25,000 to $34,999	67 (8)
$35,000 to $49,999	132 (16)
$50,000 to $74,999	221 (27)
>75,000	290 (35)
Not answered	48 (6)
Marital Status	
Married (or marriage-like relationship)	696 (84)
Other or not answered	131 (16)

Note: Missing values excluded from some analysis; n is noted in these instances.

dum to the protocol addressed methyl mercury.[2] The protocols provide guidelines for the development of consumption advisories and outreach programs. Wisconsin's outreach program has used a combination of printed brochures, web pages and press releases, as well as warning signs posted near some contaminated waterways and posters sent to health care clinics.

In addition to advice for the general population, due to concerns regarding the developmental effects of PCBs and mercury, Wisconsin's outreach efforts have targeted women of child-bearing age and children as an especially vulnerable group. Recent research has linked methyl mercury exposure to higher rates of heart disease in men[3,4] and Wisconsin has begun to target messages for older adults as well. DHS initiated a statewide mercury exposure study that identified older, male anglers as a high risk group that ate more fish and had higher hair mercury levels than others.[5] This finding was consistent with earlier studies of Great Lakes sport fish consumers that found higher levels of PCBs and dichlorodiphenyldichloroethylene (DDE) in the blood of men compared to women.[6,7]

In an effort to evaluate the overall reach and impact of Wisconsin's advisory program on a subpopulation that has not been targeted previously by the state's outreach efforts, an online survey was deployed to collect dietary, health, and awareness information from male anglers aged 50 and older. This was created as part of a multipronged strategy (including biomonitoring of human samples to test for nutrients and contaminants commonly found in fish) to strengthen the scientific basis for fish consumption advisories and help achieve a better understanding of the risks and benefits of sport fish consumption. Another goal is to develop and employ modern risk communication strategies to effectively elicit fish consumption behavior changes that will result in reduced human body burdens of persistent, bioaccumulative contaminants found in the Great Lakes fishery. Wisconsin's strategy for improved advisory communication is part of the US EPA Great Lakes Restoration Initiative (GLRI). This article presents findings from 827 fishermen who completed this survey between October 2011 and May 2012.

METHODS

An online survey developed by the Wisconsin Department of Health Services' Great Lakes Research Program was deployed in October 2011. Men who fished in Wisconsin waters, lived in Wisconsin at least part of the year, and were 50 years old or older were eligible to participate in this survey. Recruitment included a series of press releases, Department tweets on Twitter, and notices in state agency and other fishing and lake organization publications targeted at fishermen. As of May 2012, 827 men completed the survey, providing information on their fishing practices, the species of fish they catch and eat, their awareness of local and statewide consumption advisories, and their consumption of sport fish (fish caught by the respondent or someone they knew) and commercially purchased fish. Respondents also were asked standard demographic questions and a few questions about their health.

At the conclusion of the survey, respondents were provided with the correct responses to a series of questions about consumption advisories related to mercury and PCB contamination. They also were provided with links to the DNR website for fish consumption advisory information and the DHS website link for 2 advisory pamphlets.

All statistical analyses were conducted using SAS 9.2 software (SAS Institute Inc, Cary, North Carolina). Where missing values have been excluded from analysis, this has been noted in the tables and text.

Human Subjects

This study was reviewed by the University of Wisconsin Health

Sciences Human Subjects Review Board and determined to be exempt.

RESULTS

Sample Demographics

Fifty-five percent of survey respondents were between the ages of 50 and 60 years (mean 60) (Table 1). Compared to the Wisconsin general population of men aged 50 and above, study participants were more likely to report their race as white only (98% vs 95%) and to have attended or graduated from a 4-year college (74% vs 52%). Approximately half were working either full- or part-time or were self-employed, and 42% were retired (vs 31% retired for this same demographic for the state as a whole). The majority of respondents were married or in a marriage-like relationship (84%). The majority (62%) reported annual household incomes above $50,000 compared to 56% for this demographic subgroup for the entire state. Conversely, only 3% of the sample reported an income below $15,000 compared with 7% for the state (statewide demographics based on 2010 American Community Survey Public Use Microdata Sample file). Twenty-four percent of respondents reported living in a county bordering either Lake Michigan or Lake Superior.

Table 2. Average Number of Fish Meals Consumed Per Year.

	Sportfish	Purchased Fish	Purchased Shellfish	All Fish and Shellfish
Total sample (N = 812-824)	43	34	17	93
By Residence in a Great Lake County or Other Area				
Great Lake County residence (n = 194-195):	48	36	17	101
Non-Great Lake County residence (n = 617-628):	41	33	16	91
By Work Status				
Working (n = 396-403):	38[a]	33	16	87[a]
Retired (n = 343-348):	51	36	18	105
By Great Lakes Sport Fish Consumption Status				
Consume Great Lakes sport fish (n = 457-463)	55[a,b]	36	18[a]	110[a]
Do NOT consume Great Lakes sport fish (n = 355-360)	27	31	14	72

[a] Significant difference based on *t* test of means; $P < 0.05$
[b] 35% of the sport fish meals consumed by Great Lakes sport fish consumers were from 1 of the Great Lakes
Note: A range is given for the total N and the n by residence, work status, and Great Lakes sport fish consumption due to missing data for some types of fish and/or some of the predictor variables.

Fishing and Fish Consumption

Fishing is a popular activity in Wisconsin, with more than a million resident licenses sold each year.[8] For the 2011 license year, slightly more than 300,000 license holders were men aged 50 or older. Ninety-four percent (94%; n = 804) of our study sample held a current (2011 or 2012) Wisconsin fishing license and the average number of years fishing in Wisconsin waters (not including the Great Lakes) was 45. Eighty-three percent (83%) of respondents had fished the Great Lakes at some time in their life. Among these men, the average number of years fishing in 1 or more of the Great Lakes was 19.

The average number of fish and shellfish meals consumed was 93 meals per year (just under twice a week) (range: 0-624, median: 74). Sportfish comprised almost half of this total (range: 0-416, median: 28) (Table 2). The average number of sport fish meals differed significantly based on work status and status as a consumer of Great Lakes sport fish versus non-Great Lakes sport fish consumers. Men who ate fish caught from a Great Lake reported significantly more sport fish meals than anglers who did not eat Great Lakes sportfish (55 vs 27, $P < 0.05$). Retired men ate sport fish more often than men who were employed (51 vs 38, $P < 0.05$).

Advisory Awareness

Respondents were asked if they had seen advisory pamphlets published by DHS and DNR. The front covers of 3 pamphlets were displayed in the survey. The "Family Guide to Eating Fish from Wisconsin" and "Guide to Eating Fish for Older Adults" review safe fish eating practices for local sport fish and commercially purchased fish, specifically listing species of fish and recommended frequency of consumption. The "Older Adults" guide also discusses beneficial nutrients in fish and safe preparation practices to reduce PCB exposure. "Choose Wisely," the pamphlet, provides species- and location-specific advice based on the DNR's monitoring program.

Though most (73%; n = 819) of the men in our study ate sport fish more than once a month and 26% (n = 819) ate sport fish more than once a week, 67% did not recall seeing any of the 3 featured pamphlets (data not shown). The "Choose Wisely" guide was the most commonly seen pamphlet (25%) and the "Older Adults" guide was the least commonly seen (10%). Only 4% of anglers in our study had seen all 3 pamphlets (data not shown).

Respondents also were asked to indicate all of their sources of locally-caught sport fish advisory information. The most common response was the fishing regulation guide (published by the DNR) provided with their license (73%). This guide presents a 1-page, general statewide advisory with reference to the DNR website for additional detail. The DNR website and publications (referring to any materials published by the DNR) were noted by over half of respondents (65%); these materials present general and site-specific advisories. The other common response included warning signs posted along the lakes and rivers these anglers fish (60%). Due to elevated PCB levels, DNR posts signs along the Sheboygan River, Cedar Creek and upper Manitowoc River; county health departments post signs along parts of the Milwaukee River; and DHS posts the Lower Fox River/Green

Table 3. Advisory Knowledge by Residence and Fish Consumption.

Total Sample (N = 827)	Nothing %	Some %	A Lot %
Polychlorinated Biphenyls (PCBs)	33	52	15
Mercury	7	65	28
PCBs			
By Residence[a]			
Live in a Great Lake county (n = 195)	26	56	18
Do not live in a Great Lake county (n = 631)	35	51	14
By Great Lakes Sport Fish Consumption Status[a]			
Consume Great Lakes sport fish (n = 464)	28	54	18
Do NOT consume Great Lakes sport fish (n = 361)	40	50	10
By Consumption of Sport Fish[a]			
None (n = 47)	45	45	10
Up to once a month (1-12/year) (n = 178)	37	52	11
More than once a month up to twice a month (13-24/year) (n = 135)	35	51	14
More than twice a month up to once a week (25-52/year) (n = 248)	31	53	16
More than once a week (53+/year) (n = 211)	28	53	19
Mercury			
By Residence			
Live in a Great Lake county (n = 195)	8	70	22
Do not live in a Great Lake county (n = 631)	7	64	29
By Great Lakes Sport Fish Consumption Status[a]			
Consume Great Lakes sport fish (n = 464)	6	63	31
Do NOT consume Great Lakes sport fish (n = 361)	8	69	23
By Consumption of Sport Fish[a]			
None (n = 47)	13	66	21
Up to once a month (1-12/year) (n = 178)	6	72	22
More than once a month up to twice a month (13-24/year) (n = 135)	8	62	30
More than twice a month up to once a week (25-52/year) (n = 248)	8	66	26
More than once a week (53+/year) (n = 211)	5	60	35

[a] Statistically significant differences, $P < 0.05$; based on M-H chi-square test.

Bay. Not all waters are posted. Only 4% of respondents reported getting advisory information from a health care professional (data not shown).

Nearly all of the men who completed the survey knew something about advisories for mercury while 67% had heard of advisories for PCB-contaminated fish (Table 3). Respondents were asked to indicate how much they knew about each advisory based on a 5-point scale ranging from "nothing" to "a great deal." In order to boost cell sizes for analysis, the 5 levels of awareness were combined into 3 categories: nothing, some, and a lot. Men who had eaten sport fish caught from the Great Lakes in the previous 12 months knew significantly more than others. For PCB awareness, 18% of the men who ate Great Lakes sport fish knew "a lot" compared to 10% of those who did not eat Great Lakes sport fish. These differences were significant for mercury awareness as well. Amount of sport fish consumed also was associated with advisory awareness. Men who ate fewer sport fish meals per year knew less about the advisories compared to those who ate more (Table 3); these differences were more pronounced at the extremes of the knowledge scale (knew nothing or knew a lot). These differences were significant for both the mercury and PCB advisories ($P < 0.05$). This finding is encouraging as those who eat more are also more likely to be at greater risk due to greater exposure.

Residents of counties that border Lakes Michigan or Superior knew more about the PCB advisories than others (based on an M-H chi-square test, $P < 0.05$) (Table 3). Seventy-four percent (74%) of the men who resided in a Great Lake county had heard about PCB advisories compared to 65% of anglers in other counties. This may be due to the fact that about half of Wisconsin's PCB-contaminated sites, especially those undergoing remediation, are located in the Great Lakes basins.

Behavioral Changes

The survey included questions related to behavioral changes. These questions asked whether the respondent ate fewer fish meals, ate different fish types (species), or avoided fish from certain locations because of concerns with contamination. More than half of the men reported at least 1 change; 24% had made more than 1 change. The most commonly reported change was the source (water-body) of their fish meal (55%) while only 15% reduced their fish intake (Table 4).

For each behavior, there were significant differences in the percentage of men who reported changes based on familiarity with a DHS or DNR pamphlet or their self-reported level of knowledge of the mercury and PCB advisories. These 3 items are all highly correlated (Spearman correlation $P < 0.05$). Men who had not seen any of the pamphlets were less likely to have changed their behaviors than men who had seen at least 1 pamphlet (46% vs 33% made no change at all due to concern with chemical contamination). Greater knowledge of PCB and mercury advisories was significantly associated with changes in behavior as well (Table 4).

Men who had not attended college were the least likely to change any behavior (54% made no change), and those living in a county along the Lake Michigan or Lake Superior boundary were more likely than others to have changed the amount of sport fish meals they ate (22% vs 12%) and the source of these meals (66% vs 52%). There were no significant differences for any of the behavioral changes based on number of sport fish meals consumed per year.

DISCUSSION

Most survey respondents were aware of advice concerning mercury (93%) and PCBs (67%). Men who ate sport fish more than once a week were more likely to be very knowledgeable of these advisories. The fact that men who ate more sport fish knew more about the consumption advisories is encouraging since these men are at greater risk of exposure. This study population also appears to be more knowledgeable of advisory messages than other groups DHS has studied in the past. In particular, a study conducted in 1998-1999 of women of child-bearing age[9] found that only 26% of Wisconsin women were aware of the state's advisory for mercury in sport fish. The higher level of awareness among male anglers may be the result of self-selection by men who have an interest in this issue compared to the women in the 1998-1999 study who were part of a random digit-dial telephone survey.

Based on responses to this survey, our advisory program does not appear to discourage men from eating the fish they catch. Most of the men who took part in this survey were aware that local sport fish can be a source of exposure to persistent contaminants and were willing to change some of their consumption behaviors while continuing to eat an average of 1 sport fish meal per week. The more common behavioral changes included modifying the species they ate and/or the water-body source of their meals. The Wisconsin advisory messages encourage these types of actions and these results provide evidence of successful communication. National Health and Nutrition Examination Survey (NHANES) data has revealed similar results for other sub-populations.[10] Data from 1999 to 2004 revealed that elevated blood mercury among women of child-bearing age declined without significant changes in amount of fish consumed. This was suggestive of changes to fish types consumed rather than reduction in amount eaten. Knuth et al[11] also discussed the challenge of advisories to address the trade-offs between risks and benefits related to fish consumption. For our study population, it does appear that participants are not losing any health benefits by eliminating fish from their diet.

Table 4. Behavior Change Due to Contamination Concern.

	Ate Fewer Fish Meals % (n)	Ate Different Types % (n)	Ate From Different Locations % (n)	No Change % (n)
Total sample (N = 827)	**15 (121)**	**24 (202)**	**55 (457)**	**42 (344)**
By Residence				
Great Lakes counties (n = 195)	22 (43)[a]	28 (54)	66 (129)[a]	31 (61)[a]
Non-Great Lakes counties (n = 631)	12 (78)	23 (148)	52 (328)	45 (282)
By Sport-fish Consumption				
Up to once a month (1-12/year) (n = 178)	15 (26)	25 (44)	56 (100)	41 (73)
More than once a month up to twice a month (13-24/year) (n = 135)	19 (26)	25 (34)	52 (70)	46 (62)
More than twice a month up to once a week (25-52/year) (n = 248)	14 (35)	25 (61)	58 (144)	39 (96)
More than once a week (53+/year) (n = 211)	12 (25)	24 (51)	56 (119)	40 (85)
By Education				
High school or less (n = 192)	12 (23)	19 (36)[a]	43 (82)[a]	54 (103)[a]
Some college or college degree (n = 615)	15 (93)	26 (162)	59 (365)	38 (231)
By Advisory Awareness[b]				
Have not seen any of the 3 advisory pamphlets (n = 550)	12 (68)[a]	21 (113)[a]	52 (288)[a]	46 (252)[a]
Seen at least 1 of the advisory pamphlets (n = 277)	19 (53)	32 (89)	61 (169)	33 (92)
By Level of Knowledge of Mercury Advisories				
Nothing (n = 60)	3 (2)[a]	7 (4)[a]	40 (24)[a]	58 (35)[a]
Some (n = 538)	13 (72)	23 (122)	55 (295)	43 (229)
A lot (n = 228)	21 (47)	33 (76)	61 (138)	35 (80)
By Level of Knowledge of PCB Advisories				
Nothing (n = 275)	8 (22)[a]	14 (38)[a]	44 (121)[a]	55 (150)[a]
Some (n = 429)	16 (68)	26 (111)	59 (251)	38 (164)
A lot (n = 123)	25 (31)	43 (53)	69 (85)	24 (30)

[a] Significant difference at $P<0.05$ level using chi-square test; changes are not mutually exclusive.
[b] Having seen 1 of the DHS advisory pamphlets and/or the DNR pamphlet.
Note: Having seen advisory materials and level of knowledge of mercury and polychlorinated biphenyls (PCBs) advisories are all highly correlated ($P<0.05$).

Wisconsin's advisory outreach program has been moving away from almost exclusive reliance on traditional printed materials, such as brochures, to include the use of electronic messaging, such as interactive websites, Twitter and e-mail messaging. In order to reach older fishermen, DHS and DNR will need to continue with its multipronged outreach program. This may need to include targeted distribution of printed materials (especially to those unable or unlikely to use or have access to a computer or the Internet), redesigned web pages that display advisory information in a more prominent manner, seasonal news releases, and updated signage near contaminated waterways. The majority of study respondents (67%) indicated that they had not seen any of the DHS/DNR fish advisory brochures. These materials have been distributed in print form for decades but also can be downloaded from the DHS and DNR websites. Targeted distribution and the redesign of web pages may boost the visibility of these brochures or the messages provided within. In addition, as the fishing regulation guide was widely acknowledged by respondents as 1 of their sources of information (73%), expanding the information provided in this guide may prove to be the most effective method to reach the largest audience. Finally, as only 4% of respondents identified health care professionals as a source of

advisory information, DHS may need to encourage physicians and other health care professionals to discuss the health benefits of eating fish that are low in mercury and other contaminants with their patients.

The strength of this study relates to the large sample of older Wisconsin fishermen; a population not previously targeted for study or advisory outreach. These study volunteers were able to use the Internet to access and complete the survey with relative ease based on the average number of minutes they spent on the site. Efforts to provide information on websites are a more cost-effective way to disseminate advisory information compared to distribution of printed materials. However, outreach efforts must first focus on getting anglers to access the relevant sites (this component appears to be lacking as few had seen the advisory pamphlets that are available in print and also on DHS/DNR websites). New outreach tools being explored by DHS and DNR include e-mail subscription services, messages posted using social media, and an online query page where one can view advisories for a specific water-body of interest. Though new tools are in development, lack of access to the technology and computer illiteracy will require that the DHS and DNR continue to provide outreach in print form as well.

The study weaknesses relate largely to the method used to gather data. The use of an online survey introduces bias as respondents must be computer literate and have access to the Internet. Furthermore, our outreach promoting the survey focused on press releases in local newspapers, flyers at fishing expositions, articles in the DNR magazine, direct contact with fishing organizations, and messages by DNR and DHS using Twitter and other online notices. While we have used a variety of outlets to promote the survey, none of them is free of bias. Compared to Wisconsin's population, men who participated in this survey were more educated, had higher incomes and more leisure time (greater percentage retired), and were more racially homogeneous. These demographics likely reflect the population reached by our advisory program efforts, which have limited success reaching lower income and minority anglers. This finding is not unique to Wisconsin, as Tan et al[12] also reported on studies that have found fish consumption advisories are often less than effective in reaching non-white ethnic groups and people with lower incomes or less education. In the future, more will need to be done to ensure that all Wisconsin anglers know how to select local sport fish that are safe to eat.

CONCLUSION

The results of Wisconsin's study, while supporting the general success of the state's fish advisory program based on the high level of awareness among this subpopulation and willingness to modify behavior to improve health outcomes, also has provided useful information on future directions for outreach. Continued improvements in communication methods using social media and interactive web programs may prove to be effective outreach methods for young and old alike. The key to Wisconsin's future endeavors may be targeting ways in which to steer anglers and fish consumers towards these websites, online programs, and the like. In addition to the state's expansion of its electronic communications, DHS and DNR may choose to expand the information provided in the fishing regulation guide and may create outreach programs geared towards educating health care professionals.

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