

Fish Consumption Advisory Awareness and Behavior Among Asian Women of Childbearing Age – Milwaukee, Wisconsin, January 1, 2022–January 31, 2023

Elizabeth J. Polter, PHD, MPH;* Matthew Schinwald, MS;* Amanda Haban, MPH; Jon Meiman, MD; Carrie Tomasallo, PhD, MPH

ABSTRACT

Introduction: Asian persons in the Milwaukee, Wisconsin, area might be more susceptible to contaminant exposure because of high consumption of local sportfish and store-purchased fish. This is a particular risk to women who are pregnant or might become pregnant and breastfeeding women because of health risks to the developing fetus or child's neurological system.

Methods: We conducted a survey among women of childbearing age from 4 Asian ethnic groups (Hmong, Karen, Chinese, and Filipino) residing in the Milwaukee area to assess self-reported fish consumption from different sources, fish preparation behaviors, fish consumption behaviors during pregnancy and breastfeeding, and awareness of local and national fish consumption advisories and limits.

Results: Participants included 153 women aged 18 to 50 years. Seventy-one (46%) had consumed ≥ 1 sport-caught or store-purchased species at levels above a local, state, or federal advisory. Participants reported consuming a median of 11 Wisconsin sportfish and 24 store-purchased fish meals each year. Approximately half of participants reported reducing fish consumption or changing fish preparation methods to avoid contaminants. Overall, 62 (41%) were aware of any fish consumption advisory.

Conclusions: Self-reported fish consumption habits among certain Hmong, Karen, Chinese, and Filipino women of child-bearing age were higher than local, state, or federal advisories, and approximately half of participants self-reported awareness of local or federal fish consumption advisories. Reaching Asian diaspora communities with culturally appropriate educational materials regarding safe fish consumption might help reduce contaminant exposure.

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Author Affiliations: Wisconsin Department of Health Services, Madison, Wisconsin (Polter, Schinwald, Haban, Meiman, Tomasallo); Epidemic Intelligence Service, Centers for Disease Control and Prevention, Atlanta, Georgia (Polter). *Denotes co-first authors.

Corresponding Author: Elizabeth Polter, Wisconsin Department of Health Services, 1 W Wilson St, Ste 150, Madison, WI 53703; phone 608.266.7480; email Ura1@cdc.gov; ORCID ID 0000-0001-7336-3492

INTRODUCTION

Despite well-documented health benefits,^{1,2} consumption of certain sport-caught and store-purchased fish can also increase exposure to contaminants such as mercury, perfluoroalkyl and polyfluoroalkyl substances (PFAS), and polychlorinated biphenyls (PCB).³ High levels of contaminants in the freshwaters of Milwaukee, Wisconsin, could pose a particular risk to residents. The 1987 Great Lakes Water Quality Agreement designated the Milwaukee Estuary an Area of Concern (AOC).⁴ The Milwaukee AOC includes Milwaukee's major rivers (Kinnickinnic, Menomonee, and Milwaukee), inner and outer harbors, and nearshore area of Lake Michigan.⁴ To protect anglers from high levels of contaminants in these waters, the Wisconsin Department of Natural Resources (DNR) recommends limited consumption of certain species caught in the Milwaukee AOC.⁵

The US Food and Drug Administration (FDA) and US Environmental Protection Agency (EPA) also have published advisories to help consumers maximize the health benefits of fish consumption while reducing contaminant exposure. Federal advisories include limiting consumption of store-purchased fish species with high contaminant levels and avoiding specific preparation methods (eg, boiling and poaching) and fish parts (eg, skin and head).^{1,6}

Exposure to contaminants in fish is a particular risk to women who are pregnant or might become pregnant⁷ and breastfeeding women, because of health risks to the developing fetus's or child's neurological system.⁸ Prenatal exposure to mercury, PCBs, and/or

PFAS may lead to low birthweight^{9,10} and neurodevelopmental disorders.^{11,12} Thus, it is particularly important that women of childbearing age know and follow fish consumption advisories.

In 2021, an estimated 74 977 persons of Asian descent resided in the 4 counties of the Milwaukee AOC (Milwaukee, Ozaukee, Washington, and Waukesha counties). Over half (40 418; 54%) were born outside the United States.¹³ To capture the experiences of heterogeneous Asian communities in Milwaukee, we focused on 4 groups: Hmong, Karen, Chinese, and Filipino. Approximately 24% of Asian people in the Milwaukee area are Hmong, of whom one-third were born in the United States.¹³ Additionally, approximately 6029 refugees from Burma arrived in the area between 2000 and 2021,¹⁴ many of whom are of Karen ethnicity. Two additional ethnic groups, Chinese and Filipino, also have large, primarily foreign-born populations in the Milwaukee area.¹³

Previous studies reported that Asian immigrants residing in urban areas of North America consume fish more often and have higher blood and hair levels of mercury than non-Asian residents of the same areas.¹⁵⁻²⁰ Our prior study assessing fish consumption and advisory awareness among Burmese refugees residing in the 4 counties of the Milwaukee AOC found that most were unaware of local and state safe-eating fish advisories and limits.²¹ During 2021, our team conducted a focus group to understand the influence of culture, attitudes, and beliefs on the fish consumption habits of Asian women of childbearing age (WCBA) who resided in the 4 counties of the Milwaukee AOC.²² Focus group participants reported eating local sportfish (fish caught in local waters by participants or persons they knew) because of availability, taste, and cost savings. All participants were aware of contaminant risks in fish. However, only a limited number had specific knowledge of fish consumption advisories, and many believed they did not have the self-efficacy to avoid contaminants. Focus group participants who reported high self-efficacy were more willing to follow health messages.²²

As a quantitative complement to our focus group study, we conducted a cross-sectional survey to better understand fish consumption choices and fish advisory awareness among Asian WCBA who reside in the Milwaukee area.

Table 1. Demographic Characteristics of 153 Asian Women of Childbearing Age by Ethnicity — Milwaukee, Wisconsin, January 1, 2022–January 31, 2023

	Total (N=153)	Chinese (N=37)	Filipino (N=12)	Hmong (N=52)	Karen (N=52)
Age, years; mean (SD)	34 (8.3)	38 (9.3)	37 (6.1)	34 (8.1)	29 (6.5)
Years in the United States, mean (SD)	20 (13)	18 (11)	22 (13)	33 (7.3)	8.3 (3.2)
Years in Milwaukee area, mean (SD)	14 (11)	9.8 (8.5)	14 (7.2)	25 (11)	7.2 (3.2)
Household income, ^a No. (%)					
≤\$24,999	21 (14)	4 (11)	1 (8)	5 (10)	11 (21)
\$25,000–\$49,999	51 (33)	1 (3)	2 (17)	10 (19)	38 (73)
\$50,000–\$74,999	19 (12)	5 (14)	2 (17)	10 (19)	2 (4)
\$75,000–\$99,999	22 (14)	5 (14)	4 (33)	12 (23)	1 (2)
≥\$100,000	40 (26)	22 (59)	3 (25)	15 (29)	0
Education, No. (%)					
No high school diploma	27 (18)	1 (3)	0	1 (2)	25 (48)
High school diploma or GED	29 (19)	3 (8)	1 (8)	7 (13)	18 (35)
Some college	15 (10)	1 (3)	1 (8)	10 (19)	3 (6)
Associate or bachelor's degree	56 (37)	16 (43)	7 (58)	27 (52)	6 (12)
Postgraduate, professional, or doctoral degree	26 (17)	16 (43)	3 (25)	7 (13)	0
Employment, No. (%)					
Full-time	82 (54)	18 (49)	7 (58)	42 (81)	15 (29)
Part-time	30 (20)	11 (30)	1 (8)	6 (12)	12 (23)
Unemployed	41 (26)	8 (22)	4 (33)	4 (8)	25 (48)
Does anyone in your household use SNAP or WIC services, No. (%)					
Yes	51 (33)	2 (5)	3 (25)	11 (21)	35 (67)
No	102 (67)	35 (95)	9 (75)	41 (79)	17 (33)
Cigarette use, No. (%)					
Every day	3 (2)	0	0	3 (6)	0
Some days	1 (1)	0	0	1 (2)	0
Not at all	149 (97)	37 (100)	12 (100)	48 (92)	52 (100)

Abbreviations: GED, General Educational Development; SNAP, Supplemental Nutrition Assistance Program; WIC, Women, Infants, and Children.

^aParticipants were asked whether their per year income was <\$15,000; \$15,000–\$24,999; \$25,000–\$34,999; \$35,000–\$49,999; \$50,000–\$74,999; \$75,000–\$99,999; or ≥\$100,000. Categories were collapsed as shown above based on sample size.

METHODS

Recruitment and Eligibility

The Wisconsin Department of Health Services (DHS) conducted this survey during January 1, 2022–January 31, 2023. Participants were recruited through community-based convenience and snowball sampling. Community advisory group members, schools, DNR listservs, and community organizations distributed recruitment materials to potentially eligible persons. We also asked participants who completed the survey to recruit additional participants within their social networks.

Eligible participants must have met the following criteria: (1) residing ≥1 year in the following Wisconsin counties: Milwaukee, Waukesha, Washington, or Ozaukee; (2) female; (3) self-identified as 1 of 4 major Asian ethnicities in the Milwaukee area: Chinese, Filipino, Hmong, or Karen; (4) aged 18 to 50 years; (5) had consumed ≥1 meal of fish caught from waterbodies in Wisconsin in the last 12 months by the participant or someone the participant knows; (6) the only member of their household to participate in

Table 2. Fish Consumption During the Preceding Year of 153 Asian Women of Childbearing Age by Ethnicity – Milwaukee, Wisconsin, January 1, 2022–January 31, 2023

	Total ^a (N=153)		Chinese (N=37)		Filipino (N=12)		Hmong (N=52)		Karen (N=52)	
	Median Annual Meals (IQR)	No. (%) Who Exceeded Consumption Advisories	Median Annual Meals (IQR)	No. (%) Who Exceeded Consumption Advisories	Median Annual Meals (IQR)	No. (%) Who Exceeded Consumption Advisories	Median Annual Meals (IQR)	No. (%) Who Exceeded Consumption Advisories	Median Annual Meals (IQR)	No. (%) Who Exceeded Consumption Advisories
Wisconsin sport-caught	11 (5–23)	12 (8)	10 (4–20)	1 (3)	24 (14–33)	0	10 (5–26)	7 (13)	10 (4–19)	2 (4)
Milwaukee sport-caught	6 (2–18)	50 (33)	6 (2–12)	15 (41)	11 (2–21)	3 (25)	5 (1–14)	12 (23)	7 (3–19)	20 (38)
Store-purchased	20 (9–46)	33 (22)	54 (27–80)	13 (35)	33 (20–62)	3 (25)	14 (6–25)	7 (13)	16 (9–31)	10 (19)
All fish ^b	40 (18–64)	71 (46)	63 (39–90)	22 (59)	72 (46–89)	5 (42)	29 (15–51)	18 (35)	31 (17–49)	26 (52)

Abbreviation: IQR, interquartile range.

^aThe total number of fish meals per participant was calculated as a tally of self-reported meals eaten of all species from each source in the preceding year.

^bThe total number of all fish meals was the sum of Wisconsin sportfish (including Milwaukee Estuary Area of Concern sportfish) and store-purchased fish). The total number of participants exceeding advisories was the number reporting consumption of any Wisconsin, Milwaukee area, or store-purchased fish above advisory levels.

the telephone survey; and (7) had not participated in a previous project about fish consumption with Wisconsin DHS.

Interested participants completed a screening survey to determine eligibility. Screening surveys written in English, Chinese, and Hmong were administered through REDCap instruments hosted by DHS. Based on community feedback, Filipino participants received information in English. As many persons in the Karen community do not have reliable access to email, screening forms written in Karen were administered by mail.

Data Collection

Trained interviewers administered the survey in each participant's preferred language (English, Chinese, Hmong, or Karen) by telephone. Prior to each interview, we mailed or emailed visual aids to participants that included a map of the waterbodies in the Milwaukee AOC and photographs of each fish species or variety evaluated. Survey items assessed participant demographics, fish consumption habits, health beliefs about fish, and awareness of fish advisories. Participants received a \$50 gift card for completing the survey.

Self-Reported Fish Consumption During Preceding Year

We assessed consumption of 27 sportfish species and 13 store-purchased fish varieties. For each sportfish species, interviewers asked, "In the past 12 months, how many times did you eat [species] from Wisconsin waterbodies?" Then, if participants reported any consumption of the species in Wisconsin waterbodies, the question was repeated for the Milwaukee AOC. Participants also reported their consumption of several store-purchased fish species.

Table 3. Fish Consumption Behaviors and Behavior Changes Among Asian Women of Childbearing Age – Milwaukee, Wisconsin, January 1, 2022–January 31, 2023

	Total (N=153)	Chinese (N=37)	Filipino (N=12)	Hmong (N=52)	Karen (N=52)
No. Responding "Yes" (%)					
Have you ever made the following changes to avoid mercury or polychlorinated biphenyls (PCBs)?					
Eaten fewer fish meals	60 (39)	13 (35)	4 (33)	27 (52)	16 (31)
Eaten different types or species of fish	76 (50)	23 (62)	6 (50)	22 (42)	25 (48)
Avoided eating certain parts of fish (head, fat, belly, skin)	80 (52)	17 (46)	3 (25)	27 (52)	33 (63)
Avoided eating fish from some fishing locations	78 (51)	21 (57)	4 (33)	26 (50)	27 (52)
No. Responding "Sometimes," "Very Often," or "Always" (%)					
When preparing fish, how often do you or the person who prepares your fish use:					
Skin of the fish	132 (86)	34 (92)	11 (92)	42 (81)	45 (87)
Head of the fish	119 (78)	28 (76)	8 (67)	42 (81)	41 (79)
Guts, organs, or other innards of the fish	20 (13)	1 (3)	1 (8)	7 (13)	11 (21)
Belly fat of the fish	20 (13)	1 (3)	1 (8)	7 (13)	11 (21)
When cooking fish, how often do you or the person who prepares your fish:					
Smoke or dry fish	41 (27)	7 (19)	5 (42)	12 (23)	17 (33)
Pickle fish	9 (6)	2 (5)	0	3 (6)	4 (8)
Use fish to make fish paste	7 (5)	2 (5)	1 (8)	1 (2)	3 (6)
Pan fry	129 (84)	29 (78)	11 (92)	47 (90)	42 (81)
Grill, or roast fish	106 (69)	21 (57)	11 (92)	41 (79)	33 (63)
Deep fry fish	109 (71)	15 (41)	9 (75)	44 (85)	41 (79)
Boil or poach fish	98 (64)	22 (59)	7 (58)	46 (88)	23 (44)
Braise fish	55 (36)	18 (49)	2 (17)	14 (27)	21 (40)
Use fish or fish parts to make broth, stock, curry, or soup	90 (59)	15 (41)	6 (50)	27 (52)	42 (81)

Fish Preparation and Consumption Behaviors, and Fish Consumption Advisory Awareness

Participants reported whether they had made fish consumption changes to avoid contaminants, including eating fewer fish meals, eating different types of fish, avoiding certain parts of fish, or avoiding fish caught in certain locations. Using a 5-point Likert scale, participants reported how often they consumed parts of fish that might increase contaminant exposure (ie, skin, head, guts, organs or other innards, or belly fat). They reported which preparation methods they used to grill or roast fish, including an EPA-recommended

option to reduce contaminant exposure. Additionally, the EPA recommends avoiding several fish preparation options, including pan frying, deep frying, boiling or poaching, braising, or using fish or fish parts to make broth, stock, curry, or soup. Finally, 3 options without an associated EPA recommendation, including smoking or drying fish, pickling fish, and using fish to make fish paste were included.²³

Participants who indicated a prior pregnancy described any changes to their fish consumption during pregnancy and breastfeeding. Finally, all participants reported their awareness of sportfish advisories for Wisconsin and the Milwaukee AOC and FDA or EPA limits for store-purchased fish. Those who were aware of any fish advisory answered items assessing attitudes towards the advisories.

Fish Consumption Limits

For Wisconsin sportfish, we used limits provided by the Wisconsin DNR for the Milwaukee AOC, and for general Wisconsin Inland Waters.⁵ For store-purchased fish, we used fish consumption limits set by the FDA and EPA.¹ For fish consumption advisories' limits for consuming fish of the same species but different sizes (eg, ≤6 meals per year for walleye >22 inches and ≤1 meal per month for walleye <22 inches), we used the more restrictive limit. For species that did not have a specific limit for the Milwaukee AOC, we used the Wisconsin Inland Waters limit.⁵

Statistical Analysis

We summarized participant characteristics and self-reported beliefs, behaviors regarding fish consumption during pregnancy and while breastfeeding, and knowledge of fish consumption advisories. We calculated means and standard deviations for continuous variables and frequencies and percentages for categorical variables. We dichotomized Likert scale items for analysis (eg, “extremely effective” or “very effective” vs “somewhat effective,” “a little effective,” and “not at all effective”).

For fish consumption in the preceding

Table 4. Fish Consumption Behavior During Most Recent Pregnancy Among Asian Women of Childbearing Age — Milwaukee, Wisconsin, January 1, 2022–January 31, 2023

	Total (N = 153)	Chinese (N = 37)	Filipino (N = 12)	Hmong (N = 52)	Karen (N = 52)
Have you ever been pregnant?					
Yes, n (%)	113 (74)	25 (68)	12 (100)	36 (69)	40 (77)
If you have ever been pregnant, did you eat fish during your most recent pregnancy?					
Yes, n (%)	89 (79)	22 (88)	10 (83)	21 (58)	36 (90)
If you reported consuming fish during your most recent pregnancy, what was the frequency of your fish consumption during that pregnancy vs before pregnancy?					
Decrease, n (%)	26 (30)	5 (23)	4 (40)	8 (38)	9 (26)
Same, n (%)	55 (63)	13 (59)	6 (60)	10 (48)	26 (74)
Increase, n (%)	7 (8)	4 (18)	0 (0)	3 (14)	0 (0)
In the time before your most recent pregnancy, did you eat the same fish species?					
Yes, n (%)	79 (89)	19 (86)	8 (80)	18 (86)	34 (94)
Did you avoid eating certain fish species during your most recent pregnancy?					
Yes, n (%)	31 (35)	7 (32)	6 (60)	10 (48)	8 (22)
I didn't eat fish during my most recent pregnancy because (n)	24	3	2	15	4
I was concerned that the chemicals in fish were harmful to my baby's health, n (%)	19 (79)	2 (67)	2 (100)	13 (87)	2 (50)
I did not like the taste of fish meals, n (%)	1 (4)	0 (0)	0 (0)	0 (0)	1 (25)
I was concerned that eating fish during pregnancy can make delivery difficult, n (%)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
I did not have time to clean and prepare fish, n (%)	3 (13)	1 (33)	0 (0)	2 (13)	0 (0)

Table 5. Fish Consumption Behavior While Breastfeeding Among Asian Women of Childbearing Age by Ethnicity — Milwaukee, Wisconsin, January 1, 2022–January 31, 2023

	Total	Chinese	Filipino	Hmong	Karen
Of participants who reported a previous pregnancy (n):	112	25	12	36	39
Did you breastfeed after your last pregnancy? ^a					
Yes, n (%)	75 (67)	23 (92)	8 (67)	21 (58)	23 (59)
Of participants who reported breastfeeding after most recent pregnancy (n):	75	23	8	21	23
Did you eat fish when you were breastfeeding?					
Yes, n (%)	57 (76)	22 (96)	7 (88)	9 (43)	19 (83)
Of participants who reported eating fish while breastfeeding after most recent pregnancy (n):	57	22	7	9	19
Fish consumption frequency while breastfeeding vs before pregnancy					
Decrease, n (%)	8 (14)	5 (23)	0 (0)	3 (33)	0 (0)
Same, n (%)	43 (75)	12 (55)	7 (100)	6 (67)	18 (95)
Increase, n (%)	6 (11)	5 (23)	0 (0)	0 (0)	1 (5)
While you were breastfeeding, did you eat the same fish species?					
Yes, n (%)	50 (88)	18 (82)	6 (86)	8 (89)	18 (95)
Did you avoid eating certain fish species while breastfeeding?					
Yes, n (%)	39 (68)	8 (36)	3 (43)	2 (22)	5 (26)
Of participants who breastfed after their most recent pregnancy and reported not eating fish while breastfeeding (n):	18	1	1	12	4
I didn't eat fish while breastfeeding because I was concerned that chemicals in fish were harmful to my baby's health.					
Yes, n (%)	9 (50)	1 (100)	1 (100)	5 (42)	2 (50)
I didn't eat fish while breastfeeding because I did not have time to clean and prepare fish.					
Yes, n (%)	2 (11)	0 (0)	1 (100)	1 (8)	0 (0)
I didn't eat fish while breastfeeding because I did not like the taste.					
Yes, n (%)	3 (17)	0 (0)	0 (0)	2 (17)	1 (25)

^aOne participant selected “prefer not to answer.”

year, we calculated the median and range for each sport-caught and store-purchased species. For each individual species, we compared self-reported consumption to advisories to determine the number of participants reporting consumption above the advisory. For all species, limits for weekly or monthly consumption were multiplied by 52 or 12, respectively, to calculate limits for annual consumption.

We compared the proportion of Asian WCBA aware of Milwaukee, Wisconsin, and EPA and FDA advisories with consumption over advisory limits for any Milwaukee or store-purchased species, respectively. We conducted chi-square tests to determine whether awareness of advisories was associated with consumption over advisory limits in the preceding year. Analyses were completed using R version 4.1.3 (R Core Team, 2021). This activity was reviewed by the Centers for Disease Control and Prevention (CDC), deemed not research, and conducted consistent with applicable federal law and CDC policy (45 CFR part 46.102(l)(2), 21 CFR part 56; 42 USC Sect 241(d); 5 USC Sect 552a; 44 USC Sect 3501 et seq).

RESULTS

A total of 153 Asian WCBA participated, including 37 Chinese, 12 Filipino, 52 Hmong, and 52 Karen. The average participant age was 34 years (SD=8.3 years) (Table 1). Overall, participants had resided in the Milwaukee area and United States for an average of 14.4 years (SD=11.1 years) and 19.9 years (SD=12.9 years), respectively. Hmong participants had resided in the Milwaukee area an average of 25 years, whereas Karen participants had resided in the Milwaukee area an average of 7.2 years. Compared with Chinese and Filipino participants, a higher proportion of Hmong and Karen participants were in lower income and education categories. Approximately three-quarters of Chinese, Filipino, and Hmong participants were employed full- or part-time, whereas approximately half (48%) of Karen participants were unemployed (Table 1).

Fish Consumption

Overall, participants reported annually consuming a median of 11 (interquartile range [IQR] 5-23) Wisconsin sportfish meals, including 6 (IQR 2-18) from the Milwaukee AOC, and a median of 20 store-purchased fish meals (IQR 9-46). Among the 4 ethnic groups, Chinese participants reported the highest store-purchased fish consumption, and Filipino participants reported the highest sportfish consumption (Table 2). One-third of participants (n=50, 33%) reported consumption above advisory levels for ≥ 1 species from the Milwaukee AOC (Table 2). For store-purchased fish, 33 participants (22%) reported consumption above advisory levels for ≥ 1 store-purchased species (Table 2). However, average self-reported consumption for each individual fish species was low; only 1 sport-caught species (total Wisconsin white bass) and 2 store-purchased species (salmon and tilapia) had median

consumption above zero (Supplemental Tables 1 and 2). Most participants who reported fish consumption exceeding advisory levels reported a limited number of meals for a fish species with zero limit (ie, species listed as, “do not eat” or “choices to avoid”). For example, 44 (29%) participants reported eating carp (listed “do not eat”) from the Milwaukee AOC (Supplemental Table 1). However, among this group, the median annual carp consumption was only 2 meals (Supplemental Table 1). For store-purchased fish, 23 participants ate king mackerel, 4 ate shark, 10 ate swordfish, and 3 ate tilefish—all of which were classified as fish “choices to avoid” (Supplemental Table 2).

Fish Preparation Behaviors

Certain participants reported they had made behavior changes to avoid harmful contaminants from fish. Sixty (39%) participants reported eating fewer fish meals, 76 (50%) reported eating different species of fish, and 80 (52%) avoided eating certain parts of the fish. However, most participants reported keeping the skin (86%) or head (78%) of fish at least some or most of the time while preparing fish. Additionally, 146 (95%) participants reported sometimes using cooking methods that can trap fat (and consequently, contaminants) within the fish. This included pan-frying (n=129, 84%), boiling or poaching (n=98, 64%), or using the fish in a broth or soup (n=90, 59%). Hmong participants (n=27, 52%) reported eating fewer fish meals to reduce contaminant exposure, compared with approximately one-third of Chinese, Filipino, and Karen participants. Other behavior changes varied across ethnic groups. For example, 21 (57%) Chinese participants reported avoiding certain types of fish or fish caught at certain locations, whereas 27 (52%) Karen participants reported avoiding eating certain parts of the body (Table 3).

Fish Consumption Changes During Pregnancy and Breastfeeding

Among 113 participants who reported a previous pregnancy, 89 (79%) reported eating ≥ 1 fish meal during their most recent pregnancy. Of these 89 women who did consume fish, 62 (70%) reported that fish consumption remained the same or increased during pregnancy. Although 79 (89%) did not change the species of fish they consumed during pregnancy, 31 (35%) of 89 reported that they avoided certain fish species while pregnant.

Among 24 participants who did not eat fish during their most recent pregnancy, 19 (79%) reported that they avoided fish because of concerns that chemicals in fish were harmful (Table 4). Among 75 participants who reported breastfeeding after their last pregnancy, 57 (76%) consumed fish while breastfeeding. Of those, 49 (86%) reported fish consumption the same or higher while breastfeeding than before pregnancy, and most did not change the species they were eating. However, 39 (68%) reported avoiding certain species while breastfeeding (Table 5).

Awareness and Attitudes Regarding Fish Advisories

Only 29 (19%) respondents were aware of local fish consumption advisories, 39 (25%) were aware of Wisconsin sportfish advisories, and 34 (22%) were aware of FDA or EPA advisories. Karen participants had the lowest advisory awareness, with 2 (4%) aware of local advisories, 1 (2%) aware of state advisories, and zero aware of FDA or EPA advisories. Awareness was highest for Chinese and Filipino participants, of whom approximately 33% (16/49) were aware of local advisories, 47% (23/49) were aware of state advisories, and 33% (17/49) were aware of FDA or EPA advisories (Supplemental Figure). Among 29 respondents who were aware of local advisories, 10 (34%) reported that they knew “some,” “quite a bit,” or “a great deal” about the advisories. Of 39 respondents who were aware of Wisconsin sportfish advisories, 10 (26%) reported that they knew at least “some,” “quite a bit,” or “a great deal” about the advisories. Among 34 participants who were aware of FDA or EPA advisories, 11 (32%) reported that they knew “some,” “quite a bit,” or “a great deal” about the advisories.

Overall, sportfish consumption did not vary meaningfully by advisory awareness. Eight (28%) participants who were aware of Milwaukee advisories and 41 (34%) participants who were not aware of Milwaukee advisories consumed ≥ 1 meal above Milwaukee AOC advisories ($P=0.74$). Few participants reported consumption above Wisconsin sportfish advisory limits, including 4 (10%) of 39 participants who were aware of Wisconsin advisories and 8 (7%) of 114 who were not aware of Wisconsin advisories ($P=0.48$). For store-purchased fish, 14 (41%) of 35 participants who reported awareness of FDA or EPA fish advisories ate ≥ 1 “choices to avoid” fish meal, compared with 19 (16%) of 114 participants who were not aware of store-purchased fish advisories ($P=0.28$).

DISCUSSION

From our survey of a multiethnic cohort of Asian WCBA in the Milwaukee area, we found that approximately half of participants reported consumption of ≥ 1 store-purchased or sportfish meal above recommended levels. Approximately a quarter of participants were aware of any fish consumption advisory. Although approximately half of participants reported past changes to their fish consumption to avoid contamination, many also reported using unsafe fish cooking methods that can trap contaminants in fish.

Fish are a good source of important nutrients and can improve overall health.²⁴ In the United States, non-Hispanic Asian persons are approximately 3 times as likely as any other racial and ethnic group to eat seafood at least twice per week.²⁵ However, risks can be associated with fish consumption, because chemical pollutants from the environment can accumulate in the tissues of fish, such as in fat tissue.^{26,27} Both risks and benefits of sportfish consumption are enhanced in WCBA.²⁴ In Milwaukee’s Asian communi-

ties, clinicians should engage with communities to ensure that the highest-risk groups are aware of advisories. Partnership with community groups and leaders was instrumental to our recruitment efforts for this survey, and these same groups may be essential for future educational efforts.

Most participants were not aware of local, state, or national fish consumption advisories. By comparison, in a survey of mostly White, male anglers, 72.8% were aware of Wisconsin advisories, and 60.1% were aware of Milwaukee advisories.²⁸ Low advisory knowledge—even among those who were familiar with advisories—might explain why awareness of advisories was not associated with sportfish consumption behavior. For store-purchased fish, those who reported advisory awareness reported higher consumption of high-contaminant fish. Despite these findings, participants who were aware of advisories reported that they were easy to understand and follow. Health care providers and public health practitioners can share advisory information (Supplemental Table 3) to increase awareness of fish consumption advisories among Milwaukee’s Asian WCBA.

Strengths and Limitations

This project has multiple limitations. First, we recruited participants by convenience and snowball sampling, and findings might not represent their overall WCBA communities. Second, food frequency questionnaires have been shown to underestimate overall consumption.^{29,30} We attempted to increase the reliability and validity of our survey by providing pictures of fish species and a map of the Milwaukee AOC. However, misclassification of fish consumption data was likely. Third, participant recruitment fell short of recruitment goals for the Chinese and Filipino communities. Findings for these groups might not represent community views or behaviors. However, although the limited number of Filipino participants in this study reported higher average consumption than Hmong or Karen participants, community feedback suggests that their recruitment shortfall occurred because sportfishing is not common among Milwaukee’s Chinese and Filipino communities. Thus, the findings of this survey might not be as relevant to them as it is to Hmong and Karen communities. Despite its limitations, however, our findings provide disaggregated insight into the fish consumption behaviors of Milwaukee’s heterogeneous Asian communities. With multilingual surveys conducted over the phone and screening surveys conducted both on paper and online, we were able to conduct a representative evaluation.

CONCLUSIONS

This study provides new insight into the fish consumption habits, health beliefs, and advisory awareness among a multiethnic sample of Asian WCBA in Milwaukee. Approximately half of participants reported ≥ 1 fish meal above advised levels for the species and location. We also found limited awareness of fish advisories, increased risk for exposure to contaminants during pregnancy, and limited

adherence to safe fish preparation practices among all groups. These findings underscore the need for educational materials on safe fish consumption tailored to heterogeneous Asian WCBA communities.

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Appendix: Supplemental materials are available at www.wmjonline.org.

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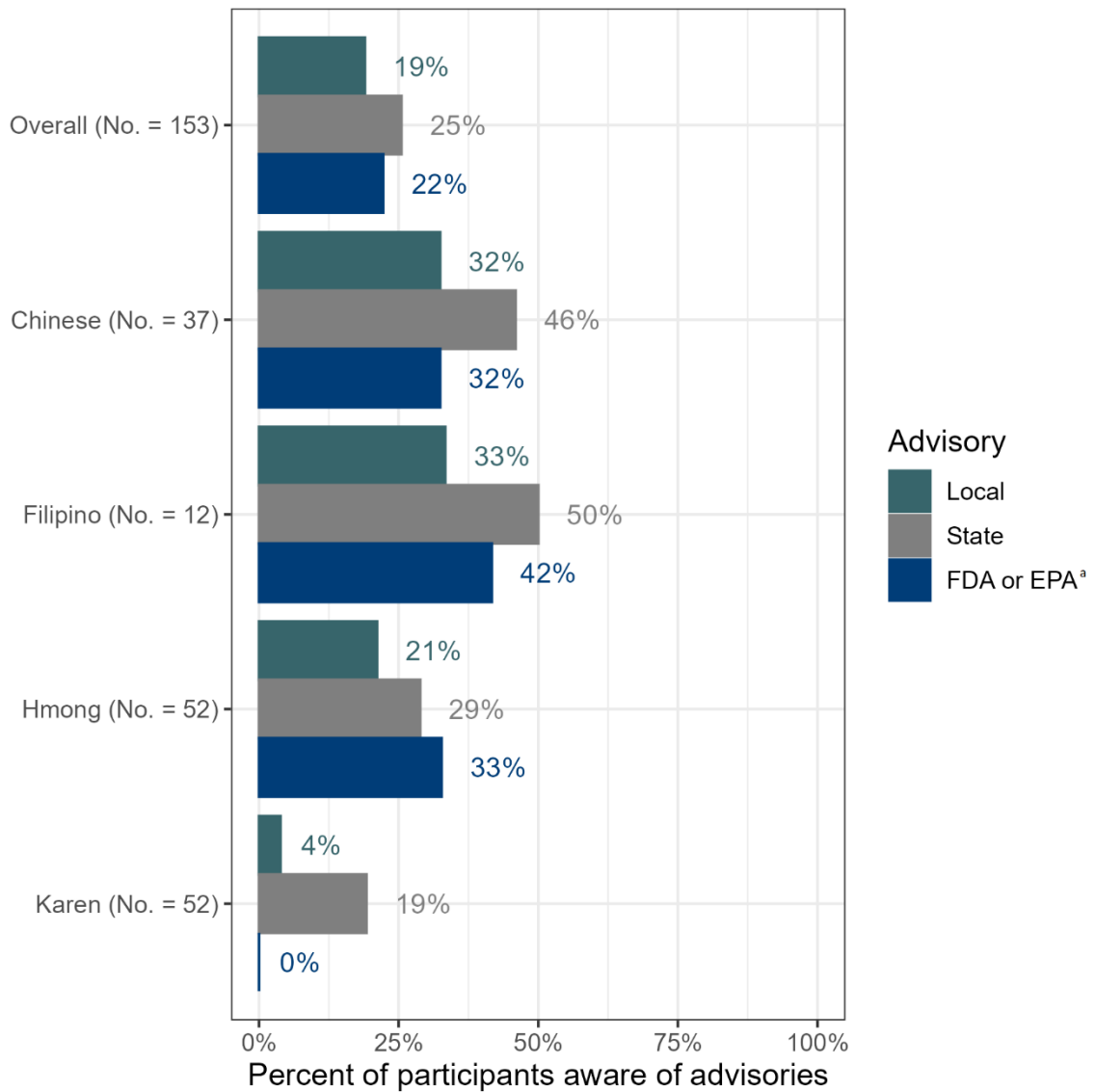
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Supplemental Figure. Awareness of sportfish advisories among Asian women of childbearing age by ethnicity — Milwaukee, Wisconsin, January 1, 2022–January 31, 2023



^aFDA and EPA: U.S. Food and Drug Administration and U.S. Environmental Protection Agency.

Supplemental Table 1. Proportion of participants exceeding consumption advisories and median consumption during the preceding year of individual fish species fresh-caught in Milwaukee estuary area of concern and Wisconsin waters among Asian women of childbearing age — Milwaukee, Wisconsin, January 1, 2022–January 31, 2023

	Milwaukee Estuary Area of Concern			Wisconsin		
	Recommended annual maximum meals ^a	No. (%) women who exceeded consumption advisories	Median number of annual meals (Range)	Recommended annual maximum meals ^b	No. (%) women who exceeded consumption advisories	Median number of annual meals (Range)
Black Crappie	6	2 (1)	0 (0–12)	52	0	0 (0–40)
Bluegill	12	0	0 (0–12)	52	0	0 (0–20)
Brown Trout	12	0	0 (0–7)	52	0	0 (0–7)
Buffalo	12	1 (1)	0 (0–25)	12	1 (1)	0 (0–25)
Bullhead	12	0	0 (0–10)	52	0	0 (0–10)
Carp	0	44 (29)	0 (0–25)	12	1 (1)	0 (0–25)
Chinook	12	0	0 (0–10)	12	0	0 (0–12)
Salmon						
Chubs	12	0	0 (0–8)	12	0	0 (0–8)
Coho Salmon	12	0	0 (0–12)	12	0	0 (0–12)
Lake Trout	52	0	0 (0–6)	52	0	0 (0–6)
Lake White	12	1 (1)	0 (0–20)	12	2 (1)	0 (0–36)
Large Mouth Bass	12	0	0 (0–12)	12	0	0 (0–12)
Muskellunge	0	3 (2)	0 (0–3)	0	3 (2)	0 (0–3)
Northern Pike	12	0	0 (0–2)	12	0	0 (0–5)
Rainbow Trout	52	0	0 (0–8)	52	0	0 (0–12)

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Red Horse	6	0	0 (0-4)	12	0	0 (0-4)
Rock Bass	12	1 (1)	0 (0-24)	52	0	0 (0-24)
Sheepshead	12	1 (1)	0 (0-25)	12	2 (1)	0 (0-25)
Small Mouth Bass	12	0	0 (0-12)	12	0	0 (0-12)
Smelt	12	0	0 (0-6)	12	0	0 (0-6)
Walleye	6	1 (1)	0 (0-10)	12	0	0 (0-12)
White Bass	12	2 (1)	0 (0-50)	12	5 (3)	2 (0-50)
White Perch	12	0	0 (0-7)	12	0	0 (0-7)
White Sucker	6	1 (1)	0 (0-8)	12	0	0 (0-8)
Yellow Perch	52	0	0 (0-6)	12	1 (1)	0 (0-20)

^a Advisories for fish consumption in the Milwaukee Estuary Area of Concern [5]

^b Advisories for fish consumption in Wisconsin overall [5]

Supplemental Table 2. Proportion of participants exceeding consumption advisories and median consumption during the preceding year of individual store-purchased fish species among Asian women of childbearing age — Milwaukee, Wisconsin, January 1, 2022–January 31, 2023

	Recommended annual maximum^a	No.(%) women who exceeded consumption advisories	Median number of annual meals (range)
Cod	156	0	0 (0–48)
Halibut	52	0	0 (0–24)
King Mackerel	0	23 (15)	0 (0–48)
Pollock	156	0	0 (0–20)
Salmon	156	0	3 (0–104)
Shark	0	4 (3)	0 (0–2)
Swordfish	0	10 (7)	0 (0–6)
Tilapia	156	1 (1)	3 (0–250)
Tilefish	0	3 (2)	0 (0–3)
Tuna: Albacore	52	0	0 (0–48)
Tuna: light	156	0	0 (0–100)
Tuna: fresh or frozen	52	0	0 (0–48)

^a Fish advisories come from the U.S. Food and Drug Administration’s (FDA) and U.S. Environmental Protection Agency’s (EPA) resource “Advice about eating fish.” “Best Choices” are recommended to be eaten 2 or 3 times per week, or up to 156 servings per year. “Good Choices” are recommended to be eaten 1 time per week (up to 52 per year), and “Choices to avoid” are not safe at any level of consumption (0 servings per year) [1].

Supplemental Table 3. List of Fish Consumption Advisories Referenced in this Manuscript

Advisory	Website ^a
Milwaukee Estuary Area of Concern	Wisconsin Department of Natural Resources (DNR) Query Tool (select “Milwaukee Area Estuary from Estabrook Falls to Harbor Mouth including Menomonee and Kinnickinnic Rivers): https://apps.dnr.wi.gov/fishconsumptionadvisoryquery/ More information on the Milwaukee Estuary Area of Concern: https://dnr.wisconsin.gov/topic/GreatLakes/Milwaukee.html
Wisconsin State Waters	Choose Wisely Publication https://widnr.widen.net/s/s6mkcq6tmr/pub_fh_824_choosewisely
FDA/EPA	Advice about Eating Fish: https://www.fda.gov/food/consumers/advice-about-eating-fish

a. Website URLs accurate as of September, 2024.