BIOMONITORING PILOT STUDY
HAIR MERCURY LEVELS IN CLIENTS ATTENDING THE SPECIAL SUPPLEMENTAL NUTRITION PROGRAM FOR WOMEN, INFANTS AND CHILDREN (WIC) PROGRAM

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HAWAII STATE
DEPARTMENT
OF HEALTH

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Summary

In 2008 and 2009, hair mercury levels were measured in 643 participants of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Fish consumption information was collected at the same time by questionnaire. Hair mercury results ranged between less than the limit of quantitation to 10.35 ppm. The average hair mercury in adults was 1.4 ppm and 0.76 ppm in children. Nineteen percent of children and 42% of adults had hair mercury levels that equaled or exceeded the EPA's hair reference level of 1.2 ppm. Nationally, approximately 3.5 % of women exceed EPA's reference concentration in blood. Fifty four percent of adults and 63% of children reported eating less than the USDA 2015-20 *Dietary Guidelines for Americans* recommended 2 servings of fish a week.

Background

Mercury is persistent and ubiquitous in the environment. Methyl mercury, one of the organic forms of mercury can bioaccumulate up the food chain leading to high concentrations in predatory fish. The primary source of exposure to humans is the consumption of fish and marine mammals.

The National Academy of Sciences (NRC, 2000) reviewed the toxicological effects of methyl mercury to prepare recommendations on the establishment of a scientifically appropriate reference dose. The information summarized here is cited from the NAS review. Methyl mercury is a developmental neurotoxicant. Studies of health effects associated with extremely high mercury exposures that occurred during the Minamata poisoning in Japan and Iraq seed grain poisoning showed more serious effects in offspring that were exposed and in some cases at lower exposure levels than in adults. Two epidemiological studies conducted in the Faroe Islands (Grandjean et al. 1998, 1999) and New Zealand (Kjellstrom et al. 1986, 1989) found evidence of neurotoxicity in the offspring of women exposed to chronic low dose methyl mercury through fish consumption. The endpoint found to be associated with methyl mercury exposure through fish consumption was poor performance on some neurobehavioral tests. A third study, conducted in the Seychelles islands (Davidson et al. 1995, 1998) did not find such an association. The NAS used the results from the Faroe Island studies to derive a reference dose of 0.1 ug/kg per day to protect against adverse developmental neurotoxicological effects. This corresponds to a blood

mercury concentration of 5.8 ug/L.

Fish is an important food source in Hawaii. The Hawaii WIC Program has taken a leading role in the education of families on this important public health concern. Sampling by the Hawaii Department of Health (DOH) in 2003 indicated that ahi and other large pelagic species contain significant levels of methyl mercury. Based on these results, a fish advisory was developed for pregnant women and children advising these populations to restrict consumption of the higher mercury fish. The DOH distributes approximately 10,000 fish advisory brochures a year.

Despite the education campaign, data from two sources indicate that mercury exposure levels in Hawaii exceed national levels. Data from the DOH's Heavy Metal and Pesticide Exposure Database indicate that more than 50% of women of childbearing age that were tested for mercury from 2002-2006, have mercury blood levels that exceed EPA's reference concentration of 5.8 ug/L. Sato et al. (2006) measured mercury in cord blood of 188 women giving birth at Kapiolani Medical Center in Honolulu, Hawaii. They found that 28 % of the samples exceeded the reference concentration. Nationally, approximately 6 % of women exceed EPA's reference concentration. Therefore, a need exists to better characterize mercury exposures in Hawaii with the goal of designing education and outreach efforts to minimize risks from mercury exposure. A biomonitoring program is the most effective strategy to accomplish this task.

Methyl mercury accumulates in growing scalp hair. Concentrations in hair are proportional to levels in blood but are about 250 times higher (Clarkson, 2002). Hair provides a convenient specimen for biomonitoring because it is non-invasive and readily obtainable.

Study Population

The target population for this study is women and children enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). The WIC program serves children from 0 to 5 years of age, pregnant and postpartum teens and adult women. Women do not have to be pregnant to participate. WIC currently serves approximately 26,949 women, infants, and children in Hawaii (including over 2404 pregnant women). The initial goal was to enroll only WIC clients. However, there was interest from mothers, guardians, and grandmothers of WIC clients not enrolled in the program to be tested. We included these participants in the testing, but subsequently don't have some demographic information.

Recruitment into Study and Procedures

In 2008, staff from the Biomonitoring Project coordinated with the WIC Program to set up information tables at various WIC clinics throughout the islands to recruit volunteers to participate in the study. Clients were told that they would be given their hair mercury results along with any nutritional counseling if the results were elevated.

Each participant who agreed to be in the study was asked to fill out a questionnaire and an informed consent form (see attached). After informed consent had been completed, the biomonitoring staff collected hair and put it into a labeled Ziploc bag. Hair was transported to the Hawaii State Laboratory with chain of custody procedures.

Privacy

Each participant was given a unique numerical identifier linked to her WIC identification. The DOH principal investigator (Barbara Brooks, Ph.D.), UH research assistant (Yesid Romero Ph.D., MD),WIC nutritionist (Sher Pollack, M.S., R.D.) and WIC epidemiologist (Dr. Don Hayes) had access to the mercury results linked to personal contact information.

Reports produced from this information gave group information and did not identify specific individuals. Confidential information is kept in locked cabinets or on password protected computers.

Informed Consent

Informed consent was obtained from each survey participant following guidelines approved by the University of Hawaii Committee on Human Studies and Hawaii Department of Health. Prior to testing, each participant and a parent or legal guardian of each minor participant was required to sign an informed consent. Pregnant and postpartum preteens ages 12 to 17 were also required to sign an assent form. A copy of these forms is attached.

Survey Forms

In addition to completing consent/assent forms, each participant was asked a few questions to gather information.

Sample Collection

Approximately 50-100 strands of hair (about 1/8 inch in diameter) were collected at the neck nape using stainless steel scissors. The hair strands were tied with dental floss at the scalp end of the hair and stored in a labeled Ziploc bag. After hair collection the hair samples were either stored in a file cabinet in a room that required a password to enter or immediately transported to the Hawaii State Laboratory with Chain of Custody form. The first 1 to 3 cm of the scalp end was cut and analyzed for mercury. This hair length represents approximately the past 1 to 3 months of mercury exposure (Oken, 2005).

Mercury Analysis

A hair sample is accurately weighed in a quartz sample boat and it is placed on the Milestone DMA-80 sample tray. The instrument inserts the sample into a contained reaction tube, dries it and then combusts the sample while trapping the mercury on a gold amalgamator. The combustion products are purged out of the reaction tube and then the amalgamator is heated to purge the mercury through the detector. Loss of volatile mercury compounds is essentially eliminated since there are no sample digestion steps.

Calibration solutions were prepared from a National Institute of Science and Technology (NIST)-traceable mercury standard and were used to make ten-point calibration curves. The assay results in µg of mercury from the curve divided by the sample weight in grams resulting in parts per million (ppm) of mercury in the sample. The Lower Limit of Quantitation (LOQ) of hair is at least 0.2 ppm of mercury and with a Relative Standard Deviation of ±6% and a 3 sigma of ±20%. The 0.2 ppm level is well below the 1.2 ppm concentration (1.2 ppm was established as not significantly harmful). There were 654 hair samples analyzed and one out of 10 split samples replicates (n = 61) were analyzed to check for subsampling variability. Internal lab quality control fortified samples (QC) and Standard Reference Materials (SRM) were run with each sample set. The QCs

(n = 106) plus the SRMs (n = 99) covered a full range of levels from 0.1 ppm to 23 ppm levels targeting the similar mercury levels detected in the samples. Together, these quality control samples (n= 205) resulted in an average of 98% recovery with a standard deviation of 9.5%.

This study was performed under CLIA guidelines. Although mercury is detected by the instrument at lower levels, the Limit of Quantitation (LOQ) is determined by signal to noise ratio and the standard deviation at that level. The variability increases as you get to lower values on the ten-point standard curve. Over time, precision measurements of the lowest standard resulted in too much scatter/lack of precision. After the first 50 tests, the LOQ was increased from 0.025 ppm to 0.20 ppm of mercury where there was less variability and the relative standard deviation (RSD) was ±6% with a resulting 3-sigma value within ±20% at the 0.20 ppm LOQ. The earlier reported low-level data between 0.025 to 0.2 ppm of mercury is valid but may have a greater variability.

Data Management, Analysis and Interpretation

The Environmental Protection Agency's Reference Dose (RfD) is 5.8 ug/L in blood. This is the level assumed to be without appreciable harm. The RfD was determined by applying an uncertainty factor of 10 to a dose (58 ug/L) that was the lower 95% confidence limit of a dose associated with an increase proportion of abnormal scores on the Boston Naming Test for children exposed in utero (NRC, 2000). The blood mercury level of 58 ug/L corresponds to a hair mercury concentration of 12 ppm and the RfD corresponds to a hair level of 1.2 ppm.

Women whose hair mercury levels exceed 5 ppm, which is slightly less than ½ of the level associated with developmental neurotoxicological effects were actively counseled through letters and follow up phone calls on ways to choose fish with lower levels of mercury. Free retesting was offered. All participants received a letter informing them of the hair mercury results. Additionally, DOH was available for consultation with the participant's primary care provider. Summary reports of the hair mercury levels were provided to each clinic at the end of the study.

The letter provided to the participants is shown below.

LINDA LINGLE
GOVERNOR OF HAWAI'I

CHIYOME L. FUKINO, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAI'I
DEPARTMENT OF HEALTH
P.O. Box 3378
HONOLULU, HAWAII 96801-3378

In reply, please refer to:
File:

Date

Dear XXXX-

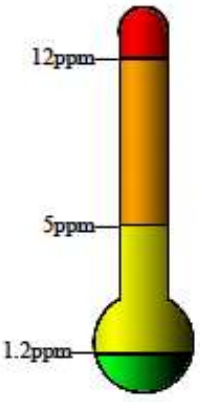
Thank you for participating in the Hair Analysis for Mercury and Arsenic Project of the Hawaii Department of Health. **The result of your hair mercury test is listed below.**

Results:

The amount of mercury measured in your hair sample was **X.X ppm** (parts per million).

- ☐ The result of your test was good, you should not change which fish you eat.
- ☐ We recommend you choose fish lower in mercury. Use the "Local Guide to Eating Fish Safely" pamphlet we have included with your test results to help choose fish low in mercury.
- ☐ We recommend you only eat fish listed as "eat any time" from the "Local Guide to Eating Fish Safely" pamphlet. We will call you or you can call our office at 586-4249 for more assistance.

The following points will help you understand what your level means:



- We don't expect a result of zero. Almost everyone has some mercury in their hair.
- A result of 12 ppm or higher is considered harmful for the developing brain. It may be ok for adults who won't become pregnant, but most people should change their eating habits to lower a level this high.
- A result between 1.2 ppm and 12 ppm does not necessarily mean that a developing baby will be affected because there is a built in safety factor. However, mercury has no health benefits in the body. We suggest that you take steps to lower your mercury levels, especially if you are pregnant or about to become pregnant. In order to prevent approaching the unsafe level of 12 ppm, we will contact you if your hair result is above 5 ppm to talk about steps that you can take to reduce your mercury.
- A result below 1.2 ppm is considered safe for anyone. This level was chosen as a guideline with a built-in safety factor.

(over)

If you have any questions about this study or about your result, we are happy to discuss them with you. Please feel free to contact us by e-mail at barbara.brooks@doh.hawaii.gov, or by phone at 586-4249. We will respond as quickly as possible to your questions.

Again, thank you for participating in this study. We hope you find the information in this letter to be useful, and we wish you the best.

Sincerely,

Barbara A. Brooks, Ph.D.
State Toxicologist

Data Analysis

The Excel data analysis package was used to evaluate the data. Values that were less than the limit of quantitation were assigned a value of the Lower Limit of Quantitation.

Results

Table 1 summarizes the number of adult and children participants, average age, hair mercury levels and number of participants exceeding EPA's reference level of 1.2 ppm as well as DOH's retesting level of >5 ppm. Six hundred and fifty four participants provided hair samples. Eleven samples are not included in the final data set because some of these were retests, several women were not of childbearing age and one sample had insufficient hair. Demographic data are missing from some of the participants because they were family members of WIC clients and not enrolled in the WIC program.

The average age of the children was 3.2 years and the average age of the adults was 30 years. The average adult mercury hair level of 1.40 ppm (geometric mean was 0.94 ppm) was almost double that of the children's hair level of 0.76 ppm (geometric mean 0.43 ppm). Forty two percent of the adults had mercury levels $\geq$ to 1.2 ppm, while 19 percent of the children $\geq$ to 1.2 ppm. Thirteen adults and 2 children had hair mercury levels $\geq$ 5 ppm. One of the children whose hair level exceeded 5 ppm was retested with a blood test and found not to have elevated mercury. That child also consumed little fish. The source of the elevated hair mercury level in that child was not determined. No participants had hair mercury levels that exceeded 12 ppm, the maternal hair level associated with subtle neurodevelopmental effects in children exposed in utero.

Table 1. Hair Mercury Results

Age Group	Number	Average Age [a](years)	Hair Mercury Average (ppm)	Hair Mercury, Geometric Mean (ppm)	Hair Mercury Range	Number of Non-Detects (<LOQ)[b]	Number and Percentage of Hair Samples≥1.2 ppm	Number of Hair Samples ≥5 ppm
Adults	406	30.03 (17.48-45.69)	1.40	0.94	<LOQ-10.35	19	170 (42%)	13
Children	237	3.19 (0.21-12.50)	0.76	0.43	<LOQ-7.00	39	45 (19%)	2

[a] Age data available for 367 adults and 228 children.
[b] (LOQ) Lower Limit of Quantitation ranged between 0.025- 0.2 parts per million.

Figure 1 shows the racial makeup of the adult participants. Asians comprised the largest percentage of adult participants at 35%, followed by Multiple (33%), Hawaiian Pacific Islander at 21% and White at 11%.

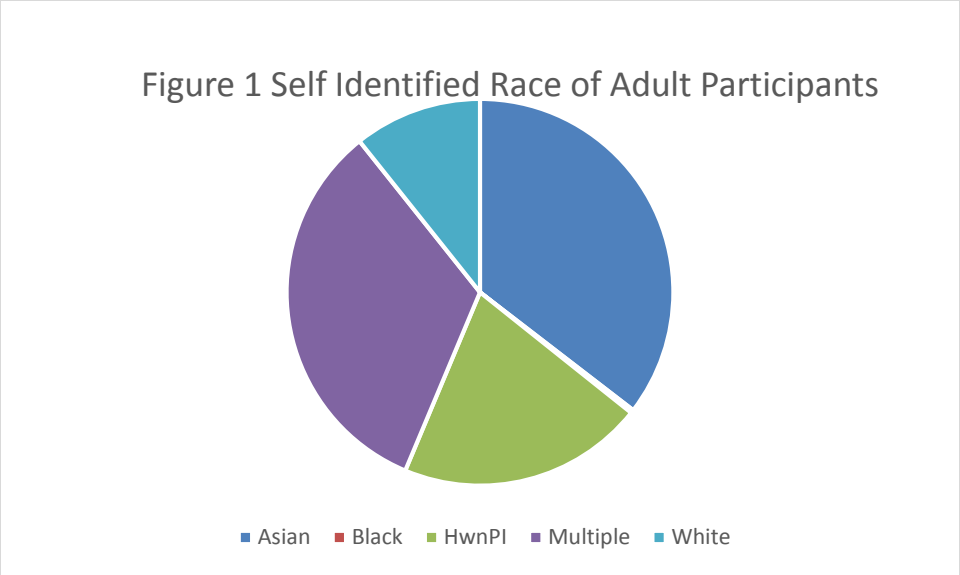


Table 2 shows the fish consumption rate and associated hair mercury levels in adults and children answering question 1 in the questionnaire (See attached). Nine participants did not answer the question. For answers that involved a fish consumption range (e.g. 4 to 6 times a week), DOH assigned the midrange value (i.e. 5) for that participant.

Ninety eight percent of adults and 88% of children reported consuming fish during the previous 30 days. Average hair mercury levels increased as the fish consumption rate increased in both children and adults. Fifty four percent of adults and 63% of children reported eating less than the USDA 2015-20 *Dietary Guidelines for Americans* recommended 2 servings of fish a week.

Average hair mercury levels increased in adults from 0.66 ppm in adults reporting no fish consumption to 1.88 ppm in adults reporting greater than 4 fish meals a week. The geometric mean ranged from 0.2 ppm to 1.44 ppm. Children showed a similar trend with average hair mercury levels ranging from 0.37 ppm in non-fish eaters to 0.97 ppm in children eating more than 4 fish meals a week. The geometric mean ranged from 0.23 ppm to 0.68 ppm.

Table 2. Fish Consumption Rate and Hair Mercury Analysis

Age Category	Consumption Frequency	Number	Percentage	Average Hair Mercury level (range) ppm	Geometric Mean Hair Mercury Level (ppm)
Adults	none	8	2	0.66 (<LOQ-3.19)	0.2
	<2 times a week	211	52	1.10 (<LOQ-5.45)	0.78
	2-4 times a week	118	29	1.68 (<LOQ-10.35)	1.15
	>4 times a week	67	17	1.88 (<LOQ-9.75)	1.44
Children	none	28	12	0.37(<LOC-2.1)	0.23
	<2 times a week	117	51	0.72 (<LOC-7)	0.38
	2-4 times a week	62	27	0.81(0.08-4.7)	0.53
	>4 times a week	23	10	0.97 (0.15-3.83)	0.68

Table 3 summarizes the average daily ounces of fish consumed along with the average serving size of fish. Daily ounces was calculated by multiplying the weekly consumption rate by the ounces of fish consumed and dividing by 7. Information on serving size is missing for some participants because the questionnaires weren't filled in or the information was not easily converted to ounces. For example, numerous people answered "small piece" or "small fish" for serving size.

As shown in Table 3, the average daily consumption of fish in fish consumers was 1.59 ounces/day in adults and 0.85 ounces/day in children. The average fish serving size was 4.39 ounces in adults and 2.57 ounces in children.

Table 3. Average Daily Fish Consumption and Serving Size in Fish Consumers

Age Group	Number	Average daily ounces consumed	Number	Average Serving Size (ounces)
Adults	341	1.59 (0.02-24)	345	4.39 (0.5-16)
Children	179	0.85 (0.005-9)	187	2.57 (0.5-8)

The top 5 fish species consumed by the WIC participants is shown in Table 4. More than ½ of the participants reporting eating ahi in the past month followed by 47% eating canned tuna. Salmon, mahimahi and aku were also among the top 5 fish consumed.

Table 4. Top Fish Species Consumed in Adults and Children

Fish	Number	Percentage of Participants
Ahi	403	63
Canned tuna	302	47
Salmon	160	25
Mahimahi	109	17
Aku	89	14

DOH has developed guidelines for consumption of fish for pregnant women, nursing mothers and young children to promote fish consumption but minimize mercury exposure. These guidelines recommend that sensitive populations eat ahi no more than once every 2 weeks (<0.5 serving a week) to minimize mercury exposure. As shown in Table 5, 34% of the participants reported eating ahi more than the recommended DOH guidelines.

Table 5. Number of Participants exceed DOH Recommended Ahi Fish Consumption Guideline

Ahi Times per Week[a]	Number	Percentage
0	263	41
<0.5	160	25
>0.5[b]	220	34

[a] The numbers in this table are lower than Table 4 because some participants reported eating ahi but did not provide frequency

[b] Exceeds DOH fish consumption guidelines of ½ serving a week

One survey question asked whether the participants had heard about mercury and eating fish. The majority of the participants had heard some information on mercury and fish consumption. Average hair mercury levels were similar in groups answering yes or no.

Table 6. Have you Heard Anything about Mercury and Eating Fish

Answer	Number	Average Hair Mercury Level (ppm)
Yes	413	1.25
No	139	1.33

Discussion

This study collected information on fish consumption rates through a questionnaire along with mercury hair measurements in clients of the WIC program in Hawaii. The Department of Health previously reported on fish consumption for adults in Hawaii obtained through telephone interviews using the Hawaii Health Survey (HHS) (Baker et al. 2012). The HHS found that 90 % of the adults consumed fish at least once a month with 41.6% of adults eating fish 2 or more times a week. The HHS also found that the fish consumption rate in Hawaii is more than twice that of the national average.

For the present study, 98 % of the adult WIC participants reported eating fish in the past month with 46% of adult participants eating fish 2 or more times a week. This study confirms the previous work by DOH that showed that over 50% of people surveyed did not eat at least 2 servings of fish a week as recommended by the USDA 2015-2020 *Dietary Guidelines for Americans (*USDA, 2015).

Hair mercury levels are higher in women and children in this study compared to those measured in a national survey (McDowell et al. 2004). Nineteen percent of children and 42% of adults had hair mercury levels that equaled or exceeded the EPA's reference level of 1.2 ppm. Nationally, approximately 3.5% of women exceed EPA's reference concentration in blood (EPA, 2013). No participants had hair mercury levels that exceeded 12 ppm, the maternal hair level associated with subtle neurodevelopmental effects in children exposed in utero.

The geometric mean hair mercury in adults of 0.94 ppm was almost 5 times higher than hair mercury levels measured in adults in the National Health and Nutrition Examination Survey (NHANES) from 1990-2000. (McDowell et al., 2004). The geometric hair mercury of 0.43 ppm in the current study was 3.6 times higher than hair mercury levels measured in children of the NHANES study. An earlier study done in Hawaii (Sato et al., 2006) also found that women had higher levels of cord blood mercury compared with the national average.

Not unexpectedly, frequent fish eaters had higher mercury hair levels than non-consumers. The geometric mean mercury hair level was about 6 times higher in frequent adult fish consumers than non-consumers (1.44 ppm to 0.2 ppm) and 3 fold higher for children (0.68 ppm to 0.23 ppm).

The higher hair mercury levels can be explained by the both the quantity of fish consumed and fish preferences of the WIC participants. Even though over 50% of the participants in the WIC study reported not eating the recommended amount of fish, hair mercury levels are higher than those found in NHANES (McDowell et al. 2004). This can be explained partly by the type of fish preferred by the WIC participants. Sixty percent of the participants consumed ahi in the past month. Ahi, often eaten raw, can be yellowfin tuna, bigeye tuna or albacore. DOH recommends pregnant women, nursing mothers and young children eat ahi no more than twice a month because of mercury levels. About 1/3 of the participants exceeded DOH's recommended fish consumption level.

Mahaffey et al. (2009) found that blood mercury levels in women living near coastal areas were more likely to exceed EPA's reference dose than mercury levels in women living near non coastal areas. Within the US, people living near coastal areas consume more fish as well as consume fish with higher mercury levels than those living in non-coastal areas.

Adult Asians and Pacific Islanders comprised more than ½ of the WIC participants. Maheffey (2009) also reported that some ethnic origins were associated with higher blood mercury levels. People of Asian descent whose food preferences are influenced by Asian dietary patterns, tended to consume fish more frequently, in greater variety and higher quantity than non Asians.

Hawaii Department of Health developed a brochure for pregnant women, nursing mothers and young children on guidelines to minimize mercury exposure through fish consumption (http://health.hawaii.gov/wic/files/2013/05/mercury.pdf). DOH encourages fish consumption, because fish are an important part of a diet being high in protein and nutrients and low in saturated fatty acids and cholesterol. The strategy of the DOH is to reduce mercury exposure by eating fish with low mercury levels and reducing consumption of fish with high levels of mercury. We will continue to promote fish consumption while providing recommendations on choosing lower mercury fish.

Conclusions

Hair mercury levels are higher in women and children in this study compared to those measured in a national survey. No participants exceeded 12 ppm, the maternal hair level associated with subtle neurodevelopmental effects in children exposed in utero. Over 50% of participants reported not eating the recommended two servings a fish a week. More efforts to promote fish consumption of lower mercury fish targeting pregnant women and young children will provide maximal health benefits.

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Attachments

For Staff Use Only
Date:_____ Time:_____
ID#_____ Clinic:_____

Consent Statement

I have read this form or it has been read to me. I have had a chance to ask questions about this project and my questions have been answered. I agree to be part of this project. **I have marked the parts below that I will do.**

1a. Yes ☐ No ☐ **Give some hair to test for mercury.**

1b. Yes ☐ No ☐ Answer a few questions about my or my child's fish-eating habits.

2a. Yes ☐ No ☐ **Have the hair also tested for arsenic.**

2b. Yes ☐ No ☐ Answer a few questions about my or my child's hobbies and habits that are related to arsenic exposure.

I_____ (print name), agree to hair testing and answering a few questions for:

(___) Myself

(___) My child

❑ I need a _____ language interpreter to translate my test results for me.

❑ I want my mercury results sent to my health care provider: _____
Physician's Name

_____
Address

_____
Signature

_____

_____
Address

_____
Phone

Fish Eating Habits Survey

For Staff Use Only

ID#_____

We would like to know about your child's fish eating habits. Please take a few minutes to answer these questions as completely as possible about the child who is taking part in this project.

1. Whether it is breakfast, lunch, dinner, or snacks - canned, frozen or fresh -- how many times did your child eat fish in the past month?
   - ☐ None (If none, skip to question 4.)
   - ☐ Several times a day
   - ☐ Once a day
   - ☐ 4 to 6 times a week
   - ☐ 2 to 3 times a week
   - ☐ Once a week
   - ☐ 2 to 3 times per month
   - ☐ Once a month
   - ☐ Other: _____ (list how often)

2. What type of fish does your child eat? Please write in how often your child eats each type of fish checked off.
   - ☐ Ahi, (fresh tuna) How often? _____
   - ☐ Aku, (fresh Skipjack tuna) How often? _____
   - ☐ Canned tuna How often? _____
   - ☐ Kajiki (Pacific Blue Marlin) How often? _____
   - ☐ Mahimahi (Dolphinfish) How often? _____
   - ☐ Ono (Wahoo) How often? _____
   - ☐ Opah (Moonfish) How often? _____
   - ☐ Shark How often? _____
   - ☐ Shutome (Swordfish) How often? _____
   - ☐ Other: _____ (Please specify) How often? _____
   - ☐ Other: _____ (Please specify) How often? _____
   - ☐ Don't know How often? _____

3. When your child eats fish, how large a serving do they eat? (3 ounces of fish is about the size and thickness of a deck of playing cards or a computer mouse.)

-please turn survey over-

4. Have you heard anything about mercury and eating fish? ☐ Yes ☐ No (If no, you are done.)

5. If yes, who did you hear this from? (Please check all that apply.)
   ☐ Doctor ☐ Family/Friends ☐ Department of Health Brochure ☐ Television ☐ WIC
   ☐ Other: _____
   (Please specify)

6. If yes, what did you hear? _____

7. Has this information led you to change your family's fish eating habits? ☐ Yes ☐ No (If no, skip to question 10.)

8. If yes, what did you change?
   - ☐ Serve more fish
   - ☐ Serve less fish
   - ☐ Serve only fish advised
   - ☐ Stop serving fish
   - ☐ Other: _____

9. If yes, when did you make that change?
   - ☐ More than one month ago
   - ☐ Less than one month ago

10. If no, what is the reason you continued your family's same fish eating habits? (Please check all that apply.)
    - ☐ My family and I don't eat fish
    - ☐ The advice does not apply to my family
    - ☐ My family and I already follow the advice
    - ☐ The advice was too hard to follow
    - ☐ I don't agree with the advice
    - ☐ Other: _____

Thank you for your help!