Mercury Public Health Surveillance in Colorado: 2011 Annual Report

Developed by:

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Executive Summary

Mercury is a highly toxic and naturally occurring metal. Human exposure can occur in occupational settings, or from sources such as amalgams, pharmaceuticals, cosmetics, folk medicines, and household products. In the US, humans primarily accumulate mercury through the consumption of seafood. The Environmental Protection Agency (EPA) and the National Academy of Sciences (NAS) recommend keeping blood mercury levels less than 5µg/L, especially for pregnant women to decrease the risk of neurodevelopment effects.

Colorado Board of Health rules require clinical laboratories to report all cases of elevated levels of mercury in blood and urine. Active follow-up of mercury reports was initiated for the first time in Colorado in 2008. In 2010, a pilot project report was completed based on the limited data set received during 2008-2009 that described mercury exposure in Colorado residents who have been reported to the Colorado Department of Public Health and Environment (CDPHE) because of elevated blood mercury levels. In 2011, the first complete investigation was published which described mercury exposure in Colorado residents based on elevated blood mercury reports received in 2010. This is the second complete investigation which describes mercury exposure in Colorado residents based on elevated blood mercury reports received in 2011. A survey was administered to a subset of the reported cases with elevated blood mercury levels in order to further characterize the potential for elevated exposures and health risks. The mercury surveillance program of the Disease Control and Environmental Epidemiology Division (DCEED) of CDPHE also provides information to affected individuals and health care professionals with the objective of reducing the incidence of elevated levels of mercury among Colorado residents.

All blood mercury reports (n=541) received by the mercury surveillance program during a 1-year period were evaluated for exposures and health risks using the reference blood mercury level of 5.0µg/L recommended by the EPA and NAS. One hundred and sixty six cases were at or above this reference blood mercury level (blood levels of 5.0 to 94µg/L). The age of these 166 cases ranged from 1-82 years, 19% were women of child-bearing age, and 66% were older than 46 years of age. In addition, 45% of cases had blood mercury levels that put them at risk of developing adverse nervous system effects, based on the Center for Disease Control and Prevention's (CDC) case definition for mercury poisoning of 10µg/L. It is important to note that only 2 cases (1%) were children between the ages of 1-17 years.

A survey on demographics, life style, fish consumption, and health concerns was sent to 158 cases with levels > 5µg/L for whom contact information was available. Among those who responded (25%), the results suggested that moderate to heavy consumption of fish that are commercially available in grocery stores and restaurants in Colorado resulted in moderate elevations in blood mercury. These results are consistent with the findings of the 2010 surveillance report. Health education through discussions and materials was provided to the 39 cases who returned the survey.

Our findings have some limitations. Given the public concern for methyl mercury in seafood, people who eat more fish may have been more likely to request testing, thus

leading to testing bias. There was no chart review of the symptoms for each of the cases in the survey, and symptoms reported by the cases to their care providers may have been caused by other conditions. Selection bias may have been present since self-reported data is limited by a respondent's memory and ability to answer questions. The response rate for the survey was low, and these results cannot be generalized to the population. The 2011 surveillance period included only blood mercury results, thus limiting the ability to investigate exposures to inorganic and elemental mercury from sources such as dental amalgams. There was a noticeable homogeneity in the survey respondents in terms of education level attained and race (Appendix A, Table A1). Finally, four different laboratories analyzed the blood samples and this may introduce variability in sensitivity and accuracy.

Overall, we conclude that excess consumption of commercially available fish from grocery stores and restaurants can result in elevated blood mercury levels in Colorado residents. This emphasizes a need to educate Colorado residents about how to choose fish to maximize health benefits, while minimizing health risks.

INTRODUCTION

Mercury is a highly toxic and naturally occurring metal. Human exposure can occur in occupational settings, or from sources such as amalgams, pharmaceuticals, cosmetics, folk medicines, and household products. All people have at least some amount of mercury in their body. Mercury enters the body via inhalation, ingestion and absorption through the skin. The Centers for Disease Control and Prevention (CDC) reports that the geometric mean blood mercury concentration in the U.S. population age 20 years and older is 0.956-1.14- µg/L from the updated tables of the National Health and Nutrition Examination Survey for the year 2009-2010 (CDC, 2012). In the United States, humans are exposed to mercury mostly through fish consumption and certain occupations (CDC, 1996). Significant controversy surrounds mercury in dental amalgams and the current scientific evidence does not support a causal association between this and various systemic symptoms (CDC, 2009; Woods et al 2007).

In nature, mercury exists in three forms: elemental, organic and inorganic salts. All forms are poisonous to humans and can produce a wide range of health effects depending on the amount and duration of exposure. High levels of any form of mercury can permanently damage the brain, kidneys and a developing fetus. Yet, there are major differences in the biological response to inorganic and organic mercury, as well as its route of exposure (Material Safety Data Sheet, 2008; ATSDR, 2006).

Metal mercury vapors and methyl mercury are most harmful because both can access the brain. Mercury accumulates in the body and causes delayed neurological effects. The neuro-developmental effects are most sensitive and well-documented in humans. Other health impacts include cardiovascular disease, immune deficiency and reproductive complications. Early clinical symptoms include paresthesia (tingling and numbness in the toes, fingers, mouth and lips), ataxia (lack of coordination of muscle movement), generalized weakness, vision and auditory difficulties, muscle spasms and tremors (Olsen, 2009).

Another important aspect to elevated blood mercury levels are its effect on children. The US Environmental Protection Agency (EPA) has determined that children born to women with a blood mercury concentration of 5.8µg/L or higher are at increased risk of adverse health effects. In addition, both the EPA and the National Academy of Sciences (NAS) have determined that 32µg/L of mercury in the blood of pregnant women doubles the risk of the child having an abnormal performance on a range of neurodevelopmental tests (EPA, 2001). Both recommend keeping the blood mercury level <5µg/L (NAS, 2000; EPA IRIS, 2001) for pregnant women. This blood mercury level corresponds to the EPA reference dose (RfD) for methyl mercury of 0.1µg/kg body weight/day, below which exposures are likely to be without appreciable adverse health effects, even for sensitive individuals. This reference dose gives guidance to public health and regulatory programs seeking to reduce mercury exposures and adverse health effects.

Nationally, professional groups and federal programs maintain their own guidelines. The CDC only considers blood or urine mercury levels above 10µg/L as significant (Belson et al., 2005). The American Conference of Governmental Industrial Hygienists (ACGIH) uses a Biological Exposure Index which sets the occupational exposure limit

for serum inorganic mercury toxicity at 15µg/L. The Agency for Toxic Substances and Disease Registry (ATSDR, 2006) recommends the neurotoxicity threshold for methyl mercury to be 50µg/L in the blood for self-reported nonspecific complaints (malaise, weakness, decreased cognition) and 200µg/L in the blood for physical exam findings (paresthesia, ataxia, visual difficulties and worsening hearing).

The State of Colorado "Regulations Pertaining to the Detection, Monitoring, and Investigation of Environmental and Chronic Diseases (6 CCR 1009-7)" require that within 30 days of the test all clinical laboratories in the state report any blood and urine tests where mercury levels exceed 5µg/L for blood and 20µg/L for urine. This is intended for the protection of the developing fetus based on the available toxicological health information. Colorado's mercury surveillance system is built on the above-mentioned reporting requirement that includes the collection of sufficient information about tested individuals. The system further depends on follow-up conducted by the program staff or health care providers to identify the source of exposure.

PURPOSE

Overall, the purpose of mercury surveillance in Colorado is to improve the tracking, prevention, and mitigation of human health impacts of environmental and occupational exposures to mercury. This investigation describes mercury exposure in Colorado residents, who have been reported to the Colorado Department of Public Health and Environment (CDPHE) because of elevated blood and/or urine mercury levels, and survey results (e.g., demographic, life style) that can be used to further characterize those with potential for elevated exposures and health risks. Furthermore, we evaluate the efficacy of the current surveillance and investigation mechanisms in reducing elevated mercury levels among Colorado residents. The data are also used, when possible, to conduct interventions to reduce exposures and potential adverse health effects to the individuals with the elevated blood and/or urine mercury levels.

METHODS

Participating Laboratories and Reporting Mechanism

Analytical laboratories in Colorado are required to submit elevated blood and urine mercury data. Major reporting laboratories include Quest Diagnostics, Lab Corp, and Specialty Labs.

The labs currently report their data via an electronic system. Reports are submitted to CDPHE at a minimum of once per week. Variables reported include personal identifiers (name, gender, age, and birth date), ordering health care provider contact information, and clinical information (date of test, date of report, clinical test used, and test result). Most reports lack demographic information, such as residential address, race or ethnicity. The health care provider listed on the laboratory report was contacted by telephone and asked to provide patient contact information.

Prioritization of Survey Eligible Cases: Action Thresholds
Although the CDPHE reportable level is >5µg/L for blood, laboratories report all blood mercury tests performed within their facility regardless of residency status. The follow-up survey and exposure investigations focused on all individuals residing in Colorado with blood mercury test result >5µg/L; however, cases with a level of 5 µg/L were sent a survey if they were females of childbearing age (19-45 years).

Patients for whom an address was successfully obtained were sent an introductory letter and follow-up survey (Appendix B). Patients chose either to complete the questions on the paper form and return it to the mercury surveillance program of DCEED, or to complete the follow-up survey by phone with a staff member.

Categorization of Survey Eligible Cases
All reports above >5µg/L received by the mercury surveillance program of DCEED were categorized in to three blood groups using selected cut points:

- 5.0 to 9.9µg/L (referred to as 5-9): Where the lower-end is based on the EPA's RfD of 0.1 µg/kg/day which corresponds to < 5µg/L of methyl mercury in blood, and the upper-end is below the CDC's case definition for chemical poisoning, which is blood mercury levels exceeding 10µg/L.
- 10.0 to 14.9µg/L (referred to as 10-14): Where the lower-end is based on CDC definition of poisoning exceeding 10µg/L and the higher-end is based on the ACGIH Biological Exposure Index (BEI) for blood mercury of 15µg/L for occupational exposure to inorganic mercury.
- >15.0µg/L (referred to as 15+): Blood levels above occupational BEI of 15µg/L.

Survey
Information collected during the survey included potential environmental or occupational exposures to mercury, and health effects experienced by reportable cases. Seafood consumption was classified as the number of meals consumed per week which contained fish or seafood. Information about portion size was also obtained. After completing the survey, general information was provided to the patient about limiting potential mercury intake. Exposures were also evaluated to determine if additional public health or occupational health and safety measures were warranted to prevent or reduce susceptibility to others facing similar conditions.

All information obtained from laboratory reports and surveys was used for public health surveillance and prevention purposes only. The data was maintained in compliance with CDPHE policies for the privacy and security of confidential and protected health information.

For survey respondents with more than one test, the first test result was used for mercury group level classification.

RESULTS

Summary for All Reported Tests

Between January 1st and December 31st, 2011, the mercury surveillance project received 541 laboratory reports of blood mercury tests. The data reported for 2011consisted entirely of blood mercury as no reportable urine mercury cases were received during this period. Of the reports received, blood mercury levels ranged from 1.0 to 94.0µg/L with a geometric mean blood mercury level of 2.73µg/L (Table 1).

Table 1. Summary of All Blood Mercury Test Results

Group	Range µg/L	Mean µg/L	*Geometric Mean µg/L	Median µg/L	*n*
All Cases	1-94	4.53	2.73	2	541
Males	1-35	4.17	2.57	2	281(52%)
Females	1-94	4.92	2.90	2	260(48%)

*Geometric mean was calculated for all tests among individuals above 19 years.

Table 2 shows the mercury surveillance program received laboratory reports on 345/511 (68%) individuals with blood mercury levels below 5.0µg/L, which was below the CDPHE reporting requirement, and 166 individuals with blood mercury levels at or above the CDPHE reportable level of 5.0µg/L. Twenty-two percent (111/511) were from 5-9µg/L, 8% (35/511) were from 10-14µg/L, and 4% (20/511) were greater than 15µg/L.

Of the 20 reported cases with blood mercury levels greater than 15µg/L, 4 (20%) were between 30-50µg/L and 1 (5%) was greater than 50µg/L. Eleven percent (55/511) of the blood mercury tests exceeded CDC's case definition for mercury poisoning (i.e. a level above 10µg/L), and 4% (20/511) exceeded ACGIH's BEI for occupational exposure (i.e., a level above 15µg/L). Two females of child-bearing age exceeded the 32µg/L, which is EPA's threshold of pregnant women for increased risk of neurodevelopmental effects on the fetus.

Table 2. Total Number of Cases Received During the 2011 Surveillance Period

Blood Mercury Level (PPB;☐ µg/L)	# Reports	Gender		Age (Male and Female)			Women Aged 19-45
		Female	Male	< 19	19-45	46+	
< 5.0	345/511 (68%)	160/247 (65%)	185/264 (70%)	46/48 (96%)	117/171 (68%)	182/292 (62%)	53/85 (62%)
5-9	111/511 (22%)	61/247 (25%)	50/264 19%)	1/48 (2%)	36/171 (21%)	74/292 (25%)	20/85 (24%)
10-14	35/511 (8%)	15/247 (6%)	20/264 (8%)	0	9/171 (5%)	26/292 (9%)	7/85 (8%)
15+	20/511 (4%)	11/247 (4%)	9/264 (3%)	1/48 (2%)	9/171 (5%)	10/292 (3%)	5/85 (6%)
Total	511	247/511 (48%)	264/511 (52%)	48/511 (9%)	171/511 (33%)	292/511 (57%)	85/511 (17%)

NOTE: For individuals/cases with multiple blood tests, the maximum blood mercury level was retained for analysis.

Nine percent (48/511) of all reported cases were from people under the age of 19. Two of these individuals had levels above or at 5.0µg/L and belonged to the age group 1 to 17 years. Seventeen percent (85/511) of reported cases were from women of child-bearing age (Table 2).

Characteristics of Survey Eligible Cases by Age and Gender

One hundred and sixty six reported cases met the eligibility criteria of a report above 5µg/L. As shown in Table 3, slightly more females (52%) than males (48%) had reported tests that met the eligiblity criteria. Blood mercury levels in males ranged from 5-35 µg/L with a geometric mean of 9.03 µg/L and in females it spanned from 5-94 µg/L with a geometric mean of 8.54 µg/L. For the 166 survey eligible cases, the age range was1-82 years old (data not shown), with the majority older than 46 years of age (66%, 110/166) and the remaining cases (34%, 56/166) between 1-45 years old (Table 4). Nineteen percent of cases (32/166) were women of child-bearing age (Table 4). The majority of the cases had blood mercury levels between 5-9µg/L (67%, 111/166).

Table 3. Summary of Blood Mercury Levels for All Eligible Cases

Group	Range µg/L	Mean µg/L	*Geometric Mean µg/L	*n*
All Cases	5-94	10.20	8.77	166
Males	5-35	10.02	9.03	79(48%)
Females	5-94	10.37	8.54	87(52%)

NOTE: Geometric mean was calculated for all individuals/cases above 19 years. When an individual had multiple blood tests, the maximum blood mercury level was retained for analysis.

Table 4. Summary of Survey Eligible Cases by Gender and Age

Blood Mercury Level (PPB; □µg/L)	# Reports	Gender		Age (Male and Female)			Women Aged 19-45
		Female	Male	<19	19-45	46+	
5-9	111/166 (67%)	61/87 (70%)	50/79 (63%)	1/2 (50%)	36/54 (67%)	74/110 (67%)	20/32 (63%)
10-14	35/166 (21%)	15/87 (17%)	20/79 (25%)	0	9/54 (17%)	26/110 (24%)	7/32 (22%)
15+	20/166 (12%)	11/87 (13%)	9/79 (11%)	1/2 (50%)	9/54 (17%)	10/110 (9%)	5/32 (16%)
Total	166[a]	87/166 (52%)	79/166 (48%)	2/166 (1%)	54/166 (33%)	110/166 (66%)	32/166 (19%)

[a] For individuals/cases with multiple blood tests, the maximum blood mercury level was retained for analysis.

Characteristics of Patients tested by Geography

As shown below in Table 5, 48% of reported cases (194/404, 48%)) were received from individuals in the six county Denver metro areas. This distribution is expected since more than half of the overall Colorado state population is concentrated in the same area. Reported cases outside of the metro area were distributed throughout the rest of the state (25 out of 64 counties of Colorado) as shown in Table 5. Pitkin County had the highest rate in the state, where one provider ordered blood mercury tests for 33% of reported cases (8/24). Boulder had the highest number of reported cases (23%, 91/404). It is, important to note that the calculated rate from each county should be interpreted with caution because of small numbers.

Table 5. Distribution of persons by County

County	# Reports	Rate per 100,000
Adams	**13**	**2.94**
Arapahoe	**24**	**4.20**
Boulder	**91**	**30.89**
Delta	6	19.38
Denver	**24**	**4.00**
Douglas	**25**	**8.76**
Eagle	9	17.24
El Paso	25	4.02
Garfield	7	12.41
Gilpin	2	*
Grand	2	*
Gunnison	2	*
Hinsdale	1	*
Jefferson	**17**	**3.18**
Lake	2	*
La Plata	2	*
Larimer	48	16.02
Logan	4	17.61
Mesa	14	9.54
Moffat	7	50.74
Montrose	5	12.11
Morgan	4	14.21
Ouray	1	*
Pitkin	24	139.96
Routt	4	17.01
Saguache	1	*
San Miguel	2	*
Summit	1	*
Teller	2	*
Washington	3	*
Weld	32	12.66
Total	**404**	

Notes:

- Bold values represent Denver metro area.
- Rate per 100,000 = # of individuals for a particular county (e.g., 24 for Denver) divided by the population of that county x 100,000
- * Rates were not calculated when reports were received for < 4individuals
- Of the 511 individuals tested, 404 had residential addresses listed

Summary of Survey Results

Response rate
Out of 166 individuals, surveys were sent to 158 individuals who were Colorado residents and for whom contact information was obtained. Thirty nine surveys were completed and returned for a response rate of 25% (39/158). The highest response rate (35%) was among those with blood mercury levels above 15 µg/L (Table 6).

Table 6. Summary of reportable cases for the 2011 surveillance period

Blood Mercury Level (PPB,□µg/L)	# Survey eligible reports	Mailed Surveys	Completed Surveys	Response Rate
5-9	111/166 (67%)	106 (67%)	25 (64%)	24%
10-14	35/166 (21%)	32 (20%)	7 (18%)	22%
15+	20/166 (12%)	20 (13%)	7 (18%)	35%
Total	166 [b]	158[a] (84%)	39	25%

[a] Surveys were sent to158 individuals (with response rate of 25%) for whom contact information was available
[b] The response rate based on 166 eligible cases was 24%

Blood mercury Levels of Surveyed Cases
Blood mercury levels for the 39 cases who completed surveys ranged from 6.0 to 36 µg/L. As shown in Table 6, 25 surveys were completed for the 5-9 µg/L blood mercury group, 7 for the 10-14µg/L group, and 7 for the 15+µg/L group. Of the 39 surveys completed, eight (21%) were completed by women of child-bearing age (data not shown). In relation to the 39 completed surveys, 36% (14/39) exceeded CDC's Case Definition for chemical poisoning of 10µg/L, and 18% (7/39) were above the ACGIH's BEI of 15µg/L for occupational exposure to inorganic mercury.

Demographics
Everyone that completed and returned a survey reported having college, graduate, or professional level education (Appendix A, Table A1). The number of males (15/39) who completed the survey was less than females (24/39). However, in the 15+µg/L group, 4 out of 7of the respondents were males. Most respondents were White, Non-Hispanic with the exception of one African-American and one Hispanic. Only one individual reported having children under the age of 7 years that lived with the individual or visited frequently (Appendix A, Table A5.1). Only one of the survey respondents was noted to be pregnant or nursing (Appendix A, Table A5.3). No respondents had a child living with them who had come into contact with any mercury-related spills (Appendix A, Table A5.2).

Reasons for Blood Mercury Testing
As shown in Appendix A, Table A3, a large majority of survey respondents (30/39, 77%) reported that their primary care provider (PCP) had informed them of their blood mercury results. Eighty seven percent (34/39) reported knowing why their PCP had ordered the blood mercury analysis. The main reasons included symptoms such as chronic fatigue, fibromyalgia as well as patient request due to high fish consumption.

Thirty six percent (14/39) of the respondents had been tested for blood mercury in the last five years. Fifteen percent (6/39) had another blood mercury test scheduled and 31% (12/39) did not intend on having a blood mercury test in the future (Appendix A, Table A3).

Potential Sources of Mercury Exposure
Most of the respondents reported fish consumption as their potential primary source of mercury exposure (Table 7). One respondent reported to have been occupationally exposed to mercury (Table A8). All survey respondents reported eating fish and a majority reported having at least one amalgam filling. Thus, most respondents probably had multiple potential exposure sources to mercury. This investigation, however, had a limited ability to determine the contribution of mercury from sources other than the fish consumption because urinary mercury levels, which are needed to detect inorganic mercury, were not ordered by the PCPs. Furthermore, since everyone reported some fish consumption, comparisons to non-fish eaters were not feasible. Nonetheless, it is reasonable to rely on the available data that indicates moderate to high fish consumption (i.e. consuming fish more than once a week) as a potential source of exposure. A summary of potential exposure sources in this group is provided in Appendix A, Table A9.1.

Table 7. Summary of Fish Consumption

	Reportable Blood Mercury Level (PPB, □□ g/L)	Daily	Few times / week	About once / week	Less than once / week	Less than once / month	Never	Don't know / not answered
How often do you eat fish or seafood?	5-9	2/25 (8%)	14/25 (56%)	5/25 (20%)	2/25 (8%)	1/25 (4%)	1/25 (4%)	0
	10-14	0	7/7 (100%)	0	0	0	0	0
	15+	3/7 (43%)	3/7 (43%)	1/7 (14%)	0	0	0	0
	Total	5/39 (13%)	24/39 (61%)	6/39 (15%)	2/39 (5%)	1/39 (3%)	1/39 (3%)	0

1) <u>Fish Consumption</u>
As shown in Table 7, consuming fish more than once a month was reported by most

survey respondents. Five percent of the respondents (2/39) reported that they ate fish less than once a week, 15% (6/39) reported once per week consumption, 61% (24/39) reported eating it a few times per week and 13% (5/39) reported daily intake. Prior to the initial blood mercury analysis, 64% (25/39) reported no change in the frequency of their fish consumption, while 28% (11/39) were eating more, and the remaining 8% (3/39) had been consuming less (Table A7.2). Most respondents bought fish at the grocery store (87%; 34/39) or ate it in a restaurant (13%; 5/39) (Appendix A, Table A7.4). Those who purchased fish at the grocery store typically bought it fresh or frozen, with the exception of canned tuna (Table A7.5).

2) Dental Amalgams

Overall, a large number of survey respondents (36%; 14/39) reported having dental amalgam fillings, which contain approximately 50% of mercury by weight. In the 5-9µg/L,10-14 µg/L ,and 15µg/L blood groups, the number of people with dental amalgams was 44% (11/25), 14% (1/7), and 29% (2/7), respectively (Appendix A, Table A4). The relationship between the number of tooth amalgams and blood mercury levels is unknown because the contribution of tooth amalgam to mercury levels in the body can only be evaluated through urine mercury levels.

3) Occupational

As shown in Appendix A, Table A8.1, three people worked in the healthcare industry in locations such as doctor's offices, hospitals, and/or surgery centers. The level of mercury exposure, if any, in these occupational settings is not known. Two of these individuals belonged to the 5-9 mercury level group but their responses to the survey indicated fish consumption as the likely source of mercury exposure. No individuals reported working in a mine or any occupational settings in which mercury exposure has been well established (Appendix A, Table A8.1).

4) Religious Practices, Folk Medicine/Herbal Remedies, Antiques, and Outdated Medication

As shown in Appendix A, Tables A9 and A9.1, 13% (5/39) of survey respondents noted that they could be exposed through one or more of the following potential sources; folk medicine, herbal remedies, photography development and fluorescent light bulbs. Two of these five individuals (5%) used folk medicine and/or herbal remedies and had a blood mercury level between 5- 15 µg/L. The amount of mercury in these products is not known.

5) Reported Symptoms

As shown in Appendix A, Tables A6 and A6.1, 51% of survey respondents (20/39) reported that their PCP had identified symptoms that could be related to mercury exposure during the initial office visit. The most common symptoms included numbness and tingling, insomnia, weakness, headache, and short term memory loss.

Statistical Analysis of Mercury Blood Level and Symptoms

To further examine the association between the symptoms and blood mercury levels, the Fisher's Exact Test was performed on the responses to Question 7: signs and

symptoms identified during the original doctor's visit (Table 8). For this analysis, the blood mercury levels of all survey respondents with values above 5µg/L were categorized as either "low" (> 5µg/L but < 12µg/L) or "high" (>= 12µg/L). Ten of the sixteen possible symptoms that were answer options to this question were reported and are listed. The odds ratio (OR) for each symptom was calculated for the "high" to "low" subgroups.

As Table 8 shows, most conditions had OR greater than 1.0, confidence intervals were wide, included "1.0" and had p-values greater than 0.05. Thus, there were no statistically significant associations between blood mercury level and the symptoms reported by the survey respondents.

Table 8. Association Tests (Finite Population) to Responses for Question 7:

Condition	Odds Ratio	95% Confidence Interval	p-value
Headache	1.1594	(0.8556 -1.5711)	0.6526
Incoordination	1.1111	(0.9862 - 1.2519)	1.0000
Insomnia	0.9722	(0.6567 -1.4394)	1.0000
Irritability	0.8642	(0.5975 - 1.2499)	0.5716
Leg Cramps	1.0256	(0.7827 - 1.343)	1.0000
Malaise	1.0714	(0.9737 - 1.1790)	1.0000
Depression	1.0714	(0.9737 - 1.1790)	1.0000
Numbness/Tingling	1.3043	(1.0707 - 1.5890)	0.1693
Short Term Memory Loss	1.1111	(0.8296 - 1.4882)	1.0000
Weakness	1.1111	(0.8296 - 1.4882)	1.0000

Note: p-value (0.05) is computed using the Fisher's Exact Test.

Summary of Findings for Multiple Tests

Twenty six individuals had their blood mercury levels tested more than once during the survey period, and five out of 26 returned the survey. The change in mercury level for each retested individual was measured by calculating the difference in blood level between the first and last tests within the one-year surveillance period. This difference was then averaged for all retested individuals by their mercury level group. For the 5 cases that returned surveys, there was an average change of (-5.6 µg/L) in the 10-14 µg/L mercury level group. However, a change was more noticeable (-10.36 µg/L) in the 15+ µg/L blood mercury group (Appendix A, Table A2).

When comparing all 26 individuals with multiple tests with the 5 cases with returned surveys, the same pattern of change existed across the groups (data not shown). These findings indicate that significant changes in blood mercury levels are achievable over a relatively short period of time ranging from 1 to 4 months (Appendix A, Table A2).

DISCUSSION

This investigation identified moderately elevated mercury levels through public health surveillance that may be due to moderate to heavy consumption of commercially available fish in grocery stores and restaurants in Colorado. This finding is in

agreement with the results of the 2010 surveillance report as well as previous studies on the consumption of commercially available fish and elevated blood mercury levels (Hightower and Moore, 2003; Kale and Goodman, 2002). It should be noted that the sample size in this investigation was not sufficiently large to provide a clear picture of the extent of exposure or the consumption characteristics of consumers. Only two cases (2/166) were under the age of 19 years. Fish consumption could not be investigated in relation to demographic factors because there was little variation in the race/ethnicity and educational level of respondents. In fact, almost most respondents were white and had at least a college degree. The data did not demonstrate specific pattern of blood mercury concentrations related to other potential sources of exposure such as dental amalgams or occupational exposures. This investigation could not determine the contribution of mercury from sources other than fish consumption because urinary mercury levels were not obtained. Furthermore, all persons completing the survey reported some fish consumption, so there could be no comparison to non-fish eaters.

This investigation had a limited ability to determine whether mercury is causing or exacerbating the symptoms that were self-reported. No specific pattern of symptoms related to blood mercury levels was observed. It is important to note that 45% of eligible cases (75/166) had blood mercury levels above 10µg/L, a range of possible concern for developing adverse nervous system effects based on CDC's Case Definition of chemical poisoning (Belson et al., 2005). Only one case had blood mercury levels at or above the neurotoxicity threshold of 50µg/L that is suggested by the ATSDR (ATSDR, 2006). Nineteen percent of cases (32/166) were women of child-bearing age and had levels exceeding what is considered unsafe by the EPA and NAS (i.e. 5 µg/L); however, only two of these women (2/32, 6%) had blood mercury readings above 32µg/L, which is the level that doubles the risk of fetal abnormalities.

Our findings have some limitations:

- Given the attention to methyl mercury in seafood, people who eat more fish are likely to request more testing. This may lead to testing bias. The true population prevalence of elevated mercury levels is unknown in Colorado.
- To date, quality assurance has not been performed to determine the completeness of blood lead level reporting from all laboratories in Colorado.
- A chart review of symptoms reported by cases in the survey was not done. In addition, many symptoms reported by cases to their PCPs can be caused by other conditions (e.g., diseases and chemicals).
- Selection bias may be present since self-reported data is limited by a respondent's memory and ability to answer questions.
- The response rate for the survey was low, and these results cannot be generalized to the population.
- The 2011 surveillance period included only blood mercury results. This limits the ability to investigate exposures to inorganic and elemental mercury from sources such as dental amalgams.
- There was a noticeable homogeneity in the survey respondents in terms of education level attained and race (Appendix A, Table A1).

- Four different laboratories analyzed the blood samples and this may introduce variability in sensitivity, accuracy, etc.

In conclusion, the consumption of commercially available fish from grocery stores and restaurants can result in elevated blood mercury levels. Changes in fish consumption habits may be effective in reducing potentially harmful blood mercury levels. This indicates the need to educate Colorado residents about how to properly select fish to maximize health benefits, while minimizing health risks.

In the future, the mercury surveillance program will explore ways to best reach consumers by working with other CDPHE programs that are also concerned with dietary interventions. Due to the low response rate over a 1-year period, efforts will be made to increase participation by considering other secure means of communications, such as e-mail.

There are no national guidelines for medical providers to use to determine if a mercury test is warranted. Standard guidelines for clinicians would be helpful in guiding mercury testing for the general population or specific subpopulations.

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Appendix – A: Summary Tables and Figures

Figure A1. Reported Blood Mercury Cases in Colorado by County for 2011 surveillance period

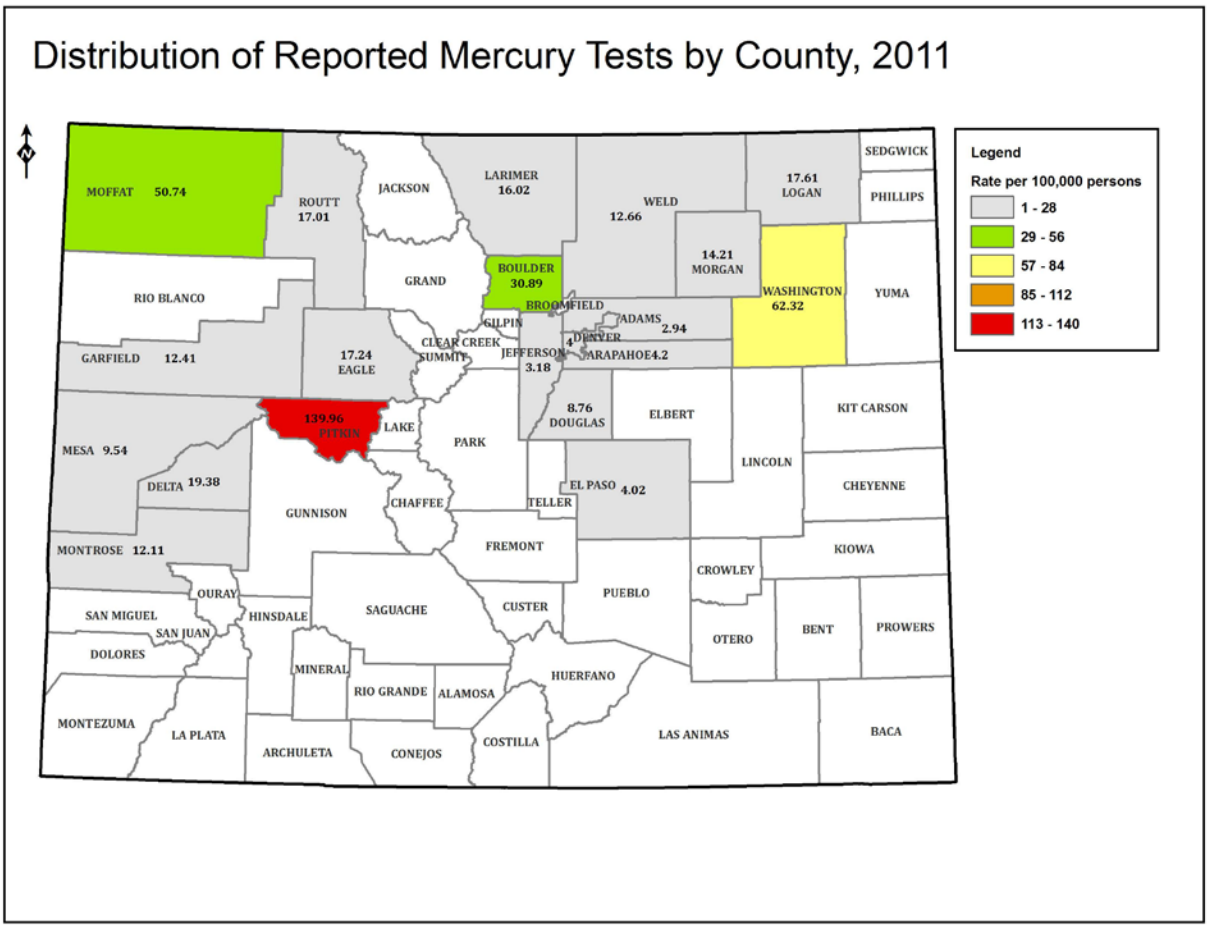

Table A1. Completed surveys: age, gender, and education during 2011 surveillance period

Reportable Blood Mercury Level (PPB, μg/L)	# Completed surveys (% of N=39)	Gender	Education level attained
5-9	25/39 (64%)	F= 17/25 (68%) M = 8/25 (32%)	college, graduate, or professional level education
10-14	7/39 (18%)	F= 4/7 (57%) M = 3/7 (43%)	college, high school, graduate, or professional level education
15+	7/39 (18%)	F= 3/7 (43%) M = 4/7 (57%)	college, high school, graduate, or professional level education
Total	39/39	F= 24/39 (62%) M = 15/39 (38%)	

Note: All cases were nonhispanic white, except one African-American and 1 Hispanic

Table A2. Patients tested more than once in 2011 surveillance period

	Initial Reportable Blood Mercury Level (PPB, μg/L)	Number of persons retested	Average change in Blood Mercury Level (PPB, μg/L)
Patients retested that filled surveys	5-9	0	0
	10-14	2	-5.6
	15+	3	-10.36
	Total	5	– 8.46
Case details for Patients retested that filled surveys	**<u>10-14</u>** Case 1: tested 2 times in 4months and 21 days, mercury level dropped from 11 to 3 (-8) PPB Case 2: tested 3 times in 1 months and 17 days, mercury level dropped from 11.3 to 8.1 (-3.2) PPB **calculation for average change in blood mercury** = (-8)+ (-3.2) = -11.2/2 =- 5.6 **<u>15+</u>** Case 3: tested 2 times in 5 month and 25 days, mercury level dropped from 15.9 to 8.9 (-7) PPB Case 4: tested 3 times in 2 months and 18 days, mercury level dropped from 27.4 to 7.1 (-20.1) PPB Case 5: tested 2 times in 25 days, mercury level dropped from 35 to 31 (-4) PP **calculation for average change in blood mercury** = (-7)+ (-20.1)+ (-4) = 31.1/3 = -10.36 **Average across groups** **(-11.2) + (-31.1) = -42.3/5 = -8.46**		

Table A3. Questions regarding reasons for requesting mercury blood test

Question	Reportable Blood Mercury Level (PPB, □□ g/L	Yes	No	Don't know/ not answered
Were you ever notified of the result of the blood/urine test for mercury?	5-9	17/25 (68%)	7/25 (28%)	1/25 (4%)
	10-14	6/7 (86%)	1/7 (14%)	0
	15+	7/7 (100%)	0	0
	Total	30/39 (77%)	8/39 (20%)	1/39 (3%)
Do you know why your doctor tested for mercury?	5-9	21/25 (84%)	4/25 (16%)	0
	10-14	6/7 (86%)	1/7 (14%)	0
	15+	7/7 (100%)	0	0
	total	34/39 (87%)	5/39 (13%)	0
Do you know how you were exposed to mercury?	5-9	16/25 (64%)	1/25 (4%)	8/25 (32%)
	10-14	3/7 (43%)	3/7 (43%)	1/7 (14%)
	15+	5/7 (71%)	2/7 (29%)	0
	total	24/39 (62%)	6/39 (15%)	9/39 (23%)
Have you had any previous mercury testing in the last 5 years?	5-9	9/25 (36%)	1/25 (4%)	15/25 (60%)
	10-14	2/7 (29%)	4/7 (57%)	1/7 (14%)
	15+	3/7 (43%)	4/7 (57%)	0
	total	14/39 (36%)	5/39 (13%)	16/39 (41%)
Do you have another mercury test scheduled?	5-9	3/25 (12%)	2/25 (8%)	20/25 (80%)
	10-14	1/7 (14%)	5/7 (71%)	1/7 (14%)
	15+	2/7 (29%)	5/7 (71%)	0
	total	6/39 (15%)	12/39 (31%)	21/39 (54%)

Table A4. Questions regarding silver amalgam fillings

Question	Reportable Blood Mercury Level (PPB, µg/L)	Yes	No	Don't know/ not answered
Do you have any silver amalgam dental fillings?	5-9	11/25 (44%)	10/25 (40%)	4/25 (16%)
	10-14	1/7 (14%)	3/7 (43%)	3/7 (43%)
	15+	2/7 (29%)	5/7 (71%)	0
	Total	14/39 (36%)	18/39 (46%)	7/39 (18%)
If you have silver amalgam fillings: have any of your fillings broken in the last 6 months?	5-9	7/25 (28%)	11/25 (44%)	7/25 (28%)
	10-14	1/7 (14%)	4/7 (57%)	2/7 (29%)
	15+	1/7 (14%)	2/7 (29%)	4/7 (57%)
	Total	9/39 (23%)	17/39 (44%)	13/39 (33%)

Table A5: Questions regarding children

Question	Reportable Blood Mercury Level (PPB, µg/L)	Yes	No	Don't know/ not answered
Do you have any children younger than 7 who either live with you, or who frequently visit you?	5-9	4/25 (16%)	21/25 (84%)	0
	10-14	2/7 (29%)	5/7 (71%)	0
	15+	0	7/7 (100%)	0
	Total	6/39 (15%)	33/39 (85%)	0

Table A5.1 Questions regarding children: mercury tests

Question	Reportable Blood Mercury Level (PPB, µg/L)	Yes	No	Don't know/ not answered
If you have any children younger than 7 who either live with you, or who frequently visit you, have these children ever been tested for mercury?	5-9	1/25 (4%)	23/25 (92%)	1/25 (4%)
	10-14	0	7/7 (100%)	0
	15+	0	6/7 (86%)	1/7 (14%)
	Total	1/39 (3%)	36/39 (92%)	2/39 (5%)

Table A5.2. Questions regarding children: exposure to mercury spills

Question	Reportable Blood Mercury Level (PPB, µg/L)	Yes	No	Don't know/ not answered
If you have any children younger than 7 who either live with you, or who frequently visit you, have these children ever been exposed to mercury spill?	5-9	0	12/25 (48%)	13/25 (52%)
	10-14	0	3/7 (43%)	4/7 (57%)
	15+	0	2/7 (29%)	5/7 (71%)
	Total	0	17/39 (44%)	22/39 (56%)

Table A5.3. Questions regarding children: exposed in-utero or via breastfeeding

Question	Reportable Blood Mercury Level (PPB, µg/L)	Yes	No	Don't know/ not answered
Is anyone in the house pregnant or nursing?	5-9	0	24/25 (96%)	1/25 (4%)
	10-14	1/7 (14%)	6/7 (86%)	0
	15+	0	7/7 (100%)	0
	Total	1/39 (3%)	37/39 (94%)	1/39 (3%)

Table A6. Questions regarding symptoms

	Reportable Blood Mercury Level (PPB, µg/L)	Yes	No	Don't know/ not answered
During your original visit, did your doctor identify any of the following signs or symptoms?	5-9	15/25 (60%)	7/25 (28%)	3/25 (12%)
	10-14	2/7 (29%)	3/7 (43%)	2/7 (29%)
	15+	3/7 (43%)	3/7 (43%)	1/7 (14%)
	Total	20/39 (51%)	13/39 (33%)	6/39 (15%)

Table A6.1. Specific Symptoms listed

Reportable Blood Mercury Level (PPB)	Headache	Poor Coordination	Weakness	Malaise	Blurred vision
Total	8	3	7	2	4
5-9	7/8 (88%)	3/3 (100%)	4/7 (57%)	2/2 (100%)	2/4 (50%)
10-14	0	0	2/7 (29%)	0	1/4 (25%)
15+	1/8 (12%)	0	1/7 (14%)	0	1/4 (25%)
Reportable Blood Mercury Level (PPB)	**Depression**	**Numbness / tingling**	**Impaired hearing**	**Short-term memory loss**	**Impaired sense of smell**
Total	2	7	4	7	2
5-9	2/2 (100%)	7/7 (100%)	2/4 (50%)	5/7 (72%0	½ (50%)
10-14	0	0	1/4 (25%)	1/7 (14%)	0
15+	0	0	1/4 (25%)	1/7 (14%)	1/2 (50%)
Reportable Blood Mercury Level (PPB)	**Leg Cramps**	**Insomnia**	**Irritability**	**Loss of Appetite**	**Other**
Total	5	8	5	1	17
5-9	3/5 (60%)	6/8 (75%)	3/5 (60%)	1/1 (100%)	15/17 (88%)
10-14	1/5 (20%)	0	0	0	2/17 (12%)
15+	1/5 (20%)	2/8 (25%)	2/5 (40%)	0	0

*****Other includes: Gingivitis, fatigue, rash, tremor, metallic taste, fever, salivation, and loss of balance**

** Symptoms not reported include: nephritic syndrome, renal failure, proteinuria, social withdrawal

Table A7. 1. Questions regarding fish consumption for patients retested with returned surveys

	Reportable Blood Mercury Level (PPB, µg/L)	Daily	Few times / week	About once / week	Less than once / week
How often do you eat fish or seafood?	5-9	0	0	0	0
	10-14	0	2/2 (100%)	0	0
	15+	2/3 (67%)	1/3 (33%)	0	0
	Total	2/5 (40%)	3/5 (60%)	0	0

Table A7.2. Questions regarding fish consumption: frequency of consumption for all received surveys

	Reportable Blood Mercury Level (PPB, µg/L)	More	Less	No Change	Don't know / not answered
Were you eating more or less fish or seafood before you saw your doctor and had the mercury test?	5-9	9/25 (36%)	3/25 (12%)	13/25 (52%)	0
	10-14	1/7 (14%)	0	6/7 (86%)	0
	15+	1/7 (14%)	0	6/7 (86%)	0
	Total	11/39 (28%)	3/39 (8%)	25/39 (64%)	0

Table A7.3. Questions regarding fish consumption: frequency of consumption for patients retested with returned surveys

	Reportable Blood Mercury Level (PPB, µg/L)	More	Less	No Change	Don't know / not answered
Were you eating more or less fish or seafood before you saw your doctor and had the mercury test?	5-9	0	0	0	0
	10-14	0	0	2/2 (100%)	0
	15+	1/3 (33%)	0	2/3 (67%)	0
	Total	1/5 (20%)	0	4/5 (80%)	0

Table A7.4. Questions regarding fish consumption: origin of fish consumed

	Reportable Blood Mercury Level (PPB, µg/L)	Grocery Store	Restaurant	Caught	Don't know / not answered
Where do the fish you eat normally come from? (More than 1 answer OK)	5-9	23/25 (92%)	2/25 (8%)	0	0
	10-14	7/7 (100%)	0	0	0
	15+	4/7 (57%)	3/7 (43%)	0	0
	Total	34/39 (87%)	5/39 (13%)	0	0

Note: The majority of the respondents use multiple sources for their fish consumption.11/39 had at least 2 options listed

Table A7.5. Questions regarding fish consumption: preparation or preservation of fish

	Reportable Blood Mercury Level (PPB, µg/L)	Canned	Fresh	Frozen	Don't know / not answered
If fish usually come from a *grocery store,* how is the fish packaged? (More than 1 answer OK)	5-9	8/25 (32%)	11/25 (44%)	6/25 (24%)	0
	10-14	1/7 (14%)	5/7 (71%)	1/7 (14%)	0
	15+	1/7 (14%)	3/7 (43%)	2/7 (29%)	1/7 (14%)
	Total	10/39 (25%)	19/39 (49%)	9/39 (23%)	1/39 (3%)

Note: 9/39 had at least 2 options listed

Table A 8. Questions regarding potential occupational exposures

	Reportable Blood Mercury Level (PPB, µg/L)	Yes	No	Don't know/ not answered
In the last 2 years have you, or someone in your household, worked in the following places?	5-9	1/25 (4%)	24/25 (96%)	0
	10-14	0	7/7 (100%)	0
	15+	0	6/7 (86%)	1/7 (14%)
	Total	1/39 (3%)	37/39 (94%)	1/39 (3%)

Table A8.1. Questions regarding potential occupational exposures: specific industry with most occupations listed

Listed Workplace – N=3				
Reportable Blood Mercury Level (PPB, µg/L)	Healthcare	Education	Business	**All others listed
5-9	2/25 (8%)	3/25 (12%)	1/25 (4%)	19/25 (76%)
10-14	1/7 (14%)	0	1/7 (14%)	2/7 (29%)
15+	0	0	1/7 (14%)	3/7 (43%)
Total	3/39 (8%)	3/39 (8%)	3/39 (8%)	24/39 (82%)

All others include: Science, Arts, computer, management, production, Self-employed, Sports, and retired

Table A9. Questions regarding other potential exposures

	Reportable Blood Mercury Level (PPB, μg/L)	Yes	No	Don't know/ not answered
Have you participated in any of the following activities recently given in Table A9.1?	5-9	4/25 (16%)	16/25 (64%)	5/25 (20%)
	10-14	1/7 (14%)	5/7 (71%)	1/7 (14%)
	15+	0/5	5/7 (71%)	2/7 (29%)
	Total	5/39 (13%)	26/39 (67%)	8/39 (20%)

Table A9.1. Questions regarding other potential exposures: listed activities

	Listed Practice or Activity - N=3, MORE THAN ONE SELECTION OK			
Reportable Blood Mercury Level (PPB)	Folk Medicine	Folk Medicine/ fluorescents bulbs	Fluorescents Bulbs	Not answered
5-9	2/25 (8%)	1/25 (4%)	1/25 (4%)	21/25 (84%)
10-14	0	1/7 (14%)	0	6/7 (86%)
15+	0	0	0	7/7 (100%)
Total	2/39 (5%)	2/39 (5%)	1/39 (3%)	34/39 (84%)

Appendix – B: Follow-up Survey

Colorado Department of Public Health and Environment

Adult Survey

Name: Date of Birth:

CONSENT: Laboratories are required to report clinical test results of mercury to the Colorado Department of Public Health and Environment. We follow up on these reports to investigate possible health problems associated with mercury, so we can take actions to reduce/prevent exposures. Sometimes this effort can also help prevent others from getting sick. According to a laboratory report, you recently had a mercury test. In order for us to do our investigation we need some information from you. We would like to ask you some questions about the potential sources of mercury exposure and your medical care. The questions take about 20 minutes and you are free to decline to participate.

There is no risk or direct benefit to you and the facts we collect will be kept private to the level allowed by law. You may refuse to answer any questions or stop the survey at any time. You may contact Raj Goyal at 303-692-2634, if you have any questions about the investigation.

Please check the appropriate response and provide additional details where applicable.

1) Our records indicate that you had a blood/urine test for mercury on 01/07/2011. Were you ever notified of the result?

☐ Yes ☐ No ☐ Don't know

2) Do you know why your doctor tested for mercury?

☐ Yes Explain: _____

☐ No

3) Why did you go to the doctor originally?
Reason for visit: _____

☐ Don't know

4) Do you know how you were exposed to mercury?

☐ Yes Explain: _____

☐ No ☐ Don't know

5) Have you had any previous mercury testing in the last 5 years?

☐ Yes Date (if known): _____
Reason (if known): _____

☐ No ☐ Don't know

6) Do you have another mercury test scheduled?

☐ Yes Date (if known): _____

☐ No ☐ Don't know

7) During your original visit, did your doctor identify any of the following signs or symptoms? **(Please check all that apply in the table below)**

☐ Yes ☐ No ☐ Don't know

Signs/Symptoms					
Headache		Incoordination		Metallic taste	
Weakness		Short-term memory loss		Fever	
Malaise		Impaired sense of smell		Rash	
Blurred vision		Leg cramps		Insomnia	
Social withdrawal		Gingivitis		Loss of appetite	
Numbness/tingling		Nephritic syndrome		Irritability	
Impaired hearing		Renal failure		Salivation	
Tremor		Proteinuria		Depression	
Other (explain)					

8) What is your current occupation?

Describe:_____

9) Where is your place of work (name / industry / location)?

Describe:_____

10) In the last 2 years have you, or someone in your household, worked in any of the following places? (**Please list in the table below)**

☐ Yes ☐ No ☐ Don't know

Work Place	**Self**	**Other (who?)**	**Job Title**
☐ Mine			
☐ Dental Practice			
☐ Electrical or electronic factory			
☐ Laboratory			
☐ Hospital or Doctors' Surgery			
☐ Coal power plant or production process			
☐ Industry making gas pressure regulators (gas meters)			
☐ Waste disposal or incineration site			
☐ Fluorescent tube or chemical production plant			
☐ Chloralkali plant			
☐ Thermometer manufacturing plant			
☐ Crematory			
☐ Any other place using mercury			

11) How long have you lived at your current permanent address? (**Please check one box)**

☐ Number of years:_____

☐ Don't know

12) What type of home do you live in? (**Please check one box)**

☐ Single family, townhouse, duplex,

☐ Mobile or modular home

☐ Apartment or condominium

☐ Other-Describe_____

☐ Don't know

13) Do you have any children younger than 7 who either live with you, or who frequently visit you? (**Please check one box)**

☐ Yes ☐ No ☐ Don't know

14) In the past year, are you aware of any mercury spills that your child may have come in contact with? Examples of mercury spills include broken thermometers, dial thermostats, broken compact fluorescent light bulbs (CFLs). (**Please check one box)**

☐ Yes ☐ No

If you are aware of a spill:

When did this spill occur? Date: _____ Don't know
Who cleaned up the spill? _____ Don't know
How was the spill cleaned? _____ Don't know

15) Have these children ever been tested for mercury? (**Please check one box)**

☐ Yes
Name(s):_____
Age(s): _____
Result(s):_____

☐ No ☐ Don't know

16) Is anyone in the house pregnant or nursing? (**Please check one box)**

☐ Yes # Pregnant:_____ # Nursing:_____

☐ No ☐ Don't know

17) How often do you eat fish or seafood? (**Please check one box)**

☐ Never ☐ Daily ☐ About once/week

☐ Few times/week ☐ About once/month

☐ Less than once/month ☐ Don't know

☐ Less than once/week

18) What portion of fish do you usually eat per meal? 1 portion = 6 oz of cooked fish and 8 oz of uncooked fish (i.e., a portion approximately the size of the palm of your hand or a deck of cards).
Describe:_____

19) Were you eating more or less fish or seafood before you saw your doctor and had the mercury test? (**Please check one box)**

☐ More Describe:_____

☐ Less Describe:_____

☐ No change ☐ Don't know

20) What type of fish do you normally eat? (**Please check one box)**
List: _____(Adding more space for people can list several types of fish)
_____
_____

☐ Don't know

21) Where do the fish you eat normally come from? (**Please check one box)**

☐ Grocery store ☐ Caught

☐ Restaurant ☐ Don't know

22) If fish usually come from a *grocery store*, how is the fish packaged? (**Please check one box)**

☐ Canned ☐ Frozen

☐ Fresh ☐ Don't know

23) If the fish is normally *caught*, where was the fish caught? (**Please check one box and describe)**

☐ Ocean List/describe:_____

☐ River/stream List/describe:_____

☐ Lake List/describe:_____

☐ Don't know

24) Have you participated in any of the following activities recently? **(Please check a box in the table below and describe)**

☐ Yes ☐ No ☐ Don't know

Activity or Practice	**Description**
☐ Religious practices (Azogue, Santeria, Espiritismo)	
☐ Folk Medicine/ Herbal Remedies	
☐ Antiques (clocks, mirrors, lamps)	
☐ Outdated Medicine (laxatives, worming medications, teething powders)	
☐ Photography development	
☐ Broken thermometers/electrical switches	
☐ Fluorescent light bulbs	

25) How many silver amalgam dental fillings do you have? (**Please check one box)**

☐ Yes ☐ None ☐ Don't know
#Fillings:__

26) **If you have silver amalgam fillings:** have any of your fillings broken in the last 6 months? (**Please check one box)**

☐ Yes ☐ No ☐ Don't know
#Fillings:_____

27) When did you last visit the dentist?
Date:_____

☐ Don't Remember

28) Could you please provide the following information so that we can update our records?

- First name:_____
- Middle name:_____
- Last name:_____
- Previous last name (if applicable): _____
- Date of Birth (mm/dd/yyyy):_____
- Gender:_____

Primary address:

- Street Number: _____
- City, State and Zip Code: _____
- Primary phone number:_____
- Alternate phone # (if applicable):_____

If you have lived at this residence for less than 6 months, please provide your previous address:

- Street Number: _____ City: _____
- State: _____ Zip: _____

Alternate address (if applicable):

- Street Number: _____
- City, State and Zip Code: _____

29) How would you describe your race or ethnicity? (**Please check one box)**

☐ White

☐ African American

☐ Asian

☐ Hispanic

☐ Pacific Islander

☐ Alaskan/American Indian

☐ Other:_____

☐ Don't know

30) What is the highest level of education that you have completed? (**Please check one box)**

☐ 7th grade or less

☐ Some high school

☐ High School Graduate

☐ Some College or Technical School

☐ College/ Technical School Graduate

☐ Graduate Degree

☐ Professional Degree

☐ Don't know