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Mercury exposure education provided by women's health clinics in Duval County, Florida

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Abstract

Duval County (Jacksonville, FL, USA) has a long history of environmental health hazards, especially prevalent within its urban core, referred to as Health Zone 1. In 2009, the Duval County Health Department conducted a survey of awareness of and actual exposure to methylmercury among women in the county. The survey found that women with more education or higher incomes had a higher awareness of potential mercury exposures. Furthermore, women in the urban core were less aware and had higher exposure than those in more affluent areas. This study assesses the mercury-exposure awareness and education by healthcare providers serving women of child-bearing age. We surveyed 28 women's health clinic offices. Sixty-one percent (17/28) indicated that they provide mercury exposure education to female patients, either written or verbal. Of these, only half (8/17) provide written education materials. Ninety-three percent of the providers indicated that a benefit to providing education on mercury exposure, is having "healthier developing fetuses and young children in the community". Two barriers identified by providers to offering information on mercury exposure and risk were (a) a lack of interest among patients, and (b) a lack of clear, understandable educational materials. The long-term goal of our * -8project is to develop and distribute culturally effective, low literacy materials for distribution by health clinics, to document the increased awareness of mercury exposure risks, and to lessen the adverse health outcomes that may result from mercury exposure among vulnerable population groups in Duval County.

Keywords: awareness; Duval County; education; health zones; mercury exposure; women of childbearing age.

Introduction

Mercury is a versatile and ubiquitous element existing in the environment in both inorganic and organic forms. Several forms of mercury can be harmful to humans. Methylmercury, a kind of organic mercury, is formed when water-based bacteria cause inorganic mercury to bind with carbon. This form of mercury is the most toxic to humans (1). Phytoplankton feed on the bacteria that convert mercury into methylmercury. The methylmercury is then passed up the food chain until it accumulates in the tissues and muscles of large, predatory fish, such as swordfish, shark, barracuda, walleye, large tuna, and sea bass, a process called bioaccumulation. The mercury levels of larger fish can be up to one million times higher than ambient water mercury levels (1).

Women of childbearing age are at increased risk for methylmercury exposure if they consume too much of certain types of fish. The mercury readily crosses the placenta and enters the nervous system of the fetus, thus causing neurologic damage to the fetus (2). The United States Environmental Protection Agency (US EPA) states that neonates who have been exposed to methylmercury as a fetus can be born with developmental issues, such as impaired "cognitive thinking, memory, attention, language, and fine motor and visual spatial skill". In adults, mercury exposure can result in "impairment of the peripheral vision, disturbances in sensations ('pins and needles' feelings, usually in the hands, feet, and around the mouth), lack of coordination of movements, impairment of speech, hearing and walking, and muscle weakness" (3).

The most well-known case of severe methylmercury exposure from fish consumption occurred in Minamata, Japan in the 1950s, when high concentrations of mercury were expelled from industrial plants into nearby waterways (4). Of the 2252 individuals diagnosed as having Minamata disease from this outbreak, 1043 died (5). The Minamata outbreak resulted in newborns with severe developmental disabilities, including "cerebral palsy, mental retardation, and seizures" (4, 6). Another large population exposure occurred in Iraq

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in the 1970s due to contaminated bread (7). Similar to the Minamata outbreak, study of the Iraq outbreak revealed that adverse health effects in young children could occur at mercury exposure levels as low as 10–20 ppm in maternal hair (8). Both outbreaks provide valuable population-based information on the relationship between level of environmental mercury exposure and the health impact on adults, children, and developing fetuses.

A recent study reported that methylmercury exposure among pregnant women results in a broader range of adverse effects on the fetus than had previously been appreciated. In a 2007 study conducted by Xue et al. (9) at the Harvard School of Public Health, women who delivered prematurely (before 35 weeks' gestation) were found to have higher hair methylmercury levels than women who delivered at term. This study is the first of its kind to investigate the relationship between preterm birth and mercury levels of pregnant women.

The US EPA and other environmental agencies have identified the following as the most vulnerable population groups for methylmercury exposure—women of childbearing age including pregnant women, nursing mothers, the developing fetus and young children (10). A blood analysis report on mercury for the 1999–2000 National Health and Nutrition Examination Survey (NHANES) indicates that 8% of women 16–49 years old had a blood-mercury level above the US EPA recommended level of 5.8 $\mu g\ L^{-1}$ (2). The US EPA and the Centers for Disease Control and Prevention (CDC) estimate that perhaps more than 300,000 newborns per year may be at risk for developmental disabilities associated with methylmercury exposure (2).

Duval County, Florida

Unique to Duval County, is the sprawling St. John's River and the Atlantic shoreline that creates Jacksonville's coastal communities. The river and the beaches are the foundation for Jacksonville's sport fishing industry. The American Sportfishing Association's 2007 "Sportfishing in America" (11) reported that Florida is the number one state for total expenditures related to fishing, with $4.4 billion total expenditures per year and nearly 2.77 million reported anglers (12). As expected from the popularity of fishing, and from being a coastal community, the risk of exposure to mercury from fish consumption is substantial. Residents in the urban core of Duval County may be at especially high risk because they are more likely to fish to provide an additional source of food and to use fishing as an additional source of income. The residents of the urban core also have lower overall education and may lack knowledge of the potential for mercury exposure and its health impact.

The residents of Duval County are also exposed to mercury from ash produced by electricity-producing incinerators used from the 1950s to the present. The ash from the incinerators was used as land fill, predominantly in the urban core of Jacksonville. Mercury, along with lead, arsenic, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and dioxins, has been uncovered in the soils, surface water, ground water, and sediments of the ash sites in many local neighborhoods, predominantly in the inner-city areas (13). Additionally, the US EPA reported Duval County as having the highest mercury emissions for all counties in the state of Florida in 2003 (14), accounting for 21% of the state's total mercury emissions by power plants (14). The US EPA reports that Florida is ranked 11th among states for levels of mercury emissions from power plants. Furthermore, of the total mercury air emissions in the state of Florida, the majority (91%) are due to power plant emissions. In 2005, the US EPA created the Clean Air Mercury Rule, recognizing the dangers of mercury emissions, and limiting the amount of mercury emissions from coal-fired power plants (15). Thus, the significant power plant industry in Duval County causes concern among environmental health experts and the community, as mercury enters the surrounding air, water, and soils of Jacksonville.

Because of the potential for mercury exposure in Florida and other states, efforts are growing to study this issue. For example, the 2009 Pregnancy Risk Assessment Monitoring System (PRAMS) surveillance project added a question to determine if the provider had discussed with the pregnant woman "how eating fish of high mercury levels could affect the baby" (16).

Mercury exposure awareness and education

The US EPA and the US Food and Drug Administration (US FDA) have created educational advisories on the risks of mercury exposure for women, targeting women of childbearing age, women who are pregnant, nursing mothers, and mothers of young children (10). The recommendations suggested by these organizations include dietary guidelines for fish consumption and provide general information to the public. Local agencies have created more specific education on advisories, including the National Listing of Fish Advisories (17) (which allows individuals to research specific state, tribal, and federally issued fish consumption advisories) and a booklet titled "Your guide to eating fish caught in Florida" (10).

Although advisories and education are available, many residents remain unaware of the dangers of mercury exposure. A 2008 study conducted in Pensacola, a coastal community on Florida's panhandle, used hair sampling to test the mercury levels of women of childbearing age (16–49 years) and surveyed the women about their mercury awareness (18). The results indicated that the women with significantly elevated mercury levels had consumed fish within 30 days before sampling (18), and that only a minority (31%) of women were aware of these advisories (18). In the summer of 2009, the Duval County Health Department's (DCHD) Environmental Health Division conducted a study to assess the mercury levels in women of childbearing age throughout Duval County, as well as to document their awareness of the risks of mercury exposure. The study surveyed 703 women of childbearing age (18–49 years of age) residing throughout Duval County and performed mercury hair tests to identify mercury levels. The study found that 63.4% of the women surveyed knew about the relationship between fish consumption and mercury exposure, and only 15.7% reported being aware of specific fish consumption advisories. The study found that increasing age

and higher education were associated with higher awareness of the risks of mercury exposure. Similarly, White/Caucasians and Asian/Pacific Islanders reported a higher level of mercury awareness. Finally, the residents in the urban core of Jacksonville (Health Zone 1), which is also the poorest area in Duval County, had the lowest level of awareness of the risks of mercury exposure.

We determined to conduct a survey of women's health providers in Duval County to determine the degree to which they are providing information on mercury exposure to women of childbearing age and pregnant women. We also sought to identify provider-perceived barriers and motivating factors related to the provision of education on mercury exposure.

Methods

Participant selection

We used the 2009–2010 Jacksonville and Northeast Florida Healthcare Guide, the local yellow pages, and various internet searches to create a list of 68 clinics or private practice offices that provided healthcare for women of childbearing age. Women's health providers included obstetricians, gynecologists, women's clinics, DCHD clinics, birth centers, and pregnancy centers.

Instrument: Duval County mercury exposure women's health provider survey

The survey was developed by a research team from the University of Florida College of Medicine-Jacksonville's Center for Health Equity and Quality Research (CHEQR) and the DCHD Environmental Health Division. The survey consisted of a 17-item questionnaire with answer choices in a checklist format, designed to capture a comprehensive viewpoint of the participants. A fax/e-mail version and a telephone version were developed. Each participant was asked to complete the survey by telephone and if unable to complete the survey by telephone, were offered to complete the survey by fax/email. The survey included questions about the health center's patient demographics, as well as the types and methods of mercury exposure education provided.

The survey is modeled to identify key barriers and motivators for the office to provide education on mercury exposure. The barriers and motivators are based on Health Belief Model (HBM), which includes "perceived susceptibility", "perceived severity", "perceived benefits", and "perceived barriers" of undertaking a health behavior, which in this case was the provision of education on mercury exposure by the office (19). Questions were asked about the providers' perceptions of their patients' susceptibility to mercury exposure, the clinic effects of mercury exposure, and the benefits or barriers to providing mercury exposure education (20). "Cues to action" and "self-efficacy", which lead to the "likelihood to action" in the HBM, were addressed with the final questions of the survey, which ask if the provider would be willing to implement and use an educational packet on mercury exposure for their patients in the future. For those that answer 'yes' to this question, a "cue to action", such as receiving free educational materials from the DCHD may be a catalyst to the practice providing education. Moreover, those that answer 'yes' are indicating their belief that they are capable of providing education if given the tools (high self-efficacy).

The clinics were asked to describe the demographics of the patient population that they serve to determine if any of these characteristics are associated education practices. We characterized the clinics by geography, which is organized by 6 health zones (HZ) (Figure 1). HZ 1 is the urban core of Jacksonville. We also characterized the clinics by distribution of patient insurance types. We also asked the respondents if they could identify populations of women at risk for unsafe levels of exposure to mercury.

Protocol for calling women's health clinics

Each health provider was contacted by phone. A brief summary describing the survey was read. Then, the interviewers asked to speak to the person who could best answer the survey, which often was a nurse supervisor or office manager. Once the appropriate representative for the clinic was on the phone, the representative was asked to complete the survey either by phone, fax, or email. The representatives were also asked to provide copies of any written mercury exposure education that they distribute to their patients. Data were collected over a 2-week time frame in April of 2010. Completed surveys were entered into a Microsoft Excel database, and then exported into SPSS 18.0 for data analysis. Univariate statistics for each question were calculated.

Results

Health belief model and mercury exposure education

Perceived susceptibility: demographic Of 68 women's health clinics and centers contacted, 28 surveys were returned, for a response rate of 41%. A demographic breakdown of the participating clinics and centers is provided in Table 1. The majority of clinics and centers that returned the surveys were obstetrics/gynecology offices (61%). All HZs were represented by a response from at least one health center, but the greatest number of responses came from HZ 1 and HZ 2, as these health zones have the greatest number of providers and clinics within Duval County.

Of 28 clinics and centers, 17 (61%) reported that they routinely provide information on mercury exposure to their patients. All clinics and centers responding from HZ 4 Southwest and HZ 6 Beaches provided routine education (Table 2). Among the clinics located in HZ 1 Urban Core, 67% reported that they routinely provide information on mercury exposure to their patients. The health centers that responded to the survey serve a broad range of racial, ethnic, and socioeconomic communities (Table 1). Half of the clinics and centers (50%) serve a patient population primarily of White Non-Hispanics, whereas 29% serve a patient population primarily of Black Non-Hispanics. For payer source, 39% of clinics reported that most of their patients pay by private insurance, whereas 29% reported that most of their patients pay primarily by Medicaid. Surveys were most frequently completed by nurses (36% of clinics), followed by managers (29%).

Perceived severity For the question "how often do patients ask about mercury exposure", 61% responded "not very often", 29% responded "never", 7% responded "often",

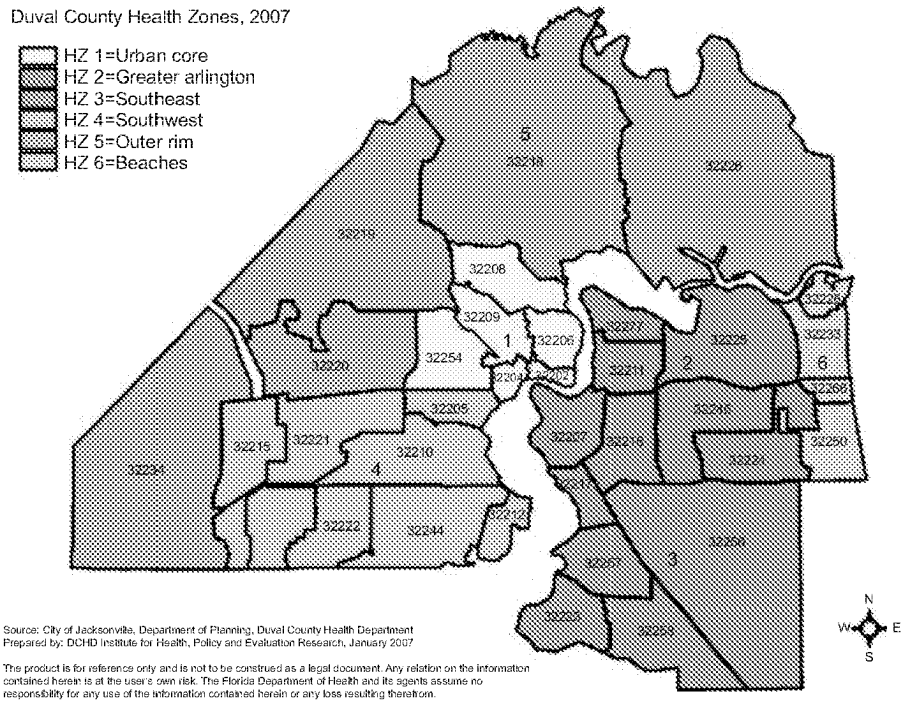

Figure 1 Duval County health zones.

and 4% did not respond to the question (Table 3). In response to the question "who do you provide mercury exposure education to" 82% said "all pregnant women," and 24% said "women who specifically ask about it" (Table 4).

Perceived benefits Of the 17 clinics and centers reporting that they routinely provide mercury exposure education, written, verbal, or both, 8 (47%) reported providing written information to their patients, whereas 16 (94%) reported

Table 1 Demographics of participating clinics and centers.

Demographics	n=28	n, %
Type of clinic or center	OB/GYN	17 (60.7)
	Pregnancy counseling and birth centers	5 (17.9)
	GYN and GYN/ONC	3 (10.7)
	DCHD and women's clinics	3 (10.7)
Clinic or center by health zone	HZ 2 Greater Arlington	12 (42.9)
	HZ 1 Urban Core	9 (32.1)
	HZ 5 Outer Rim	3 (10.7)
	HZ 6 Beaches	2 (7.1)
	HZ 3 Southeast	1 (3.6)
	HZ 4 Southwest	1 (3.6)
Type of person completing survey	Nurse	10 (35.7)
	Manager	8 (28.6)
	Midwife	4 (14.3)
	Other	4 (14.3)
	Unknown	2 (7.1)
Patient population of clinic or center is primarily:	All ages of women at all stages of their lives	18 (64.3)
	Women of childbearing age	7 (25.0)
	Pregnant women	1 (3.6)
	Other	2 (7.1)
Half or more of the patient population's race/ethnicity is:	White Non-Hispanic	14 (50.0)
	Black Non-Hispanic	8 (28.6)
Half or more of the patient population's payer source is:	Private insurance	11 (39.3)
	Medicaid	4 (14.3)
	Self-pay	4 (14.3)

Table 2 Clinics and centers by health zone that routinely provide mercury exposure.

Health zone	n	n, %
HZ 1 Urban core	9	6 (66.7)
HZ 2 Greater Arlington	12	6 (50.0)
HZ 3 Southeast	1	0 (0.0)
HZ 4 Southwest	1	1 (100.0)
HZ 5 Outer rim	3	2 (66.7)
HZ 6 Beaches	2	2 (100.0)

providing verbal education (Table 5), with 41% reporting that they provide both written and verbal education. Of the 17 who routinely provide mercury exposure education, the two highest responses for the question "what kind of mercury exposure information is provided" were, "the amount of fish that should be eaten" (12/17), "the types of fish that have high levels of mercury" (12/17); and 10/17 reported they communicated "the types of fish with low-levels of mercury". Eight of the 17 (47%) reported providing all three types of information.

In response to the question "how much time is spent discussing mercury exposure", 81% of those providing verbal education reported that 1–2 min was spent (Table 5). Moreover, the question was asked if there were benefits to providing mercury exposure education. Of the multiple-choice answers, the highest response was 93% reporting a benefit would be having "healthier developing fetuses and young children in the community" in addition to other benefits that were reported (Table 3).

Perceived barriers For the 11 clinics and centers reporting that they did not routinely provide mercury exposure education, common responses included "they don't know why", "they never thought about it", "there is a lack of educational materials", and "it's not their duty". Reported barriers to providing mercury exposure education to patients included, "lack of interest from patients" reported by 54%, "lack of clear, understandable educational materials" reported by 50%, "lack of time" reported by 36%, "lack of expertise" reported by 36%, "lack of educational materials in different languages" reported by 17% (Table 3).

Cues to action and self-efficacy

When the question was asked if mercury exposure education packets would be used if they were provided by the DCHD free-of-charge, most clinics and centers, 23/38 (82%), said they would be willing to use the education packets (Table 6). Of those who routinely provide mercury exposure education, 14/17 (82%) reported they would use the education packets. For those who reported that they do not provide mercury exposure education, 9/11 (82%) reported that they would be willing to use the mercury exposure education packets.

Discussion

More than half of the clinics and centers we surveyed reported that they provide some type of mercury exposure education to their patients, in written or in verbal form. For those that provide education, verbal education was provided almost all of the time, whereas written education was provided only about half of the time. Many clinics and centers indicated that a lack of clear, understandable educational materials was a barrier to providing written education, and a minority stated that the lack of educational materials in different languages was also a barrier. Therefore, the development of clear, understandable, culturally sensitive, multi-lingual, written educational materials is needed to enable health providers to improve their education of women of childbearing age on the risks of mercury exposure.

Although some studies have explored the healthcare providers' perspective on providing food safety education to their pregnant women patients (21), no study has focused specifically on education related to mercury exposure. A study conducted by Morales et al. (21) reported that, of the 23 healthcare

Table 3 Perceptions of mercury exposure and mercury exposure education.

Perceptions of mercury exposure and mercury exposure education	n=28	n, %
How often patients ask about mercury exposure	Not very often	17 (60.7)
	Never	8 (28.6)
	Often	2 (7.1)
	Did not respond	1 (3.6)
Barriers to providing mercury exposure education	Lack of interest from patients	15 (53.6)
	Lack of clear, understandable educational materials	14 (50.0)
	Lack of time	10 (35.7)
	Lack of expertise	10 (35.7)
	Lack of educational materials in different languages	5 (17.9)
	Other barriers	4 (14.3)
Benefits to providing mercury exposure education	Healthier developing fetuses and young children	26 (92.9)
	More awareness of mercury exposure in women	18 (64.3)
	More women will limit fish consumption	18 (64.3)
	Healthier women	16 (57.1)
	Patients will be empowered to learn about more	15 (53.6)
	Environmental health issues other benefits	1 (3.6)

Table 4 What and who the mercury exposure information is provided to.

Mercury exposure education	n		n, %
What kind of mercury exposure information is provided	17	Amount of fish that should be eaten	12 (70.6)
		Type of fish w/high Hg	12 (70.6)
		Types of fish w/low Hg	9 (52.9)
		All three	8 (47.1)
The groups of women mercury exposure information is provided to	17	All pregnant women	14 (82.4)
		Women who specifically ask about it	4 (23.5)

providers interviewed, slightly over one-third stated that they provided food safety information to their pregnant women population. Some healthcare providers noted barriers similar to those described by our participating healthcare providers, i.e., limited time with patients and limited understanding of food safety issues. The Morales study concluded that the best method for implementing food safety education was to have it performed outside the providers' offices by public health or Women, Infants, and Children (WIC) professionals.

The providers in our study also reported that patients rarely ask about mercury exposure, suggesting that awareness and interest about this topic are low among women of childbearing age. The lack of demand for information from patients related to the risks of mercury exposure may reduce the motivation of the providers to address this issue. Thus, there seem to be two significant barriers: a lack of awareness and interest among patients, and a lack of resources for providers to educate patients on the risks of mercury exposure. These two findings are consistent with the low-level of public awareness of this issue found in the 2009 Duval County Mercury Biomonitoring Study.

The limitations for this study include a relatively low response rate, which may have introduced a response bias. Those more interested in this topic (and more likely to provide education related to it) may have been more likely to respond, resulting in an overestimation of clinics that do provide education. Another limitation was that the contacted clinics did not include family practice primary care clinics, leaving a gap in information about the provider education for the women being seen in those clinics. One of the challenges in this study was obtaining someone in the clinic who could accurately answer the survey by phone on the first attempted call. However, the respondents were staff, nurses, and administrators, who should be aware of office practices on this issue. The strength of the study is that it is one of the first to document the practices of providers related to education on mercury exposure, even though the response rate was relatively low.

Health belief model implications

Whereas the majority of the clinics and centers reported providing education on mercury exposure, most did so verbally. Most clinics reported that they were likely to provide education on mercury exposure only to "all pregnant women", suggesting that the common perception is that only pregnant women are at a high enough risk to receive education. However, the education should be expanded to

Table 5 Written and verbal mercury exposure education that is provided.

Written mercury exposure education	n		n, %
Of those that provide education: written information is provided	17		8 (47.1)
Only written information is provided	17		1 (5.9)
Provided copies of written information	8		3 (37.5)
Who provides written information	8	Physician/PA/ARNP	5 (62.5)
		Nurse	5 (62.5)
		Medical assistant/ allied health prof.	3 (37.5)
Verbal mercury exposure education			
Of those that provide education, verbal education is provided	17		16 (94.1)
Of those that provide education, only verbal education is provided	17		9 (52.9)
Who provides verbal education	16	Physician/PA/ARNP	9 (56.3)
		Nurse	8 (50.0)
		Medical assistant/ allied health prof.	4 (25.0)
How much time is spent discussing it	16	1–2 min	13 (81.3)
		3–5 min	2 (12.5)
		Did not respond	1 (6.3)
Both written and verbal education			
Of those that provide education: both written and verbal education is provided	17		7 (41.2)

Table 6 Clinics and centers that will use the mercury exposure education packets.

Will use mercury exposure education packets	n	n, %
Of total completed surveys:	28	23 (82.1)
Of those who provide mercury exposure education:	17	14 (82.4)
Of those who do not provide mercury exposure education:	11	9 (81.8)
Will use mercury exposure education packets by health zone	n	n, %
HZ 1 Urban core	9	9 (100.0)
HZ 2 Greater Arlington	12	10 (83..3)
HZ 3 Southeast	1	1 (100.0)
HZ 4 Southwest	1	0 (0.0)
HZ 5 Outer rim	3	3 (100.0)
HZ 6 Beaches	2	0 (0.0)

all women of childbearing age. Unplanned pregnancies are common, and a shift to prevention is crucial to reduce the risk related to mercury exposure. The results delineate an overall high self-efficacy to provide patient education on this subject in the future, if supplied with appropriate educational materials.

Our study shows that there is room for improvement in providing mercury exposure education to women in Duval County. As a result of this study, the DCHD plans to develop an education packet of written materials that are comprehensive, yet low literacy and culturally competent, appropriate for all women in all areas of the County. We propose that the provision of free, multi-lingual educational materials on mercury exposure could improve both the number of clinics providing education and the quality of the information communicated. The clinics in the urban core and the outer rim of Jacksonville reported that they would use education packets provided by the DCHD free-of-charge. Both areas have noticeable disadvantages compared with other HZs, the urban core having the lowest average median household income and the outer rim being a semi-rural region with barriers to accessing healthcare. The DCHD plans to work with women's health clinic providers and encourage them to distribute the educational materials and to increase the time spent discussing mercury exposure with their patients. The goal is for providers to educate all women of childbearing age and not focus just on those that are pregnant. Future follow-up studies may be conducted to monitor the impact of this intervention, hopefully documenting increased community awareness of the risks of mercury exposure and increased participation by providers in the education effort.

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