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Assessment of fish consumption and mercury exposure among pregnant women in Jamaica and Trinidad & Tobago

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HIGHLIGHTS

- The preference of maternal fish intake is dependent on the country's captured fish production.
- Pregnant women in the Caribbean are susceptible to mercury exposure from fish intake.
- Consumers of large ocean pelagic fish have higher placental mercury concentrations.
- Consumers of small pelagic and reef finfish have lower placental mercury concentrations.

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ABSTRACT

Background: Fish is an essential and traditional element in the diet of most Caribbean people. However it also contains methylmercury which can have severe effects on fetal neurodevelopment. The objective of this study was to assess the fish intake of a selected group of pregnant women from Jamaica and Trinidad & Tobago and evaluate prenatal mercury exposure, using the placenta as a biomarker.
Method: Food frequency questionnaires and placental samples were obtained from participating parturients at the time of delivery at the University Hospital of the West Indies in Kingston, Jamaica (N = 100, from November 2012 to March 2013) and the Mt Hope Women's hospital in St Joseph, Trinidad & Tobago (N = 30, in June 2015). The participants were asked to identify the species of fish and the frequency of consumption. Placental samples were analysed for mercury using cold vapour atomic absorption.
Results: The fish consumption preferences for pregnant women, varies based on the marine fish catch production of each country. The main fish species that contributed to the highest estimated methylmercury exposure in Jamaica and Trinidad & Tobago were cod and shark, respectively. There was a weak association between maternal fish intake and placental mercury concentrations. The mean placental mercury concentrations in Jamaica and Trinidad & Tobago were 0.74 ± 0.5 μg/kg and 1.46 ± 0.6 μg/kg, wet weight respectively.
Conclusion: The results from this study showed an influence of Caribbean fish intake preferences on mercury exposure and thus a recommendation for continuous bio-monitoring for public health purposes.

1. Introduction

Fish is a traditional and essential element in the diet of most Caribbean people. The fishing industry is also an important source of livelihood in the Caribbean community (CARICOM). The overall consumption of fish per person in Caribbean countries is about 31 kg/yr (Masters, 2012). This is well above the global average per person of 16.4 kg/yr in 2006 (Secretariat, 2016). The fish consumption per person in some Caribbean countries, could be as high as 69 kg/yr and 66 kg/yr in Antigua & Barbuda and Anguilla, respectively (Masters, 2012). Fish is critical for a healthy diet. It contains omega 3 fatty acids and vitamins D and B12, which are important for brain development and reducing the risk of heart

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attacks (Washington State Department of Health, 2016). However, there has been heightened concern about the presence of toxic methylmercury in fish (American Heart Association, 2015). Fish consumption was shown to be a major contributor to daily methylmercury intake for coastal populations (Cheng et al., 2013).

Mercury exposure is of global concern in pregnant women because of placental transfer to the fetus (Karagas et al., 2012). The usual biomarkers for determining prenatal exposure to mercury are maternal hair, maternal blood and cord blood (Sakamoto et al., 2007). While these have some value, there are noteworthy limitations. For example, mercury concentrations in maternal blood and hair may vary over different periods of pregnancy, and the relationship between mercury in cord blood and maternal blood can fluctuate (Basu et al., 2014). Some of these limitations may be overcome by studying the placenta, which integrates fetal exposure for almost 36 weeks. In addition, the placenta is considered a non-invasive, real time monitoring specimen that can reveal both maternal and fetal exposure to elements (Iyengar and Rapp, 2001). Therefore the mercury concentrations in placenta could be a suitable biomarker, though few studies have examined maternal fish consumption and placental mercury concentrations (Ask et al., 2002; Bjornberg et al., 2005; Hsu et al., 2007).

Research on mercury exposure in the Caribbean is increasing. In a previous Caribbean study, the most common fish species consumed in Barbados was flying fish, marlin and tuna. It was found that hair mercury concentrations for Barbadians significantly increased when participants consumed 'high risk' fish (such as tuna and marlin) (Drescher et al., 2014). Another study found that mercury concentrations in the blood of pregnant women in the Caribbean were two times higher when compared to Canada and the US. This was primarily due to the frequency and fish species preference of Caribbean people. The study also showed that blood mercury concentrations vary across each island (Forde et al., 2014).

The purpose of the study was twofold: A) to characterize the fish consumption patterns of a selected group of pregnant women from Kingston in Jamaica and St. Joseph in Trinidad & Tobago, and B) to increase understanding of prenatal mercury exposure by characterizing mercury levels in the placenta. The outcomes of this study are expected to increase understanding of fish consumption in the Caribbean region along with associated concerns of mercury exposure, and together such research is needed for the purposes of public health but also to help countries meet obligations associated with the UN Minamata Convention on Mercury Pollution (Gustin et al., 2016).

2. Materials and methods

2.1. Participants

Ethical approval was granted from the ethics committee of the Faculty of Medical Sciences at The University of the West Indies Mona and St. Augustine campuses. Placental samples were collected and dietary surveys administered to participants at the University Hospital of the West Indies in Kingston, Jamaica (N = 100) and the Mt. Hope Women's hospital in St. Joseph, Trinidad & Tobago (N = 30). In both sites participants were recruited via convenience sampling. The sample collection was carried out during November 2012–April 2013 and June 2015, respectively. Informed consent was obtained from each participant. The female population of child bearing age (18–44 years) for Jamaica and Trinidad & Tobago were approximately 591,567 and 264,424 respectively (Statistical Institute of Jamaica, 2014; Central Statistical Office, 2015). Each tertiary teaching hospital institution is situated in the capital cities for both countries. There was no known occupational exposure to mercury among the participants. Both countries have different fish consumption preferences due to their fisheries sector mechanism.

2.2. Fish intake

Food frequency questionnaires were administered to participating parturients at the time of delivery. The frequency of fish consumption and the approximate amount of fish intake, using a Food Frequency Questionnaires (FFQ) similar to ones used previously (Bjornberg et al., 2005; Goodrich et al., 2016). In the current study, the participants were asked questions on 12 fish and 4 canned fish known to be commonly consumed in both countries. They were also given an option to suggest other types of fish not included in the list. Participants completed surveys detailing their fish consumption patterns within the last 3 months. The intake options included never, once/month, 2–3 times per month, once/week, 2–3 times per week, 4 or more times per week. Participants also reported consumption frequency, portion size and species.

2.3. Methylmercury intake

The mean mercury concentrations in fish were obtained from a compilation of the literature in Table 1. The mercury concentration in some Jamaican fish was obtained from a preliminary seafood assessment (Fletcher et al., 2005). The mercury concentration of the remaining varieties of fish was obtained from a large database maintained by the U.S. Food and Drug Administration (Karimi et al., 2012). The estimated methylmercury ingested dose was calculated based on daily fish intake, the mercury concentration in each species and body weight. The mean body weight for participants was 77 kg.

The basic equation to estimate methylmercury intake per body weight (μg/kg/d) is (World Health Organization, 2008):

$$\frac{\textit{Amount of fish ingested}\ \left(\frac{g}{d}\right)\ *\ \textit{Hg concentration in the ingested fish}\ \left(\frac{\mu g}{g}\right)}{\textit{Body weight}\ (\mathrm{kg})}$$

2.4. Mercury analysis

Approximately a quarter of the flat part of the placenta from the region of the umbilical cord was severed with a surgical blade. It was then placed in a sealed plastic bag and stored in a freezer at −18 °C. The samples were dried in the drying oven (Memmert, Schwabach, Germany) at 60 °C. The oven was set to maintain a constant temperature for approximately 96 h. The sample was removed from the oven and weighed intermittently every 30 min until a constant dry weigh was obtained. Mercury levels were measured following United States Environmental Protection Agency (US EPA) method 245.6 using the 400 A mercury analyzer.