Reproductive Toxicology 71 (2017) 78–83

Contents lists available at ScienceDirect

Reproductive Toxicology

journal homepage: www.elsevier.com/locate/reprotox

Factors associated with mercury levels in human placenta and the relationship to neonatal anthropometry in Jamaica and Trinidad & Tobago

Phylicia Ricketts[a,*], Horace Fletcher[b], Mitko Voutchkov[a]

[a] Department of Physics, The University of the West Indies, Mona, Kingston 7, Jamaica
[b] Department of Obstetrics and Gynaecology, The University of the West Indies, Mona, Kingston 7, Jamaica

ARTICLE INFO

Article history:
Received 21 June 2016
Received in revised form 18 April 2017
Accepted 27 April 2017
Available online 28 April 2017

Keywords:
Placenta
Mercury
Neonatal anthropometry
Caribbean
Fish intake

ABSTRACT

The aim of this study was to investigate the mercury levels in human placenta and its relationship to neonatal anthropometry for a group of selected pregnant women in Kingston and Manchester in Jamaica and St. Joseph in Trinidad & Tobago.

The participants were interviewed on their fish intake. Neonatal anthropometric data were also recorded. The placental mercury concentrations ranged from 0.64 ± 0.5 μg/kg to 1.4 ± 0.6 μg/kg. The most significant associated factor for prenatal mercury exposure was maternal fish intake. Those pregnant women who regularly ate shark recorded the highest placenta mercury concentrations. Their neonates also had slightly smaller mean head circumference and lower birth weight.

The mean placental mercury concentrations in this study were found to be lower than the literature values. Therefore it was difficult to detect any significant changes in neonatal anthropometry. This type of study can contribute to the extent of mercury exposure in the region.

1. Introduction

Mercury is a toxic substance which exists in three chemical forms: elemental, inorganic and organic. The organic form of mercury (methylmercury) is a concern for public health [1]. Human exposure to high levels of mercury can have negative effects on the central nervous system. The most common routes of mercury exposures are inhalation from polluted air, dermal contact and ingestion of contaminated food [1]. The potential sources of elemental and inorganic mercury are from dental amalgams [2] and industrial processes [3], while the primary source of methylmercury is from fish intake [4]. 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 attacks [5]. Since fish consumption is an essential tradition for Caribbean people, it is recommended that there should be an advisory for the types of fish to be consumed. Large predatory fish, such as sharks, contains higher mercury concentrations than reef finfish such as snappers [6]. This study was important to evaluate the levels of mercury exposure in Caribbean countries because of their vulnerability to mercury from the environment. Firstly, the overall fish consumption per person in the Caribbean is almost twice the global average [7,8]. Pregnant women from the Caribbean have reported higher blood mercury concentrations than their counterparts in North America particularly due to their traditional fish consumption [9]. Secondly, pregnant women in the Caribbean are known to be exposed to other sources of mercury such as dental amalgams [10]. Another source of mercury exposure may be the use of cough syrup. Some cough syrup may contain mercury-based preservatives in the form of ethyl mercury [11]. Finally, pregnant Caribbean women live in close proximity to industrial activities that release mercury into the environment. Anthropogenic production of mercury from bauxite mining and petroleum refineries takes place in densely populated capital cities [12,13]. In this study, two Caribbean countries were selected (i.e. Jamaica and Trinidad & Tobago) to investigate the impact of prenatal mercury exposure on neonatal anthropometry. These countries are selected because of the variety of fish species consumed and the principal economic activities are bauxite mining in Jamaica [14] and petroleum manufacturing in Trinidad & Tobago [15].

The susceptible target groups for mercury exposures are pregnant women and their neonates. Pregnant women are of great concerns because mercury is able to pass through the placenta to

* Corresponding author.
E-mail addresses: phylrick1@hotmail.com, phylicia.ricketts@mymona.edu.uwi (P. Ricketts).

http://dx.doi.org/10.1016/j.reprotox.2017.04.008
0890-6238/

the fetus [16]. The chemical form of mercury exposure may also be important because each form has different heath effects on the developing fetus. Some reports found that prenatal exposure to elemental mercury may result in miscarriages and birth defects, while methylmercury exposure may result in delayed neurological development during infancy [1]. This current study will used mercury concentrations in placenta to determine any changes in neonate anthropometry. Prenatal exposure to mercury may influence birth outcome measures [17]. Possible neonatal anthropometry that can be affected by mercury exposure are head circumference, body length and birth weight [18]. However, previous studies have shown mixed results or were found to be inconclusive. One study reported that placental mercury ($\sim 7.68 \pm 0.4$ μg/kg) 'significantly influenced head circumference' [17], while the other study reported that, the placental mercury concentrations were 'considerably low' (i.e. 4.1 ± 2.12 μg/kg) to determine any significant differences [18]. Therefore, this current study can add to the existing knowledge on the impact of prenatal mercury exposure.

The standard biomarkers for prenatal mercury exposures are maternal hair, maternal blood, and cord blood. However, these biomarkers are invasive and provide short term monitoring [19]. In this study term placenta, obtained at the time of birth, was selected as the biomarker for prenatal mercury exposure. The collection of placental samples is non-invasive and it allows for long term monitoring of mercury exposure [19]. Mercury is known to cross the placental barrier and accumulate in fetal tissue [20]. Previous studies have shown that mercury concentration in placenta increases with maternal fish consumption [21,22], and placenta is a possible indicator of environmental pollutants [20].

The aim of this study was to assess the associated factors of mercury exposures in a selected group of pregnant women from Kingston and Manchester in Jamaica and from St. Joseph in Trinidad & Tobago, and then investigate the relationship between mercury concentration in the placenta and neonatal anthropometry.

2. Methods and subjects

2.1. Participants

Ethical approval was granted from the ethics committee of the Faculty of Medical Sciences, The University of the West Indies Mona and St. Augustine campuses and the Ministry of Health in Jamaica, to collect placenta samples and administer dietary surveys to participants at the University hospital of the West Indies in Kingston (N = 100) and Mandeville Regional hospital in Manchester (N = 77) from Jamaica and the Mt. Hope Women's hospital in St. Joseph in Trinidad & Tobago (N = 30). The sample collection was carried out during November 2012 – April 2013 and June 2015, *respectively*. Informed consent was obtained from each participant. These groups of women were selected through convenient sampling. Maternal age, the number of dental amalgams, cough syrup intake and maternal residence were recorded. Neonatal anthropometric data (birth weight, Apgar, crown heel length, head circumference) were also obtained from delivery records.

2.2. Fish intake

Food frequency questionnaires were administered to participants about 8 h after vaginal delivery. Those parturient that underwent cesarean section answered the questionnaire prior to delivery. Previous to starting the interview, participants were asked to sign informed consent, and considerations were expressed to ensure their well being conditions for the interview. The frequency of fish consumption and the approximate amount of fish eaten were determined by using Food Frequency Questionnaires (FFQ). This FFQ was designed to include a checklist of fish species and intake options similar to ones used previously [23,24]. In the current study, the participants were asked to recall their average fish consumption during the period of pregnancy. The questionnaire included questions on 12 fresh 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. 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 reported consumption frequency, portion size and species.

2.3. Total mercury analysis

Immediately after delivery, a quarter of the placenta was collected in a clean plastic bag and stored in a freezer at −14 °C, for about two weeks, until ready for mercury analysis. Each sample was dried at 60 °C for 96 h, to remove all the moisture. The samples were then ground to achieve homogeneity.

Total mercury concentrations were measured following United States Environmental Protection Agency (US EPA) method 245.6 using the 400A mercury analyzer. About 0.3 g of dried placental tissue sample was placed in a biochemical oxygen demand (BOD) bottle with 8 ml of concentrated sulfuric acid and 2 ml of concentrated nitric acid. The BOD bottle was placed in a water bath maintained at 80 °C until the tissue completely dissolved (approximately 30 min). The sample was cooled and 15 ml of potassium permanganate and 8 ml of potassium persulfate solutions were added and returned to the water bath and digested for an additional 90 min at 30 °C. The digested sample was diluted with 55 ml of reagent water and 6 ml of sodium chloride- hydroxylamine sulfate solution was added to reduce the excess permanganate. Five (5) ml of stannous chloride solution was then added. A batch of 12 samples was measured daily over a 6 weeks period. Each sample was measured once, with blanks repeated twice and certified reference material measured after every batch. The certified reference material used was IAEA 407 (Fish homogenate). An instrument calibration curve was established by plotting standard concentrations against instrument reading absorbance. A regression statistics, $R^2 = 0.998$ was calculated. The level of detection (LOD) for total mercury in placenta was 0.5 μg/kg. The mean recovery of the reference material was found to be 77–80%.

2.4. Statistical analysis

All data analysis was performed using Windows SPSS version 19. The data was not normally distributed. Initial assessment of residual and normal probability plots were used to identify outliers. Linear regression analysis (multiple R) and Spearman's correlation coefficient were used to determine the relationships between placental mercury concentrations and neonate anthropometry. Non-parametric test (Mann- Whitney U) was used to test the difference in all variables. Descriptive statistics were examined for each variable. Statistical significant levels were set to $p < 0.05$. About 44%–48% of samples analysed for total mercury concentrations were found to be below the method detection limit (MDL), these were classified as 'non-detects'. The substitution method was used where these values were replaced with half of the LOD. All values are reported in wet weight, arithmetic mean and standard deviation, unless otherwise stated.

3. Results

3.1. Dietary survey

The mean maternal daily fish intake was highest in participants from the Kingston group ($38.5\,g \pm 43.4\,g$) and lowest in partici-