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Association of Maternal Fish Consumption with Mercury Levels of New Born Infants in a Tertiary Medical Centre in a Middle Income Country

Foong Ming Moy[1, *], Nuguelis Razali[2], Victor Chee Wai Hoe[1, 3], Golgis Karimi[1], Siti Zawiah Omar[2]

[1]Centre of Epidemiology & Evidence Based Medicine, Department of Social & Preventive Medicine, Faculty of Medicine, Kuala Lumpur, University of Malaya, Kuala Lumpur, Malaysia

[2]Department of Obstetrics & Gynaecology, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia

[3]Centre for Occupational and Environmental Health-UM, Department of Social & Preventive Medicine, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia

Email address

moyfm@ummc.edu.my (F. M. Moy)

[*]Corresponding author

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Abstract

This study aims to investigate the levels of total (T-Hg) and methyl mercury (MeHg) in new born infants and its association with maternal characteristics and fish consumption. A total of 75 Malay women were recruited from a tertiary medical centre in Kuala Lumpur, Malaysia. Data was collected using a self-administered questionnaire. Fish consumption was enquired on the types of fish and frequency consumed. Cord and maternal blood was collected and analyzed for T-Hg and MeHg. More than half (.54%) of the participants consumed fish weekly, 22% monthly and 19% daily. Kembong (Mackerel) (71%), canned fish (24%) and Kerisi (Bream) (20%) were the three most common fish consumed. Both T-Hg and MeHg levels were significantly higher in infant's cord blood ($p < 0.05$). However, the levels of T-Hg and MeHg among infants were within the safe recommended limits. There was a positive correlation between maternal and cord blood in the T-Hg ($r= 0.73$, $p < 0.01$) and MeHg ($r= 0.63$, $p < 0.01$) levels. In the multiple linear regression model, infant mercury level was strongly associated with maternal mercury level; while no significant association was noted between infant mercury level with maternal age and fish consumption. Regular monitoring of the levels of mercury in commonly consumed fish and pregnant women's exposure to mercury should be part of public health surveillance.

Keywords

Total Mercury, Methyl Mercury, Fish Consumption, Pregnancy, Infant

1. Introduction

Mercury is a naturally occurring element in the earth's crusts and is a common environmental pollutant. Mercury is found in three forms; elemental, inorganic and organic mercury. Methyl mercury (MeHg), the predominant form of organic mercury is found in marine environment which is bio-accumulated in the food chain in marine animals. Consumption of seafood provides the primary source of exposure for mercury among human [1, 2]. It is a highly neurotoxic compound to human [3].

Fish is a major source of nutrition in low and middle income countries. Fish intakes lead to better neurodevelopment in children [4] in addition to improving mother's mood [5]. MeHg can cross the placental [6] and blood-brain barrier which then affect brain development in fetus. Pregnant women who consumed large amount of fish were found to have high blood mercury level and even much higher amount were found in the umbilical cord blood [7].

Studies from Hsu et al. [8] found that consumption of two to three servings of fish per week contributed to higher total mercury concentration of maternal blood and cord blood. Prenatal mercury exposure may be associated with reduced placental and fetal growth [9]. Malaysians consume more than 50kg of fish and shellfish per person per year; second highest in Asia, after Japan [10]. The concern is that due to the large amount of fish consumed, the chance of exposure to mercury may increase [7]. Ricketts et al also reported that the most significant associated factor for prenatal mercury exposure was maternal fish intake [11].

To the best of our knowledge, currently there are no published findings in Malaysia, a middle income country, on the levels of mercury in cord and maternal blood and its relation with consumption of seafood. Therefore, this study aimed to investigate the mercury levels (T-Hg and MeHg) in pregnant women and the cord blood; and its relation to maternal characteristics and fish consumption. This will enable better planned health education materials to inform pregnant mothers on the risk of mercury exposure in Malaysia.

2. Method

2.1. Study Design and Subjects

This was a cross-sectional study carried out among Malay women with singleton pregnancy in a tertiary medical center in Kuala Lumpur, Malaysia. Women with complicated pregnancy such as gestational diabetes were excluded. Informed consent was obtained from all participants. This study was reviewed and approved by the Medical Ethics Committee in the University Malaya Medical Centre (UMMC).

Participants were required to complete a self-administered questionnaire on socio-demographic, occupation history, mercury dental filing and the types and frequency of fish consumed during pregnancy.

2.2. Assessment of Blood Mercury Concentration

Blood samples from the mothers were collected before deliveries and cord blood samples were drawn from the placenta end. The analysis of T-Hg and MeHg for both maternal and cord blood were outsourced to an external accredited laboratory. T-Hg was estimated using the accrediated laboratory in-house methods based on USEPA Methods 7473 (Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry) and MeHg using the in-house methods based on USEPA Methods 1630 (Methyl Mercury in Water by Distillation, Aqueous Ethylation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry). The methods were able to detect up to one part per billion (1 ppb) for T-Hg and MeHg.

2.3. Statistical Analysis

Statistical analyses were carried out using SPSS software version 16.0. Descriptive statistics was reported for socio-demographic data, mercury concentration in mother's blood sample and cord blood. Appropriate statistical analysis was applied to determine the association of mercury levels with fish consumption and maternal charateristics. Multiple linear regression was conducted to adjust for confounders. The level of significance was preset at $p<0.05$.

3. Results and Discussion

A total of 75 Malay mother-infants pairs participated in this study. The mean age of mothers was 27.2 ± 4.0 years, slightly more than half of them (53.4%) had tertiary education (college or university) and 78.9% were working during their pregnancy. The mean gestational age was approximately 39 weeks and 55.4% were male infants (Table 1).

Table 1. *Maternal characteristics and mercury levels of mother and infant (n=75).*

Variables	N (%)
Maternal age (mean ± SD) (years)	27.2 ± 4.0
Gestational age (mean ± SD) (weeks)	38.8 ± 1.2
Education levels (mother)	
Up to secondary	35 (46.6)
Tertiary	40 (53.4)
Working status (mother)	
Yes	59 (78.9)
Mercury dental filling (mother)	
Yes	6 (7.4)
Gender (infant)	
Female	33 (44.6)
Male	42 (55.4)
Total mercury (ppb)	Mean (95% CI)
Mother	2.57 (2.31; 2.84)
Infant	3.74 (3.34; 4.16)
Methyl mercury (ppb)	
Mother	1.16 (0.83; 1.47)
Infant	2.28 (1.91; 2.66)

ppb – parts per billion.

Higher levels of T-Hg and MeHg were found in cord blood than maternal blood. This could be due to the transfer of mercury via the placenta. During pregnancy, organic and inorganic nutrients or substances are extensively transferred to the fetus through the placenta. [7] Although infants had higher levels of T-Hg and MeHg than their mothers, the level was within the recommended safe limit of 5.8 ppb [12-14].

More than half of the participants (57%) consumed fish weekly, 22% and 19% consumed fish monthly and daily respectively. Most of the participants consumed fish twice a week or twice a month. There seemed to be an ascending trend in the mean infant T-Hg and MeHg levels with frequency of maternal fish consumption (Table 2); however it was statistically not significant. Similar results were reported by Gao et al [15].

Table 2. *Mean mercury levels of infants and maternal frequency fish consumption.*

Frequency of fish consumption	T-Hg (ppb) Mean (95% CI)	Me-Hg (ppb) Mean (95% CI)
Monthly	3.52 (2.75, 4.30)	2.25 (1.41,.3.08)
Weekly	3.61 (3.13, 4.09)	2.19 (1.80, 2.57)
Daily	4.12 (3.16, 5.08)	2.72 (1.77, 3.67)

Figure 1 shows Kembong (Mackerel), canned fish and Kerisi (Bream) were the three most common fish consumed. Kembong (Mackerel) consumed by more than 70% of participants compared to canned fish and Kerisi (Bream) which were only approximately 20%.

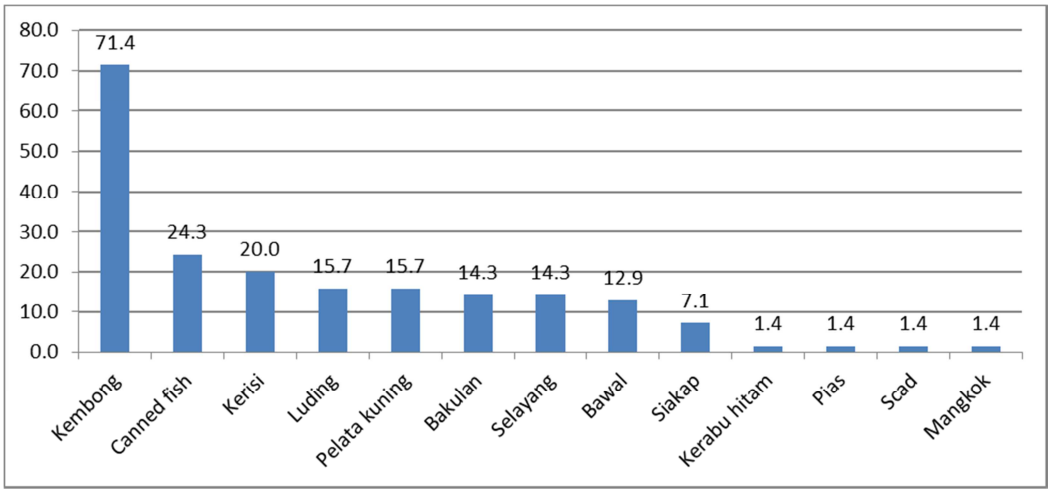

Figure 1. *Types of fish consumed among participants.*

Kembong=Mackerel, Kerisi= Bream, Plata kunning= Crawlers yellow, Selayang =Black river, Bawal= Pomfret, Siakap= Baramundi, Kerabu hitam= Black stud, Mangkok= Bowl fish

There was a positive and significant correlation between T-Hg and MeHg in infants with maternal T-Hg levels (r= 0.729, p= 0.001) and maternal MeHg levels (r= 0.724, p= 0.001) respectively (data not shown). Our results are in line with studies which showed that maternal mercury concentration was correlated with mercury level in infants [16-18].

The association of T-Hg level of infants with maternal characteristics is summarized in Table 3. In the univariate linear regression analysis, infants' T-Hg level was significantly associated with maternal T-Hg and maternal age; while Infants' T-Hg level was not associated with maternal fish consumption. In the multiple linear regression analysis, T-Hg level in infants was significantly associated with T-Hg in maternal blood after adjusted for maternal age and fish consumption, however the significant association between T-Hg in infants and maternal age was attenuated and not significant anymore (Table 3).

Table 3. *Regression analysis of T-Hg level in cord blood with maternal T-Hg, age and fish consumption.*

Variables	Crude B (95% CI)	p	*Adjusted B (95% CI)	p
T-Hg (ppb)	1.094 (0.845; 1.34)	0.001	0.66 (0.403; 0.917)	0.001
Age (year)	0.117 (0.014; 0.219)	0.027	0.05 (-0.04; 0.141)	0.261
Fish consumption frequency	0.506 (-0.19; 1.032)	0.059	0.412 (-0.065; 0.888)	0.089

*adjusted for T-Hg (mother), age and fish consumption frequency.

The strong correlation of infant and maternal T-Hg levels from our study demonstrated that neonatal mercury can be predicted by maternal mercury concentration. On the other hand, no significant association was observed between T-Hg in infant with maternal age and fish consumption after adjustment. This contradicted with study by Santos et al [17] where they found age of mother was positively and significantly correlated with T-Hg level in cord blood. However, our results concurred with another study reported elsewhere [19]. This could be due to the reason that fish commonly consumed (Kembong/Mackerel, Kerisi/Bream) among the participants in Peninsular Malaysia had low concentration of mercury. Kembong (Mackerel) was categorized in the lowest mercury fish groups (mean mercury concentration = 0.12 ± 0.04 µg/g) in the assessment of commonly consumed fish in Malaysia [20, 21].

The findings of this study need to be interpreted with caution as there are some limitations which need to be addressed. The small sample size may have inadequate power to detect statistical significance. The single ethnic group (Malays only) is not representative of the multi-ethnic population in Malaysia. Both were constraint by the budget

as the costs of analysis for T-Hg and MeHg were high. On the other hand, these preliminary results provided important insight into the mercury levels of both mothers and infants; as well as its association with maternal fish consumption. This will provide information for health education materials to be developed for pregnant mothers.

Since fish consumption lead to better neuro-development in infants [4], the current nutritional advice for pregnant mothers to consume more fish should be continued. However, further longitudinal studies with larger sample size and more diverse geographical regions are needed to confirm these findings. Regular monitoring of the levels of mercury in commonly consumed fish is also recommended, as natural and anthropogenic activities may introduce mercury to the environment which can accumulate in fish. It is also important to monitor pregnant women's exposure to mercury as part of public health surveillance.

4. Conclusions

Infants had higher T-Hg and MeHg than mothers; however the levels were within normal limit. Infants' mercury level was strongly correlated with maternal mercury levels. No significant association was observed between maternal age and fish consumption with infants' mercury levels. Our findings suggest that fish consumption pattern and the types of fish consumed among pregnant mothers from this medical centre might not pose much risk to the infants.

Conflict of Interest

The authors declare no conflict of interest.

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