



Methylmercury levels in commonly consumed fish and methylmercury exposure of children and women of childbearing age in Hong Kong, a high fish consumption community

Peggy Hiu Ying Chan^a, Michael Ho Ming Chan^b, Albert Martin Li^a, Robert Chi Keung Cheung^b, Xin Ting Yu^a, Hugh Simon Lam^{a,*}

^a Department of Paediatrics, The Chinese University of Hong Kong, Hong Kong SAR

^b Department of Chemical Pathology, The Chinese University of Hong Kong, Hong Kong SAR

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ABSTRACT

Background: Despite high fish consumption levels of Hong Kong residents, little is known about the MeHg exposure levels of Hong Kong high-risk populations (i.e. young children and women of childbearing age).

Objectives: To investigate the MeHg levels in fish commonly consumed in Hong Kong and assess the exposure levels of local kindergarten children and women of childbearing age.

Methods: A community-based survey was conducted in randomly recruited local kindergartens. The MeHg concentrations of the most commonly consumed fish items were measured. Based on their fish consumption data, subjects' MeHg exposure levels were estimated and compared with the reference dose (RfD) set by U.S. Environmental Protection Agency.

Results: A total of 2917 mother-child pairs were recruited. The MeHg levels of the fish samples ranged from < 2–1498.7 ng/g. Six frozen cod fish samples contained MeHg levels exceeding the local legal limit of 500 ng/g. The median estimated MeHg intake for children and mothers were 0.29 and 0.22 µg/kg bw/wk, respectively. Approximately 16% children and 9% mothers exceeded the RfD.

Conclusions: Apart from frozen cod fish, most fish species commonly consumed in Hong Kong had low MeHg content. Although the majority of our subjects were exposed to low MeHg levels, high fish consumers could still exceed the RfD and are potentially at risk of MeHg toxicity. To avoid excessive MeHg exposure, we suggest that young children and their mothers may consume a variety of locally available fish, but avoid consumption of frozen cod fish.

1. Introduction

Fish has high nutritional value and is an important part of the healthy diet of many people. Besides providing high-quality proteins, fish is also an excellent source of essential nutrients, such as Vitamins A and D, selenium, iodine, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (Institute of Medicine, 2007). However, fish also contains methylmercury (MeHg), which has been shown to be a potent toxicant even at low doses, and cannot be eliminated by cooking (NRC, 2000). Individuals who consume large amounts of fish can therefore be at risk of MeHg toxicity (Carta et al., 2003; Clarkson, 1998). Even at low doses, chronic MeHg exposure is associated with long-term adverse

health outcomes, including neurologic and cardiovascular effects, especially when exposure occurs during childhood or the prenatal period (NRC, 2000; Zahir et al., 2005). Based on evidence from various studies, several guideline levels were developed for MeHg risk assessment. For instance, the provisional tolerable weekly intakes (PTWI) established by the FAO/WHO is 1.6 µg/kg bw (FAO/WHO, 2005) and tolerable weekly intake established by the European Food Safety Authority Panel on Contaminants in the Food Chain is 1.3 µg/kg bw (EFSA Panel on Contaminants in the Food Chain, 2012). On the other hand, United States Environmental Protection Agency (US EPA) established a more stringent guideline for MeHg exposure - reference dose (RfD) of 0.1 µg/kg body weight/day (USEPA, 2001).

Abbreviations: DHA, Docosahexaenoic acid; EPA, Eicosapentaenoic acid; FFQ, Food frequency questionnaire; Hg, Mercury; ICC, Intraclass correlation coefficients; iHg, Inorganic mercury; MeHg, Methylmercury; NS-SEC, National Statistics Socio-economic Classification; PTWI, Provisional tolerable weekly intake; RfD, Reference dose

* Correspondence to: Department of Paediatrics, The Chinese University of Hong Kong, 6/F Lui Che Woo Clinical Sciences Building, Prince of Wales Hospital, Sha Tin, New Territories, Hong Kong SAR.

E-mail address: hshslam@cuhk.edu.hk (H.S. Lam).

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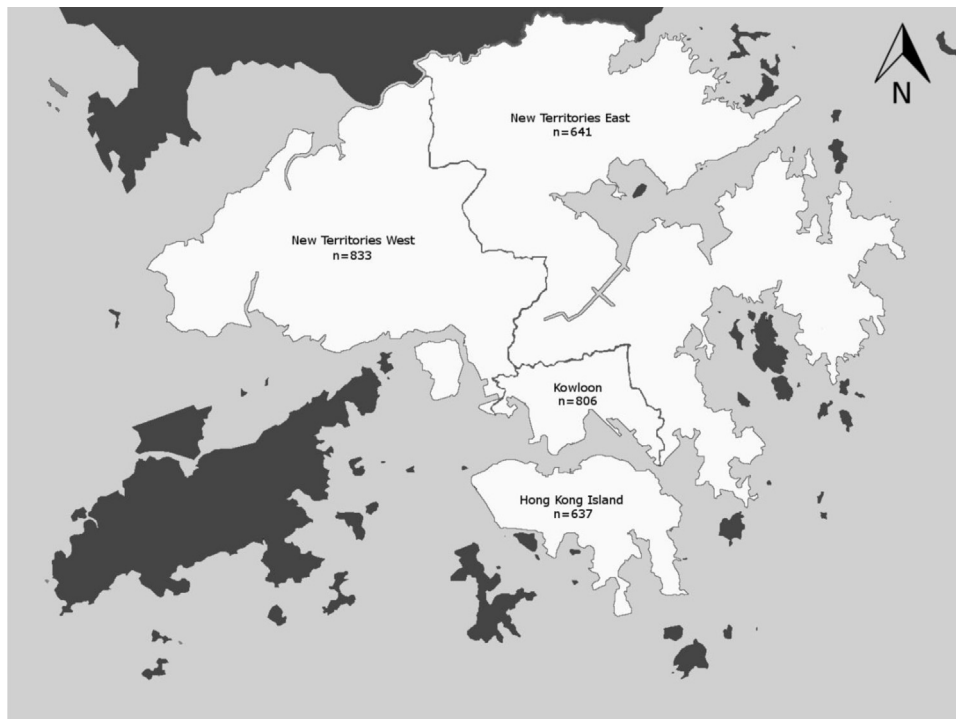


Fig. 1. Map of Hong Kong indicating subjects distribution in each region.

As a coastal city, Hong Kong has a strong cultural and culinary tradition of fish consumption and demands for fish and fishery products are very high. Fish and fishery products consumption per capita in Hong Kong is the second highest in Asia, and the seventh highest in the world (FAO, 2016). The average seafood intake per Hong Kong resident is 65.5 kg per year, which is three times higher than the global average of 19.7 kg per capita (FAO, 2016). Fish and fishery products consumption levels in Hong Kong is higher than the Seychelles Island (58.7 kg per capita), Portugal (53.8 kg per capita), Korea (53.5 kg per capita), Japan (48.9 kg per capita), and Spain (42.4 kg per capita) (FAO, 2016). Therefore, like other high fish consumption communities (Myers et al., 2007), Hong Kong residents are at risk of significant MeHg exposure. Our previous study suggested that as many as 78.4% of children in Hong Kong exceeded US EPA recommendations for prenatal Hg exposure (Fok et al., 2007). Further, a study conducted by the Centre for Food Safety in Hong Kong found that school age children who were defined as high fish consumers (95th percentile exposure level) were estimated to exceed the FAO/WHOPTWI for MeHg intake of 1.6 $\mu\text{g}/\text{kg}$ body weight (FAO/WHO, 2005).

Fish consumption patterns vary according to cultural and geographic differences and at different ages (Ahmad et al., 2016; Kearney, 2010; Olsen, 2003; Olsen et al., 2007). Fish consumption data from various localities with different MeHg exposure patterns of different high-risk groups are therefore essential to improve fish consumption recommendations to specific high-risk populations. Furthermore, in Hong Kong, MeHg exposure has been shown to be at levels close to the US EPA recommendations. Few studies have focused on populations at this MeHg exposure level. Therefore, there is a need to investigate the fish consumption patterns of high risk populations and MeHg content of fish available in Hong Kong.

In order to assess the risk of MeHg exposure from fish consumption among Hong Kong children, a community-based study was conducted to 1) investigate the fish consumption pattern of kindergarten children and their mothers (who represent women of child-bearing age); 2) measure the MeHg levels of fish species commonly consumed by these high risk populations; 3) assess their MeHg exposure levels and the percentage of subjects who exceed the US EPA reference dose (RfD) for

MeHg, and 4) compare the actual consumption amount by subjects with the maximum amounts of fish that could be taken without exceeding the RfD.

2. Methods

2.1. Study population

Children aged 3–5 years old were recruited from local kindergartens. Kindergartens in Hong Kong that were registered under the government's Education Bureau were stratified into four regions according to their geographic location: New Territories East, Kowloon, Hong Kong Island and New Territories West. In order to generate a population-representative sample of Hong Kong children, kindergartens were randomly recruited between February 2012 and April 2014 from each geographic region so that the final numbers of subjects recruited from each region would be proportional to the childhood population of that region according to the 2011 population Census statistics (Hong Kong Census and Statistics Department, 2012).

Self-administered questionnaires were distributed to the parents via the recruited kindergartens. Demographic information including child's body weight, family socio-economic status, paternal and maternal age and education levels, and maternal duration of residence in Hong Kong were collected. Socio-economic status was categorized according to the UK National Statistics Socio-economic Classification (NS-SEC). A total of 7593 children aged 3–5 years were approached via 36 randomly selected kindergartens. 3884 questionnaires were returned to the kindergartens and collected by our researchers (i.e., 51.2% response rate). In order to improve the data completeness, phone calls were made to parents if there were any missing data in the returned questionnaire. Subjects who were not living in Hong Kong were excluded from the study. Among the 3884 returned questionnaires, the following subjects were excluded from analysis: 867 subjects for inadequate completion of questionnaire (i.e., less than 80% completed, especially when missing information related to the outcomes of interest); 24 subjects without fish consumption data and who could not be contacted by telephone; 76 subjects who lived outside Hong Kong during the entire period of the

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