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Original Article

Influence of seafood and vitamin supplementation on maternal and umbilical cord blood mercury concentration

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Abstract

Background: The purpose of this study was to examine the influence of maternal seafood consumption and vitamin supplementation during pregnancy on maternal and umbilical cord blood mercury (Hg) concentration.
Methods: In this study of 145 healthy pregnant women (mean age 28.1 ± 5.2 years), we administered questionnaires, collected paired maternal/umbilical cord blood samples, and measured the anthropometrics of newborns. Blood Hg concentration was assayed by inductively coupled plasma-mass spectrometry.
Results: Sixty-one of these women (42.1%) used vitamins >3 times/wk prenatally. Seventy-eight of our study participants (61.9%) reported eating higher amounts of seafood during pregnancy. We found a strong correlation ($r = 0.76$, $p < 0.001$) between Hg levels in the paired maternal/umbilical cord blood samples. Mothers with high seafood consumption had a 2.91-fold greater risk (adjusted odds ratio 2.91, 95% confidence interval: 1.04−8.15, $p = 0.042$) of high Hg levels (>5.8 μg/L). However, mothers whose prenatal vitamin intake was >3 times/wk were found to have low Hg levels (≤5.8 μg/L) (adjusted odds ratio 0.06, 95% confidence interval: 0.01−049, $p = 0.008$).
Conclusion: High seafood consumption was an independent risk factor for high maternal Hg level, while vitamin supplementation was a protective factor. Further study is needed to investigate the specific effect of vitamins on Hg level.

Keywords: mercury; pregnancy; seafood; vitamin

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

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1. Introduction

Mercury (Hg) is a toxic contaminant that can cross the placenta, and affect fetal growth and neurodevelopment.[1−3] Hg toxicity to the fetus became well known after high maternal exposure incidents occurred in Japan and Iraq.[2,3] Seafood consumption is the major source of Hg exposure for most people.[4] However, Hg exposure associated with seafood consumption may negatively affect neurodevelopment, although seafood rich in omega-3 fatty acids is associated with enhanced neurodevelopment.[5,6] This makes the potential harm of Hg exposure and the benefit of seafood consumption on health become important issues.

According to the cord blood levels reported in Budtz-Jorgensen et al's study,[7] the Environmental Protection Agency (EPA; USA) established a reference dose of 5.8 μg/L methyl Hg (MeHg) in blood for limiting exposure to MeHg in young children and women who are pregnant, are breast-feeding, or might be pregnant.[8] American pregnant women are advised to avoid fish with high Hg levels, but to eat 227−340 g/wk of a variety of fish low in Hg to support fetal growth and development.[9] This advice is complicated by the benefit of seafood rich in omega-3 fatty acids,[5,6] and Soon et al[10] reported that a significant portion of pregnant women in Hawaii consumed more than the recommended amount of seafood. Seafood is an important part of the Taiwanese diet and therefore a concern; however, seafood is only one part of the larger Taiwanese diet and should be evaluated with other nutrients in terms of mercuric intoxication. The protective effects of selenium, zinc, vitamin E, and vitamin B complex have been implicated in the alteration of Hg metabolism.[10,11] Most data about the protective effects of these nutrients are derived from animal research,[11] and therefore, implications of these data for human populations require further study.

Asian-American people and women of child-bearing age, who consume seafood more frequently than other race/ethic groups, have higher mean MeHg levels.[12,13] Taiwan is a large Asian island where people frequently consume seafood. Hsu et al's[14] study showed that 89% of pregnant women contain blood Hg exceeding the recommended value of 5.8 μg/L. Chien et al[15] demonstrated that the mean Hg concentration in hair was 1.73 ± 2.12 μg/g in Taiwanese women of child-bearing age, exceeding the EPA reference dose of 1 μg/g. These two studies[14,15] are consistent with previous studies reporting the risk of elevated Hg in Asians.[12,13] However, the data on the accumulation of Hg in pregnant women in Taiwan remain limited.[14,15] Therefore, in this study, we measured total Hg in paired maternal/neonatal blood samples, and further investigated the relationship between Hg levels and seafood as well as vitamin intake during pregnancy in Taiwan.

2. Methods

2.1. Participants and questionnaires

For this cross-sectional study, 145 healthy pregnant women with a mean age of 28.1 years were recruited from September 30, 2010 to May 25, 2011 in the Department of Obstetrics and Gynecology of Fooyin University Hospital in Dong Gang, Taiwan. The city of Dong Gang is a major seaside fishing area in southern Taiwan. The participants received a detailed explanation of the study procedures before consenting to participate. The research protocol was approved by the Institutional Review Board of Fooyin University (FYH-IRB-099-04-02-A). Written informed consent was obtained from all participants. Data on gestational age, prenatal examination results, and characteristics of the newborn were obtained from medical records. We used interviewer-administered questionnaires to collect information on demographic characteristics, smoking habit, alcohol drinking habit, betel-nut-chewing habit, use of Chinese medicine, seafood consumption, vitamin supplement, degree of education, etc. The semi-quantitative food frequency questionnaire was derived and modified from previously validated studies.[16,17] Content validity of the food frequency questionnaire was assessed by an expert panel consisting of six nutrition experts. After gathering opinions from the experts, questions without a precise content were excluded. The degree of seafood consumption was defined as the sum scores of seafood consumption items queried in the questionnaire. The score of seafood consumption was based on the answers to the following three questions. The first question was the following: “Approximately how many grams of fresh fish do you eat per day on average?” The following were the different response options to that question: (1) small amount, 0−30 g/d (1 point); (2) moderate amount, 31−60 g/d (2 points); (3) large amount, 61−90 g/d (3 points); and (4) large amount exceeding more than 90 g/d (4 points). The second question was as follows: “Approximately how many grams of shellfish do you eat per day on average?” The different response options to that question were the following: (1) small amount, 0−10 g/d (1 point); (2) moderate amount, 11−14 g/d (2 points); and (3) large amount, ≥15 g/d (3 points). The third question was as follows: “Approximately how many grams of canned seafood (fish or shellfish) do you eat per day?” The different response options to that question were the following: (1) small amount, 0−10 g/d (1 point); (2) moderate amount, 11−14 g/d (2 points); and (3) large amount, ≥15 g/d (3 points). The higher the sum sores, the greater the consumption of seafood. In our analysis, participants with 3 points were categorized into those people whose consumption approximated the EPA recommended ranges (227−340 g/wk). Those with scores over 3 were categorized into the high-seafood-consumption group whose consumption exceeded those recommendations. Those with ≤3 points were categorized into the less-seafood-consumption group. Anthropometric measurements of newborns were made by delivery room staff following standard procedures.

2.2. Blood sampling and sample analysis

Umbilical cord and maternal venous whole blood samples were separately collected into 9 mL standard laboratory-issued EDTA tubes. All samples were processed within 2 hours of delivery and stored at −80°C. Samples were sent to the

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