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The Modifying Effects of Maternal Diet (Fish versus Rice) on the Associations Between Prenatal Methylmercury Exposure and Children's Neurodevelopment: An Investigation Utilizing Stable Mercury Isotopes

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Background: Methylmercury (MeHg) is a potent neurotoxicant. Depending on dietary practices, fish or rice consumption can be the main dietary exposure pathways of MeHg in humans. We hypothesize that neurodevelopmental impacts due to MeHg may vary depending on the maternal dietary source of MeHg, due to beneficial nutrients found in fish, not rice.

Methods: To investigate this hypothesis, we leveraged our birth cohort study in rural China where rice is an important dietary staple (n=261 mother/offspring pairs), using stable mercury (Hg) isotopes. We previously reported adverse associations between maternal hair Hg concentrations, a biomarker for prenatal MeHg exposure, and children's neurodevelopment assessed at 12 months of age using the Bayley Scales of Infant Development, Second Edition. For the same cohort, we also reported that mass independent fractionation (MIF) (represented by maternal hair $D^{199}Hg$) can distinguish MeHg intake primarily from rice versus fish. In the present study, we investigated the modifying effects of measures of maternal diet on child's 12-month Bayley scores using 1) maternal hair $D^{199}Hg$, 2) maternal self-report fish consumption frequencies, and 3) three indices for peripartum serum long-chain polyunsaturated fatty acids (PUFAs), a biomarker positively correlated with fish intake.

Results: In adjusted models, hair $D^{199}Hg$ modified the adverse associations between maternal hair Hg and child's Bayley scores (Fig. 1). Mothers who obtained a majority of MeHg from rice, not fish, were primarily in the lowest tertile of hair $D^{199}Hg$. For those mothers, a doubling in maternal hair Hg was associated with statistically significant lower (i.e., more adverse) Mental Developmental Index (MDI) scores [Beta: -4.19, 95% Confidence Interval (CI): -7.51, -0.878]. A similar trend was observed for Psychomotor Developmental Index scores (Beta: -4.13, 95% CI: -7.90, -0.363). The other indices, including maternal fish consumption frequencies and serum PUFAs, did not modify the associations between maternal hair Hg and child's Bayley scores.

Conclusions: Using hair MIF, our results indicated the dietary source of MeHg (fish versus rice) modified the adverse associations between a biomarker of prenatal MeHg exposure and children's neurodevelopmental scores. MeHg-associated decrements in Bayley scores were observed for mothers whose MeHg dose was primarily from rice, not fish.

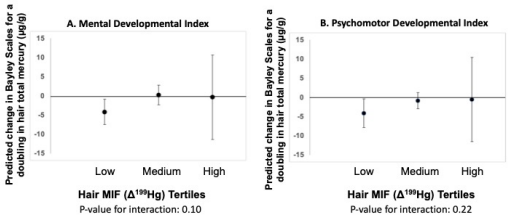

Figure 1. The modifying effect of hair mass independent fractionation (MIF) on the Bayley Scales of Infant Development-II score (assessed at 12 months of age) for a doubling in maternal hair total mercury for a) the Mental Developmental Index (MDI) and b) the Psychomotor Developmental Index. Error bars indicate the 95% confidence levels. In addition to hair total mercury, models were adjusted for maternal pre-pregnancy body mass index (3 categories), maternal age at parturition (years), daily rice ingestion (yes/no), maternal occupation (farmer/non-farmer), $\log_{10}$ total energy intake (kcal), peripartum serum Zn (μg/L), peripartum $\log_{10}$ blood lead (μg/dL), child sex, child weight for gestational age (z-score), and child's exact age at Bayley testing (months) (n=261 maternal/offspring pairs).