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Association between Blood Mercury Level and Visceral Adiposity in Adults

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Recently, there has been increasing concern with regard to health problems due to exposure to environmental pollutants, such as substances found in our food and consumer or industrial products that interfere with our body's hormone synthesis, secretion, activity, and metabolism [1,2]. Heavy metals are considered as an endocrine-disrupting chemical that can interfere with the normal endocrine system and metabolism of humans. Mercury, the most dangerous of all heavy metals [3], is widely dispersed in the environment including air, soil, dust, water, and the human food chain [4]. Mercury exists in three basic forms: elemental, inorganic, and organic [5-7]. Inorganic mercury is the toxic species found in human tissue after conversion from other forms. Organic forms of mercury from fish and elemental mercury from dental amalgams are the major environmental sources of exposure to mercury [8]. In addition, mercury was also found in cosmetic powders, plastic toys, sea mammals, and thimerosal vaccines. The Environmental Protection Agency in United States reported the safe daily mercury intake to be less than 0.1 μg/kg/day [9]. One dental amalgam filling is estimated to release about 3 to 17 μg of mercury vapor daily [9]. Several kinds of vaccine contain thimerosol as a preservative, which is suspected to be another major source of mercury [6,7,9]. The long-lived large predatory fish such as swordfish, king mackerel, and tuna, which are favorite fish dishes of Koreans, contain about 0.5 to 1 μg of methyl mercury per gram [6,7,9]. Therefore, members of the general population, not only humans in contaminated area, are exposed daily to potential environmental hazards of mercury. Mercury has no known physiologic role in human metabolism, but mercury induces mitochondrial dysfunction and oxidative stress [10,11]. It has been suggested to cause insulin resistance which is one of the underlying pathogenetic mechanism of metabolic syndrome, a constellation of cardiovascular risk factors, including central obesity, dysglycemia, dyslipidemia, and hypertension. Mercury reduces antioxidant defense by binding to sulfhydryl groups of proteins, resulting in inactivation of numerous enzymatic reactions and amino acids and depletion of N-acetyl cysteine, α lipoic acid, and glutathione, which provide about 10% to 50% of the plasma protein antioxidant capacity [12]. Since mercury has a long half-life and the human body has no mechanisms to actively excrete mercury [12], mercury accumulates in human body during lifetime. So far, several *in vivo*, *in vitro*, and epidemiologic studies have investigated the metabolic effects of mercury on the risk of obesity, diabetes, and cardiovascular disease. Prevalence of hypertension and cardiovascular diseases, such as myocardial infarction and coronary heart disease, were increased as a consequence of mercury toxicity [13]. Blood mercury concentration showed an association with waist-hip ratio in Korean men [12].

Body mass index (BMI) and waist circumference (WC), indirect measures of adiposity, has been used to estimate the association between blood mercury concentration and obesity, but the findings have been inconsistent. Park et al. [14] showed that the blood mercury concentration was significantly associated with visceral adipose tissue (VAT) as measured by dual-energy X-ray absorptiometry (DXA). Because DXA VAT is considered to be an accurate, direct measure of adiposity, the finding could be more evident than previous studies. Besides

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the major finding, Park et al. [14] also showed that the blood mercury concentration was significantly associated with homeostasis model assessment of insulin resistance (HOMA-IR), homeostasis model assessment of β-cell function (HOMA-β), and fasting serum glucose. These findings are compatible with the previous findings that methylmercury induced pancreatic β-cell apoptosis and dysfunction, and low-dose mercury induced mouse β-cell dysfunction via phosphoinositide 3-kinase/Akt signaling [15,16], although a study showed no significant correlation between HOMA-IR and HOMA-β and mercury among Koreans without diabetes [17]. Increased visceral adiposity in proportion to the blood mercury concentration could also take part in inducing the insulin resistance.

However total fat mass (TFM) did not show any association with blood mercury concentration although BMI and WC were associated with blood mercury concentration. Because BMI, an indirect measure of general adiposity, is parallel with TFM which is a direct measure of general adiposity, the discrepancy is hard to understand. As Park et al. [14] commented, their causal relationship could not be determined in their study due to the limitation of the cross-sectional design. Whether mercury accumulation in the human body causes visceral obesity or *vice versa*, or high blood mercury concentration is an innocent bystander of true culprits is much far from certain. In the general population of the United States, a strong dose-response relationship was observed between serum concentration of persistent organic pollutants and diabetes even after an adjustment for obesity in a previous study [18]. The risk of diabetes was not increased even among obese people if they had low levels of persistent organic pollutants. The study suggested that toxic pollutant itself rather than obesity would be detrimental to human health in terms of diabetes. Mercury toxicity also could increase health problems not only through obesity but other cellular pathogenetic mechanisms.

Although mercury level in blood is a widely used and well-established biomarker of exposure, and the blood concentration may be well-correlated with chronic accumulated exposure in the general population with stable environmental exposure to mercury, it mainly reflects recent exposure. Therefore, measuring blood mercury level cannot accurately estimate accumulated exposure. Other tissues such as hair and toenail can also be used to measure mercury accumulation.

Fish is the major source of exposure to mercury, and people with higher blood mercury concentration had a higher consumption rate of fish in the study by Park et al. [14]. However, it could not be determined which route contributes as the main exposure source. Measuring the inorganic and organic forms separately rather than total mercury concentration in blood could provide this information.

In fact, fish contains healthy omega-3 fatty acids and nutrition in spite of being a major source of mercury. In reality, it is impossible for merchants to differentiate mercury-contaminated fishes before serving them to consumers. Considering that people are unconsciously exposed to a variety of environment pollutants like mercury which are potential hazards to human health in daily lives, more attention is required to limit the exposure at both individual and systemic social levels.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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