Biomarkers of mercury exposure

In this guide

110. Basu et al. (2018) undertook a review of mercury biomarkers in human populations worldwide between 2000 and 2018. The most used biomarkers are the concentrations of mercury in hair, urine, blood, cord blood, toenails and fingernails and their selection can depend on factors such as the potential source of exposure, chemical form, and exposure life stage.

111. Analysis of hair is commonly used to assess exposure to MeHg, which accounts for 80–90% of the total mercury content within this matrix (Clarkson and Magos 2006; UNEP/WHO 2008; NRC 2000). Once incorporated, the mercury remains in the hair, and this biomarker can therefore provide an integrated measurement of internal exposure to MeHg. Because hair grows at approximately 1 cm per month, measuring total mercury in 1-cm segments of mothers' hair can be used to assess the monthly maternal MeHg exposure throughout pregnancy (e.g., Sakamoto et al, 2012).

112. MeHg in hair is quite stable over time, indicating that demethylation within the hair is minimal (al-Shahristani and Shihab, 1974; Berglund et al, 2005). However, it has to be taken into account that hair treatment as well as inter-individual variability in the toxicokinetics of mercury uptake from blood to hair shaft and hair growth rate may affect mercury hair content. A frequently cited total mercury blood to hair ratio of 1:250 was also used by JECFA (FAO/WHO, 2004). It is well known, that large inter-study and inter-individual variations exist, especially in populations with infrequent fish consumption (WHO, 1990; FAO/WHO, 2004; Berglund et al, 2005) and there are some indications that the total mercury blood to hair ratio is lower (Sakamoto et al, 2007; Yaginuma-Sakurai et al, 2012); however, the EFSA CONTAM Panel considered the evidence insufficient to identify a more appropriate ratio (EFSA, 2012).

113. Similarly to HHg, total toenail and fingernail mercury are used as indicators of average MeHg exposure over time, serving as a biomarker for long term MeHg (Mozaffarian et al, 2011). Reported hair to toenail ratios for total mercury are in the range 2.38 – 3 (EFSA, 2012).

114. Urine analysis primarily provides information about exposure to inorganic and elemental mercury, although in people with high seafood consumption MeHg may also contribute to the mercury content (Sherman et al. 2013). Because the concentration of the analyte may depend on the dilution of the urine, which can vary, the measurement of mercury is often expressed in terms of its concentration per unit of creatinine or in relation to the specific gravity of the urine sample.

115. Mercury measured in whole blood and provides information about recent (~1 to 2 months) exposures to both MeHg and inorganic mercury (Clarkson and Magos, 2006). In most communities, the measurement of blood total mercury is an accepted biomarker for MeHg exposure because it correlates relatively well to seafood consumption (Sheehan et al, 2014). The use of speciation can provide an indication of potential mercury sources but requires

careful sample preparation and sophisticated instrumentation. The measurement of mercury in cord blood provides information about developmental exposure (UNEP/WHO, 2008).

116. In general, careful measurement of mercury content in hair and urine offers the most convenient and cost-effective scheme to monitor mercury in a given population, particularly those situated in resource-limited settings (UNEP/WHO, 2008).

117. Cord tissue and cord blood are extensively discussed and summarised in a previous evaluation (FAO/WHO, 2007). In summary, total mercury and MeHg are in general higher (by a factor of 1.7 – 2.2) in cord blood than in maternal blood at parturition (e.g., Kim et al, 2011; Sakamoto et al, 2012). Total mercury in cord tissue correlates with MeHg in cord tissue, and total mercury and MeHg in cord tissue correlate with total mercury in cord blood. A significant relationship was reported between fish consumption during pregnancy and total mercury in cord blood (FAO/WHO, 2007). Recently, total mercury in cord blood has been shown to correlate with maternal hair total mercury; the strongest correlation was observed with maternal hair in the first 1 cm-segment from the scalp at parturition (Sakomoto et al, 2012).

118. Basu et al. (2018) stated that individuals in select general background populations worldwide with insignificant exposures to mercury sources have BHg levels that generally fall below 5 µg/L, HHg levels that generally fall below 2 µg/g, and urine mercury levels that fall below 3 µg/L, although these general background values can vary across certain geographic regions.