Bioaccessible and quasi-total metals in soil and indoor dust

BARBARA LE BOT*, ERWANN GILLES, SEVERINE DURAND and PHILIPPE GLORENNEC

EHESP-School of Public Health, Avenue du Professeur Léon Bernard, 35043 Rennes cedex, France
*Corresponding author, e-mail: barbara.lebot@ehesp.fr

Abstract: Children are exposed to metals via the ingestion of household dust and soil, but contaminated household dust is much less documented than outdoor soil. In France, environmental home surveys are carried out to assess the exposure of young children to bioaccessible lead. In other countries, most surveys of metal in dust are based on “total digestion” using strong acid to extract all the metals present in dust samples. To compare metal contamination in household dust in France with data from other countries, a sequential extraction protocol was developed to assay metal concentrations in the bioaccessible fraction as well as in “quasi-total” digestion. Nine metals (As, Cd, Cr, Cu, Mn, Pb, Sb, Sr and V) were chosen for analysis on the basis of their mean contamination level.

1. Introduction

Many metals and metalloids are commonly found in higher concentrations in indoor dust than in outdoor soil in ordinary urban environments (Rasmussen et al., 2001), although indoor settled dust contamination is much less well documented than outdoor soil contamination (Turner & Simmonds, 2006; Ibanez et al., 2010). Household dust and soil are vectors for oral exposure to hazardous chemicals (Turner & Simmonds, 2006; Hunt et al., 2008), especially for young children because of their hand to mouth behaviour (Tong & Lam, 2000; Turner & Simmonds, 2006). Although the mouthing habits of children are still being studied, it is estimated that the median number of hand to mouth contacts per hour is 7 (Ko et al., 2007). Ingested metals can accumulate in the fatty tissues, affect the nervous system during the period of maximum brain growth (Tong & Lam, 2000; Chattopadhyay et al., 2003), disrupt the normal functioning of internal organs and act as cofactors in other diseases (Tong & Lam, 2000). Various dust sampling methods are mentioned in the literature, including vacuum cleaner, gentle sweeping, gloved hands, fiberglass filter or wipe (Ibanez et al., 2010). For lead, the wipe method is designed to imitate the hand’s ability to pick up and retain particles, as described in ASTM E1728-03 (ASTM international, 2003b) and similar to AFNOR NF X46-032 (AFNOR [Association française de normalisation], 2008). This sampling method is used to determine lead concentrations, which are expressed in micrograms per square metre of wiped surface, and is recommended in guidelines for the evaluation and control of lead-based paint hazards in housing (U.S. Department of Housing and Urban Development, 1995).

Different methodologies are used for sample digestion. Most surveys of metal contamination in dust are based on quasi-total digestion with aqua regia acid (Kim et al., 1998; Tong & Lam, 2000; Lanphear et al., 2005; Turner & Simmonds, 2006; Turner & Ip, 2007). Some other studies make use of strong acids (hydrofluoric acid or perchloric acid), which provide a high degree of total element extraction (Cizdziel & Hodge, 2000; Tong & Lam, 2000; Davis & Gulson, 2005; Rashed, 2008). Although strong acids do not dissolve silicates completely, they destroy organic matter, dissolve precipitated and adsorbed metals and leach out some metals held in the silicate lattice (Rashed, 2008). To improve assessments of human exposure and...