Exposure Assessment - Statement on the effects of lead on maternal health

In this guide

Exposure from food

32. The FSA Exposure Assessment Team has provided dietary exposure data on lead for women of childbearing age (16 – 49 years of age) (Table 1, Appendix 1). The food commodities that result in the highest exposures to lead are green vegetables, miscellaneous cereals and other vegetables with mean exposure values of 0.0088, 0.0080 and 0.0063 µg/kg bw/day and 97.5th percentile values 0.034, 0.028 of 0.019 µg/kg bw/day, respectively. The total exposures via food were calculated as 0.12 µg/kg bw/day (mean) and 0.23 µg/kg bw/day (97.5th percentile).

Exposure from drinking water

33. Data on concentrations of lead in water had previously been provided by the Drinking Water Inspectorate (DWI) (for England and Wales), the Drinking Water Quality Regulator (DWQR) for Scotland and Northern Ireland Water. The concentration data from 2019 for lead in drinking water are given in Table 2, Appendix 1.

34. The FSA Exposure Assessment Team has provided values for water consumption for women of child-bearing age of 8 (median) and 32 (97.5th percentile) g (ml) of water per kg bodyweight per day. Using the upper bound mean lead concentration values in drinking water (2.15, 0.48 and 1.1 for England/Wales, Scotland and Northern Ireland respectively), the calculated exposures to lead from drinking water are shown in Table 1.

Table 1. Calculated mean and 97.5th percentile exposures for women of childbearing age to lead from drinking water, using the mean upper bound concentration values (µg/kg bw/day).

Region	**N (number of women)**	**Median ****	**97.5th percentile ****
England and Wales*	10967	0.00024	0.00098
Scotland	436	0.000054	0.00021
Northern Ireland	122	0.00013	0.00050

*Using 99th percentile lead concentration.

** Average body weight of 70.3 kg for women of childbearing age used for exposure calculation. Value provided by the FSA Exposure Assessment Team from years 1 – 11 of the rolling National Diet and Nutrition Survey, NDNS (Bates et al., 2014, Bates et al., 2016, Roberts et al., 2018).

Exposure from the air

35. Defra provide data on air pollution throughout the UK. An interactive map (Defra, 2020) shows that the majority of the country in 2020 had an average air lead concentration of 10 ng/m^3, with major urban centres in England and Wales having concentrations of 10 – 50 ng/m^3.

36. The WHO estimates that the average inhalation rate for a 70 kg adult is 20 m^3/day (WHO, 2000).

37. As a worst-case scenario, if an adult female were to be constantly exposed to an air concentration of 50 ng lead/m^3 then this would result in a daily exposure to 1000 ng of lead from the air. For women with an average body weight of 70 kg, (value provided by the FSA Exposure Assessment Team from years 1 – 11 of the rolling National Diet and Nutrition Survey, NDNS (Bates *et al*., 2014, Bates *et al*., 2016, Roberts *et al*., 2018) this gives an exposure of 14 ng/kg bw (0.014 µg/kg bw/day).

38. This assumes that there is full absorption of all lead in the particles inhaled, but this depends upon particle sizes and since some of the inhaled dose may become trapped in parts of the nasopharynx, these inhalation values are probably an overestimate, but may contribute a small amount to ingested lead.

Exposure from soil and dust

39. People may be exposed to lead through swallowing dirt that contains lead. Ingestion of contaminated soil is often as a result of "hand-to-mouth" activity and while being a more important route of exposure for toddlers and children, soil and dust still present a potential source of intake in adults, for example, from the surface of unwashed vegetables.

40. Lead concentrations in soil are influenced both by underlying lithological lead concentrations and by anthropogenic release of lead. Lead was measured in topsoil from England from a depth of 0-15 cm as part of a Defra-commissioned project (Ander *et al*., 2011).

41. Table 2 shows the lead exposures from soil for women of child-bearing age. Mean and 75th percentile lead concentrations from soil in regions classified as rural, semi-urban or urban were used to assess potential exposures of adults through soil ingestion. An ingestion rate of 50 mg soil/day was assumed based on the rate used by the Environment Agency in their Contaminated Land Exposure Assessment (CLEA) model (Environment Agency, 2009) and was based on a consensus value from studies by USEPA (1997) and Otte *et al*. (2001). It is a combined value for soil and dust as most of the evidence used to determine the ingestion rate does not differentiate between soil and household dust. Furthermore, the evidence base for selecting a representative soil ingestion rate for adults is much smaller than that for children and as such USEPA (1997) cautioned that the value is highly uncertain and based on a low level of

confidence.

Table 2. Median and 75th percentile exposure values for women of childbearing age to lead from soil. Soil lead concentrations taken from the Defra-commissioned contaminants in the soils of England report (Ander *et al*. 2011) and an ingestion of 50 mg soil/day provided by the Environment Agency (2009).

Mean/ 75th percentile	**Region**	**Soil concentration of lead (mg/kg)**	**Lead ingestion (µg/kg bw/day)***
Mean	Rural	35	0.025
Mean	Semi-Urban	57	0.041
Mean	Urban	166	0.118
75th percentile	Rural	46	0.033
75th percentile	Semi-Urban	100	0.071
75th percentile	Urban	322	0.229

* Average body weight for women of childbearing age used for ingestion rate = 70.3 kg, value provided by the FSA Exposure Assessment Team from years 1 – 11 of the rolling National Diet and Nutrition Survey, NDNS (Bates *et al*., 2014, Bates *et al*., 2016, Roberts *et al*., 2018).

42. The data presented are representative of lead concentrations in the soil in England only. There have been no individual studies investigating the lead levels in soils of Wales, Scotland or Northern Ireland.

43. No recent data were available for levels of lead measured in household dust in the UK.

44. Pica behaviour is described as the craving for and intentional ingestion of substances that are not described as food. Globally, it is thought to affect up to 28 % of pregnant women, albeit with a high degree of geographic variability (Fawcett *et al*, 2016). Therefore, pica presents a potential route of exposure to lead from soil. However, pica has not been considered as part of this statement due to the lack of data available for the consumption of soil as part of pica behaviour.

Aggregate Exposure

45. Aggregate exposure to lead from food, drinking water, soil and dust, and air was estimated by considering a number of scenarios based on available data. Table 3 shows scenarios of aggregate exposure from the sources listed above and includes estimates of average and high exposure from these sources as indicated below.

46. Average and high exposure for food and drinking water represent the mean and 97.5th percentile exposure as described in paragraphs 30 – 32. Data for exposure from drinking water in England and Wales were used as this represented the highest exposure compared to Scotland and Northern Ireland. The contribution from air in all scenarios is based on average inhalation rates and the maximum concentration from a range reported for England and Wales. For exposure from soil and dust, the average and high exposure represent the mean and 75th percentile exposure respectively for the region with the highest exposure (i.e., urban region as shown in Table 2 and paragraphs 37 - 41).

Table 3. Aggregate exposure to lead from food, drinking water, soil, dust and air*.

Scenarios	**Aggregate exposure (µg/kg bw/day)**
Average exposure from all sources[a]	0.25
High exposure from all sources[b]	0.49
High exposure from food and mean exposure from all other sources[c]	0.36

High exposure from drinking water and mean from other sources[d]	0.26
High exposure from soil and dust and mean from other sources[e]	0.36

a This scenario represents a summation of average exposure from food, water and soil and a value for air*.

b Exposure is based on summation of 97.5th percentile estimates for food and water, 75th percentile for dust and soil and a value for air*.

c Exposure is based on summation of 97.5th percentile estimates for food and the averages for water, dust and soil and a value for air*

d Exposure is based on summation of 97.5th percentile estimates for drinking water and the averages for food, dust and soil and a value for air*

e Exposure is based on summation of 75th percentile estimate for soil and dust and averages for food, water and a value for air*.

*The contribution from air in all scenarios is based on average inhalation rates and the maximum concentration identified for England and Wales as shown in paragraphs 33 - 34.