This is a background paper for discussion.
It does not reflect the views of the Committee and should not be cited.

TOX/2017/14

COMMITTEE ON TOXICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT

Review of potential risks from cadmium in the diet of infants aged 0 to 12 months and children aged 1 to 5 years

Introduction

1. The Scientific Advisory Committee on Nutrition (SACN) is undertaking a review of scientific evidence that will inform the Government's dietary recommendations for infants and young children. The SACN is examining the nutritional basis of the advice. The Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT) was asked to review the risks of toxicity from chemicals in the diet of infants, most of which has been completed, and young children. The reviews will identify new evidence that has emerged since the Government's recommendations were formulated, and will appraise that evidence to determine whether the advice should be revised. The recommendations cover diet from birth to age five years.

2. This discussion paper provides estimated cadmium exposures for infants and young children in the UK aged 0 to 12 months and 1 to 5 years, respectively. Public Health England has produced information for the general public on the risks of exposure to cadmium but there are currently no Government dietary recommendations for infants and young children which relate to this metal..

Background

3. Cadmium is a soft, silver-white or blue-white metal that exists in various mineral forms and is present throughout the environment. It is used in a wide variety of processes including electroplating , alloy production, paints and pigments, and is present in a wide range of industrial and consumer products. Cadmium concentrations in the environment reflect contributions from sources that are natural, for example volcanic activity, and anthropogenic, for example non-ferrous metal smelting.

4. The general population is primarily exposed to cadmium via food, with drinking water and inhalation from ambient air acting as minor sources of exposure. Food is considered to be a more important source of oral exposure to cadmium than drinking water. The main food plant sources of cadmium are crops such as rice and potatoes, arising from the use of phosphate fertilisers since mineral sources of phosphate are associated with Cd ores. Kidney and liver are the main sources in food of animal origin since Cd in animal feed concentrates in these organs. Tobacco

leaves accumulate cadmium from the soil and smoking may make a large contribution to intake in smokers (EFSA 2009)

5. There are currently no data showing that cadmium is an essential micronutrient for animals, plants or microorganisms. (EFSA, 2009). Only one enzyme, an isoform of carbonic anhydrase in a marine diatom, has been shown to accept cadmium as a cofactor (Lane & Morel, 2000).

6. Oral ingestion of cadmium salts in experimental animals has resulted in a wide range of adverse effects including nephrotoxicity, hepatotoxicity and metabolic effects (WHO 2011).

Toxicokinetics

7. Cadmium and its salts have low vapour pressures so inhalation is generally in the form of respirable particles, except in the vicinity of industrial sites, for example zinc smelters, where volatilisation of the metal is possible

8. Following oral exposure in humans, cadmium is bioavailable at levels of 3 – 5%. Bioavailability following inhalation appears to be higher, at 7 – 50% (EFSA 2009). Bioavailability, retention and toxicity depend upon factors such as the extent of iron storage (Gallagher *et al* 2011), pre-existing health conditions and, correlated with reduced blood ferritin levels in pregnancy, number of pregnancies.

9. Cadmium is able to cross the placental barrier but there appears to be an as yet unknown mechanism restricting its access to the umbilical cord blood, protecting the foetus to some extent.. (EFSA, 2009, Esteban-Vasallo *et al.* 2012).

10. Cadmium, transported in the blood largely in erythrocytes, enters the liver and is bound to the sulphydryl-rich protein metallothionein.(MT) This metal-protein complex is filtered by the glomerulus and reabsorbed by the cells of the proximal convoluted tubule. Cadmium thus concentrates primarily in the kidneys and to a lesser extent in the liver. Its biological half-life in the human body is very long, ranging from 10 to 30 years. (EFSA 2009)

11. The majority of ingested Cd is eliminated in the faeces whereas the proportion of the dose that is absorbed is excreted in the urine. Urine levels of cadmium (U-Cd) are used as a measure of body burden. Since urine volume varies in a manner unrelated to the mass of solutes it contains, U-Cd levels are normally expressed in terms of μg per g creatinine since the concentration of the latter compound is also expected to vary only with volume. This relationship has, however, recently been questioned (Middleton *et al*, 2016).

<u>Toxicology</u>

Acute toxicity

12. In the general population the main concern is chronic effects of cadmium, exposure and acute toxicity is largely confined to workers in the metallurgical industries where activities such as smelting and soldering vaporises the metal, which can then be inhaled.

13. Documented effects of acute exposure to high levels cadmium by inhalation resemble those of metal fume fever: cough and throat irritation with delayed effects of tight chest, pain in chest on coughing, dyspnoea, malaise, ache, chilling, sweating, shivering, and aching pain in back and limbs. From 8 hours to 7 days post-exposure, more advanced stages of pulmonary response included severe dyspnoea and wheezing, chest pain and precordial constriction, persistent cough, weakness and malaise, anorexia, nausea, diarrhoea, nocturia, abdominal pain, haemoptysis, and prostration. (ATSDR 2012)

14. Exposure in a large but unventilated space, for example using silver solder without wearing personal protective equipment, has been found result in a dose of cadmium fume that proves fatal in a matter of days from delayed pulmonary oedema or at least produces long lasting detrimental effects on the respiratory system. (ATSDR 2012)

Chronic effects

Effects on the kidney

15. Ingestion and inhalation of cadmium is known to damage to the proximal tubule of the nephron. The Cd- liver MT complex enters the bloodstream and is filtered by the glomerulus into the nephron. The proximal tubular cells reabsorb this complex, which dissociates and the liver MT is replaced by kidney MT. The kidney has a lesser capacity to produce MT. As the Cd level builds up it eventually overwhelms the cells capacity to produce MT and free cadmium causes damage at multiple sites within the cell. Low-molecular weight proteinuria, in particular of β_2-microglobulin is an early biomarker of toxicity. Later stages show reduced glomerular filtration rate, necrosis of the nephron and high molecular weight proteinuria (EFSA 2009). Cadmium-induced kidney damage may be reversible in its early stages (Gao, *et al*) but in later stages may be irreversible and progressive, even in the absence of ongoing exposure

Effects on bone

16. In adults bone density may be reduced either by direct displacement of calcium or by disruption of the metabolism of calcium and phosphate in the kidney, leading to osteoporosis and osteomalacia Renal hydroxylation of vitamin D is also inhibited and calcium absorption from the GI tract may be reduced (ATSDR 2008). https://www.atsdr.cdc.gov/csem/cadmium/docs/cadmium.pdf

17. In Japan, high levels of environmental cadmium are known to cause Itai-Itai (ouch-ouch) disease characterised by kidney dysfunction and bone degradation leading to deformity and multiple fractures. (EFSA 2009)

Oxidative stress

18. Oxidative stress is a biochemical state in which the production of reactive oxygen species (ROS) such as superoxide and hydroxyl radicals by cellular processes exceeds the capacity of the cell's antioxidant mechanisms to counteract it. The ROS can then lead to the disruption of normal cellular function by inhibiting enzymes and forming lipid peroxides and DNA adducts, for example 8-hydroxy-2'-deoxyguanosine. Cadmium is not itself redox active, existing largely in the Cd(II) state. The oxidative stress it induces is thought to be due to the displacement of iron from internal stores. The released iron then catalyses the Fenton reaction that converts hydrogen peroxide, produced by other cellular processes such as the action of oxidase enzymes, into ROS. Nair *et al (2013)* reviewed the effects of oxidative stress induced by Cd on its toxicity *in vivo* and *in vitro*, . The ROS may then be responsible for the effects seen in the kidney, bone and in carcinogenesis.

Carcinogenicity

19. The IARC have published evaluations of cadmium and its compounds a number of times (1973, 1976, 1987, 1993 and 2012) and have designated it to be a human carcinogen (Group 1) on the basis of occupational studies. Exposure to cadmium by inhalation in the general population has been statistically associated with increased risk of cancer such as in the lung (Nawrot *et al* 2015), bladder and prostate (Santana *et al* 2016). However, Golabek *et al* (2014) found that although cadmium accumulated in bladder and other tissues with age, patients with urothelial carcinoma of the bladder had statistically significant ($p < 0.001$) lower levels of Cd in bladder tissues than control patients.

20. Cho *et al* (2013) reported an association between oral exposure to Cd in Western countries and incidence of cancer of the breast, endometrium and ovary. However Adams *et al* (2014) found no evidence of an association between oral exposure to cadmium, estimated from a dietary survey and known Cd content of various foodstuffs, and cancers of the breast, endometrium or ovary in a study involving over 155 000 postmenopausal women (age 50 – 79).

21. Cadmium does not appear to be directly genotoxic but seems to act through inhibition of DNA repair mechanisms and oxidative stress, mechanisms that would be expected to have a threshold. (EFSA 2009).

22. Cadmium may also interfere with the Wnt second messenger system by displacing calcium from E-cadherins, releasing β-catenin into the cytoplasm and nucleus and promoting the pathway's cellular proliferative effects (Chakraborty *et al*, 2010).

23. Cadmium is suspected of having endocrine disrupting effects by mimicking estradiol at estrogen receptors leading to estrogen-like effects on the uterus and mammary glands, potentially leading to effects on reproduction and cancer in these organs (Aquino *et* al 2012, Chmielowska-Bąk *et al* 2013*).*

Amelioration of toxic effects

24. A number of papers have highlighted the possibility of antioxidant therapy as a means of ameliorating the toxic effects of cadmium. Sangartit et al (2014) found that tetrahydrocurcurmin from the turmeric plant reduced cadmium-induced hypertension and vascular effects in mice. Prabu et al (2010) found that oxidative stress effects of cadmium on lipids and plasma lipoproteins could be reduced in rats by treatment with quercetin and α-tocopherol. Pires *et al* (2013) and Lamas *et al* (2015) both found that intake of grape juice concentrate reduced testicular damage in rats induced by intraperitoneally administered cadmium chloride solution. Zhai *et al* (2016) found that supplementation with the gut bacterium Lactobacillus planetarium reduced damage to HT-29 cells by Cd in vitro, partially by reducing oxidative stress, and inhibited the uptake of oral Cd in mice in vivo..

Expert opinions

25. An expert opinion on exposure to cadmium in food and drinking water has been published by the European Food Safety Authority's (EFSA) Panel on Contaminants in the Food Chain (CONTAM) (EFSA, 2009). The COT reviewed cadmium in their report on metals in the diet (2003). The World Health Organization (WHO) has reviewed exposures to cadmium via drinking water as part of the development of their 'Guidelines for Drinking Water Quality' (WHO, 2011). The International Agency for Research on Cancer (IARC) has published an evaluation of the carcinogenicity of cadmium compounds (IARC, 2012). In 2016, Public Health England (PHE) produced guidance on exposure to cadmium.

EFSA

26. In their 2009 scientific opinion, the EFSA CONTAM Panel stated that, mean chronic dietary exposures to cadmium in Italian infants and children from 0.5 up to 6 years of age ranged from 3.17 to 3.75 µg/kg body weight (bw)/week, while 95th percentile chronic dietary exposures in children aged 0.5 to 12 years of age ranged from 4.95 to 6.08 µg/kg bw/week[1]

27. The EFSA CONTAM Panel considered it unlikely that dietary exposure to cadmium results in cancer in humans (EFSA, 2009).

28. As part of their assessment, the CONTAM Panel established a new tolerable weekly intake (TWI) for cadmium. Using a group meta-analysis based on urinary β_2 – microglobulin as a marker for kidney damage, a $BMDL_5$ of 1 μg U-Cd/ g creatinine was calculated. In order for the U-Cd concentration of the population to remain below 1 μg/ g creatinine by the age of 50 years, dietary exposure to Cd should stay below 0.36 μg/kg bw/day or 2.52 μg/kg bw/week. Since Cd has a long biological half- life, CONTAM established a TWI of 2.5 μg/kg bw.

[1] Estimates were only available from one dietary survey.

WHO

29. The Joint FAO/WHO Committee on Food Additives (JECFA, 2011) established a provisional tolerable monthly intake (PTMI) for cadmium of 25 μg/kg bw, which is equivalent to ~6 μg/kg bw/week or 0.8 μg/kg bw/day. This was a dietary level associated with a urinary level of less than 5.24 μg Cd/g creatinine, which was not associated with increased excretion of β_2-microglobulin in humans.

30. The maximum value for Cd in drinking water was set at 3 μg/l and for air 5 ng/m^3 (annual average)
http://www.who.int/water_sanitation_health/water-quality/guidelines/chemicals/cadmium.pdf?ua=1

IARC

31. The IARC has reviewed cadmium and cadmium compounds multiple times, most recently in 2012, and has classified them as human carcinogens that cause cancers of the lung, prostate and paranasal sinuses after inhalation (IARC, 2012). There is currently no consistency in the epidemiological data to suggest that cadmium compounds cause cancer at additional sites or by additional routes, and no tumours have been observed in oral carcinogenicity studies in experimental animals.
https://monographs.iarc.fr/ENG/Monographs/vol100C/mono100C-8.pdf

COT

32. In an earlier COT meeting (June 2009), COT stated with regard to a health based guidance value for cadmium:

> "The approach used by EFSA to derive the TWI was appropriate, although conservative. Given the conservative manner in which the TWI was derived, and that exceedances from dietary exposure are modest (generally less than 2-fold) and only for a limited part of the lifespan, they do not indicate a major concern. Nevertheless, in view of the uncertainties, it would be prudent to reduce dietary exposures to cadmium at the population level where this is reasonably practical."

PHE

33. The public information concerning exposure to Cd is found at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/569198/Cadmium_general_information.pdf
The general advice suggests that high levels of Cd exposure are only encountered by those involved in industrial applications.

Cadmium exposures in infants aged 0 to 12 months and young children aged 1 to 5 years

Sources of cadmium exposure

Human breast milk

34. In general, low levels of cadmium are found in breast milk (EFSA, 2009).

35. As part of the 2004 SUREmilk study, levels of cadmium were measured in breast milk from women in the UK. In 104 samples, only 1 had a concentration at the limit of detection (LOD) of 0.3 µg/kg, the remainder being below this value (Woolridge *et al*., 2004).

The COT[2] noted that in the SUREmilk the data were insufficiently accurate for further analysis but were not of toxicological concern. Searches for cadmium in breast milk found a number of other papers more recent than the EFSA opinion of 2009 but the latest result for the UK other than SUREmilk was from 1984. Since only one of these considered data from the UK, the searched were widened to include non-UK data. These data are summarised in Table 2 below

Table 1. Concentrations of cadmium breast milk available from the published literature

Country	Number of samples	Average concentration (µg/L)[a]	Maximum concentration (µg/L)	Reference
UK	28	0.40±0.28	1.20	Kovar *et al*1984
UK	104	-	39	Woolridge *et al*., 2004
Poland		0.11± 0.07**	-	Olszowsk *et ali*, 2016
Morocco		<1*	-	Cherkani-Hassani *et al*, 2016
Turkey	107	-	6.71	Dursun *et al*, 2016
Poland	323	2.11±6.33	7.36	Winiarska-Mieczan 2014
China		-	0.23	Sun *et al* 2013

[2] http://cot.food.gov.uk/sites/default/files/cot/cotsuremilk.pdf

China	170	0.67*	-	Liu *et al* 2013
Turkey	64	4.62 (single sample)	6.35	Gürbay *et al* 2012
Bangladesh	96	0.13*	-	Kippler *et al 2012*
Taiwan	34	0.35±0.18	-	Chao *et al* 2014
Spain	30	1.31	-	García-Esquinas et al 2011

** Mean and standard deviation excluding samples below the detection limit of 0.15 µg/**L.**
Average concentration is the mean or median, where it is the median this has been indicated with *.
Where it has been available, the standard deviation has also been provided (as ±…).

36. .

37. In 1984, Kolvar *et al* collected breast milk from 28 nursing mothers at 5 days postpartum and analysed it for cadmium using atomic absorption spectrophotometry after electrothermal excitation in a graphite furnace. Although demographic and lifestyle data were collected (place of residence relative to sources of pollution such as major roads and industrial chimneys and smoking habits) these were not taken into account when the results were presented.

38. In the absence of other UK data on cadmium in breast milk and the fact that the data from the Kolvar study are within the same order of magnitude as some of the later studies from around the world, the values from this study have been used in this discussion paper.

<u>Infant formulae and food</u>

39. Concentrations of cadmium have recently been measured in an FSA survey of metals and other elements in infant formulae and foods (e.g. commercial infant foods) (referred to as the Infant Metals Survey, FSA 2016a), and in the composite food samples of the 2014 Total Diet Study (TDS, FSA 2016b).

<u>Food contact materials</u>

40. The migration of cadmium from food contact materials could represent an additional source for the presence of cadmium in food and drinking water. The EU, in Council Directive (84/500/EEC) – migration of lead (Pb) and cadmium (Cd) into food

contact ceramic articles, has set a migration limit for cadmium from ceramic glazes into liquids contained in fillable articles as follows:

Table 2. Permissible limits of release of Cd from food contact articles

Category of ceramic wares	Permissible limit of Cd release
(1) Articles which cannot be filled and articles which can be filled, the internal depth of which, measured from the lowest point to the horizontal plane passing through the upper rim, does not exceed 25 cm.	0.07 mg/dm^2
(2) All other articles which can be filled	0.3 mg/l
(3) Packaging and storage vessels having a capacity of more than three litres	0.1 mg/l

41. Rebeniak *et al* 2014) analysed 751 samples of decorated ceramic ware in categories (1) and (2)and 452 samples of glassware from the EU and Asia between 2010 and 2012. In category (2), 51 samples had detectable but permissible levels of migration. Only 7% of the category (1) products showed Cd migration. None exceeded the permissible limit. In category (2), 8.6% of the samples had detectable Cd migration, within the permissible limit. For glassware, 19% of beverage glasses and 7% of wine/vodka glasses exceeded the permissible limit and a further 11% of the samples had detectable levels. However, the authors pointed out that food contact times in use migration would probably be lower than into the food simulant used (4% aq acetic acid), food contact time would be shorter than those used (24 hours), and migration would decline with each use of the vessel.

Drinking water

42. The primary source of cadmium in drinking water is leaching from groundwater as a consequence of dissolution from cadmium ore-bearing rocks and anthropogenic sources (WHO, 2005 and 2011).

43. In water, cadmium is present as Cd(II) In their assessment, the EFSA found the contribution of drinking water to the total exposure to cadmium to be very small across all age groups (EFSA, 2009)

44. EU legislation sets a value of 5.0 µg/L for cadmium in water intended for human consumption (Directive 98/83/EC), and a maximum level of 3 µg/L in natural mineral waters (Directive 2003/40/EC). The WHO has established a guidance level of 3 µg/L for cadmium in drinking water, but has stated that a concentration of 20 µg/L should be achievable by conventional water treatment (WHO, 2011).

45. Levels of cadmium in drinking water in 2014/2015 from England and Wales, Northern Ireland and Scotland were provided by the Drinking Water Inspectorate (DWI), Northern Ireland Water and the Drinking Water Quality Regulator (DWQR) for Scotland, respectively. Median and 97.5th percentile values calculated from this data are shown in Table 3. These values have been used to calculate exposures to cadmium from drinking water in combination with exposures from food.

Table 3. Median and 97.5th percentile concentrations (µg/L) of cadmium in water across the UK for 2014/2015.

Country	**Number of samples**	**Limit of Detection (µg/L)**	**Median concentration (µg/L)**	**97.5th Percentile concentration (µg/L)**
England and Wales	13325	0.01-0.10*	0.04	0.25
Northern Ireland	392	0.01	<0.01	0.16
Scotland	1500	0.02	<0.02	0.40

* The DWI noted that the water companies had reported a range of LODs that varied with the analytical method used, and clarified that the relevant drinking water regulations specify that the LOD must not be more than 10% of the prescribed value (5 µg/L for cadmium).

Environmental

Dust

46. Harrison (1979) determined the levels of cadmium and other metals in outside and domestic dust samples collected in Lancaster. “Available” cadmium levels in domestic dust, ie those extractable from the dust by 0.07N HCl to mimic gastric acid, were 7.3 $\pm$ 6.2 µg/g (Mean $\pm$ SD, n = 4, range 1.0 – 14.0 µg/g).

47. Turner and Simmonds (2006) determined the concentration of cadmium in 32 household dust samples from 4 regions of the UK (Birmingham , Plymouth and rural areas within 50 km of each of these cities) by ICP-MS. Across all of the samples, the median and maximum values were 1.1 and 4.9 µg/g respectively. These values will be used in the exposure assessment.

Soil

48. Cadmium is present at about 0.1 mg/kg in the Earth’s upper continental crust (Rawlins *et* al., 2012). It occurs naturally at high levels in some types of rock, and is released to soils from anthropogenic activities such as smelting. A total concentration of 10 mg/kg (for sandy loam soil) was adopted as the Soil Guideline value for residential soils (Environment Agency, 2009) and is well above the concentration found in most soils.

49. Concentrations of cadmium were measured in 5,670 topsoil (from a depth of 0 to 15 cm) samples collected between 1978 and 1982 in England and Wales. Samples were analysed 30 years later (Rawlins *et al.*, 2012). The median and 90th percentile concentrations were reported as 0.33 and 0.88 mg/kg, respectively.

50. In 2012 and 2013, the Defra published normal background concentrations (NBCs) for cadmium in soil in England and Wales (Defra, 2012 and 2013). An NBC is the 95th percentile upper confidence interval of the available data; it is defined as a contaminant concentration that is seen as typical and widespread in top-soils (depth 0 - 15 cm). In order to establish meaningful NBCs, the available soil data were grouped in domains (e.g. principal, urban, and ultrabasic) that were defined by the most significant controls on a contaminant’s high concentrations and distribution. The NBCs for each domain in England and Wales were published following a Defra-commissioned BGS project to define the typical background concentrations for soil contaminants.

51. As part of the BGS project, summary statistics were derived from topsoil data from 2 or 3 core datasets held for England and Wales (Ander *et al*., 2012 and 2013).

Although the NBCs and summary statistics were derived for several domains for England and Wales, the most significant domain for each country was the principal domain. The principal domains are areas which do not contain significantly elevated levels of cadmium. Overall, for England and Wales, the area covered by the principal domains constitutes approximately 99% and 94% of each country respectively. The summary statistics reported for the principal domain in England were a median of 0.31 mg/kg and a 95th percentile of 1.0 mg/kg (n = 4418 samples). The statistics reported for the same domain in Wales were a median of 0.33 mg/kg and a 95th percentile of 1.2 mg/kg (n = 685 samples).

52. Between 2004 and 2006, 6,862 samples of rural surface soil (depth 5 - 20cm) were collected from sites in Northern Ireland as part of the Tellus survey. The samples were collected on a systematic basis and following the protocols set out in the BGS's Geochemical Baselines Survey of the Environment (G-BASE) programme. The limit of detection (LOD) used was 0.5 mg/kg (Smyth and Johnston, 2013). The median and 95th percentile concentrations derived from the data[x] are 0.50 and 1.0 mg/kg, respectively.

53. The median value of 0.5 mg/kg (the LOD) and the highest 95th percentile concentration value for cadmium in soil from the Defra-commissioned BGS project on NBCs (1.2 mg/kg) have been used to estimate exposures to soil in this assessment. These data have been used as they are recent, and represent a relevant domain for estimating exposure for the general population.

Air

54. In the atmosphere cadmium occurs mainly as fine respirable particles (<1 µm) and is eventually suspended onto particulate matter from sea spray, industrial emissions and the burning of fossil fuels.. Metallic cadmium has a very low vapour pressure and thus would not be expected to make much contribution to atmospheric levels except in the vicinity of smelting works where vaporisation could occur Anthropogenic sources account for more than 80% of the atmospheric cadmium burden, with the remainder accounted for by natural sources such as soil dust, volcanoes and forest fires (EFSA, 2009).

55. The EU Fourth Daughter Directive (2004/107/EC) defined the 'target value' for, cadmium in the PM10 particulate fraction of ambient air as 5 ng/m^3 Member States had to transpose the 4th Daughter Directive into national law by 15th February 2007. The European Commission was due to report on its implementation by 31st December 2010. Governments had to report to the Commission on zones and agglomerations where the target values are exceeded with the first such reports being required by 30th September 2008. The DEFRA Technical report on UK supplementary assessment under the Air Quality Directive (2008/50/EC), the Air

Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2012 found no exceedances of the target value for Cd.

56. Data from 22 air sampling sites across the UK (2 in Northern Ireland, 2 in Scotland and the rest distributed across England and Wales) are collected annually by Defra .The latest data, for 2015 have yielded median values across the sites of 0.0238 to 1.18 ng/m^3 and maximum values of 0.0418 to 16.8 ng/m^3. The latter maximum value and a value of 10.3 ng/m^3 were both from a sampling site near Walsall and the only samples to exceed the 5 ng/m^3 limit set by the 4th Daughter directive.

57. While infants are very unlikely to actively smoke tobacco, the presence of second-hand smoke in the home is a possible route of exposure to cadmium. In a study in Korea, Jung *et al* 2015) found a significant positive relationship between B-Cd levels and exposure to second-hand smoke in non-smoking women at work ($p < 0.001$) and at home ($p < 0.04$) after $\geq$ 1 hour of exposure. However, Richter *et al* (2009) in the USA found no relationship between second-hand smoke exposure and urinary Cd concentrations in 776 6 -12 year-old children, although levels increased in non-smokers' urine with age.

Exposure assessment

58. Consumption data (on a bodyweight basis) from the Diet and Nutrition Survey of Infants and Young Children (DNSIYC) (DH, 2013), and the National Diet and Nutrition Survey Rolling Programme (NDNS) (Bates *et al.*, 2014) have been used for the estimation of dietary exposures for ages 4 to 18 months, and 18 to 60 months respectively. Bodyweight data used in the estimation of other cadmium exposures are shown in Table 4 below.

59. Thorough exposure assessments have been performed for the dietary sources of exposure to cadmium. The assessments for the non-dietary sources of exposure (i.e. dust, soil and air) have been included to give a more holistic view of exposures, but are not as thorough as the focus of this statement is the diet of infants and young children.

Table 4. Average bodyweights used in the estimation of cadmium exposures

Age group (months)	Bodyweight (kg)
0 to <4	5.9[a]
4 to <6	7.8[b]

6 to <9	8.7[b]
9 to <12	9.6[b]
12 to <15	10.6[b]
15 to <18	11.2[b]
18 to <24	12.0[c]
24 to <60	16.1[c]

[a] DH, 1994
[b] DH, 2013
[c] Bates *et al*., 2014

Infants (0 to 12 months)

Breast milk

60. No consumption data were available for exclusive breastfeeding in infants aged 0 to 6 months. Therefore, the default consumption values used by the COT in other evaluations of the infant diet of 800 and 1200 mL for average and high level consumption have been used to estimate exposures to cadmium from breastmilk. These estimates were based on a mean cadmium concentration of 0.4µg/L and a maximum of 1.2 µg/L. The ranges of exposure to cadmium in exclusively breastfed 0 to 6 month olds were 0.041 to 0.16 and 0.062 to 0.24 µg/kg bw/day in average and high level consumers respectively (Table 5).

Table 5. Estimated cadmium exposure from exclusive breastfeeding in 0 to 6 month old infants, with breast milk containing cadmium at 1.2 µg/L.

Cadmium concentration (µg/L)	**Exposure (µg/kg bw/day)**			
	Average consumer (800 mL/day)		**High consumer (1200 mL/day)**	
	0 to <4 months	**4 to <6 months**	**0 to <4 months**	**4 to <6 months**
Mean 0.4	0.054	0.041	0.081	0.062
Max 1.2	0.16	0.12	0.24	0.18

Values rounded to 2 significant figures (SF)

61. Data on breast milk consumption for infants aged 4 to 18 months were available from the DNSIYC and the NDNS, and have been used to estimate exposures at these ages (Table 6), based on a mean cadmium concentration of 0.4µg/L. There were too few records of breast milk consumption for children older than 18 months in the NDNS to allow a reliable exposure assessment, and breast milk is expected to contribute minimally in this age group.

62. Mean exposures to cadmium for 4 to 18 month olds were 0.010 to 0.037 µg/kg bw/day, and 97.5th percentile exposures were 0.021 to 0.062 µg/kg bw/day (Table 6).

Table 6. Estimated cadmium exposure in 4 to 18 month old infants from breast milk, containing cadmium at 0.4 µg/L.

Exposure (µg/kg bw/day)	Age group (months)				
	4 to <6	6 to <9	9 to <12	12 to <15	15 to <18
Mean	0.037	0.027	0.015	0.012	0.010
97.5th percentile	0.062	0.067	0.046	0.030	0.021

Values rounded to 2 SF

Infant formulae and complementary foods

63. Cadmium exposure estimates for this category were derived using occurrence data from the Infant Metals Survey (FSA, 2016a), based on both lower bound (LB) and upper bound (UB) concentrations. Exposure estimates for 0 to 6 month olds were calculated for exclusive feeding on infant formulae using the default consumption values of 800 and 1200 mL (Table 7). Consumption data from the DNSIYC were used to estimate exposures for 4 to 12 month olds (DH, 2013)

64. In 0 to 6 month olds, exposures to cadmium from ready-to-feed formula were 0 to 0.03 µg/kg bw/day in average consumers, and 0 to 0.04 µg/kg bw/day in high level consumers. Exposures to cadmium calculated for reconstituted formula incorporating the water concentration from the TDS, and the highest median and 97.5th percentile concentrations for cadmium in water reported in Table 3 were 0.06 to 0.22 µg/kg bw/day in average consumers, and of 0.0.08 to 0.33 µg/kg bw/day in high level consumers (Table 7).

Table 7. Estimated average and high level exposures to cadmium from exclusive feeding on infant formulae for 0 to 6 month olds.

Infant Formula	Cadmium Exposure (LB-UB Range) (µg/kg bw/day)			
	0 to <4 months		4 to <6 months	
	Average consumer (800 mL/day)	High level consumer (1200 mL/day)	Average consumer (800 mL/day)	High level consumer (1200 mL/day)
Ready-to-Feed [a]	0-0.03	0-0.04	0-0.02	0-0.03

Dry Powder [b, c]	0.06-0.08	0.09-0.12	0.05-0.06	0.07-0.09
Dry Powder [c] + TDS water of <1.2 µg/L [d]	0.19-0.22	0.30-0.33	0.15-0.16	0.23-0.25
Dry Powder [c] + median water of 0.04 µg/L [d]	0.07-0.09	0.10-0.13	0.06-0.07	0.08-0.10
Dry Powder [c] + 97.5th percentile water of 0.4 µg/L [d]	0.11-0.13	0.16-0.19	0.10-0.11	0.12-0.14

Values rounded to 2 SF
[a] Exposure based on first milk infant formula using LB to UB cadmium concentrations of 0-0.2 µg/L
[b] Exposure does not include the contribution from water
[c] Exposure based on first milk infant formula using LB to UB cadmium concentrations of 3-4 µg/kg
[d] Calculated assuming reconstituted formula comprises 85% water

65. Total mean exposures (excluding water) to cadmium from infant formulae, commercial infant foods, and other foods, for 4 to 12 month olds were 0.12 to 0.28 µg/kg bw/day, and 97.5th percentile exposures were 0.45 to 0.62 µg/kg bw/day. Detailed exposure assessments for 4 to 18 month old infants and young children are provided in Annex A. Total mean and 97.5th percentile exposures were also calculated using the highest median and 97.5th percentile concentrations for cadmium in water reported in Table 3. The resulting total mean and 97.5th percentile exposures indicated that levels of cadmium in water made a negligible contribution to total exposure (Table 8).

Table 8. Estimated exposures to cadmium from infant formulae, commercial infant foods and other foods for 4 to 12 month olds.

	Cadmium Exposure (LB-UB Range) (µg/kg bw/d)					
Food	**4 to <6 Months (n=116)**		**6 to <9 Months (n=606)**		**9 to <12 Months (n=686)**	
	Mean	**97.5th**	**Mean**	**97.5th**	**Mean**	**97.5th**
Infant formula	0.0004-0.014	0.005-0.028	0.0005-0.012	0.0013-0.027	0.0005-0.0088	0.0053-0.019
Commercial infant foods	0.053-0.055	0.23	0.080-0.082	0.29-0.30	0.076-0.078	0.32-0.33

Other foods	0.059-0.061	0.31	0.14	0.45	0.2	0.52
Total (excl. water)	0.12-0.13	0.45-0.48	0.22-0.23	0.55	0.27-0.28	0.60-0.62

Values rounded to 2 SF
* Determined from a distribution of consumption of any combination of categories rather than by summation of the respective individual 97.5th percentile consumption value for each of the three food categories

Children aged 12 to 18 months

66. Estimated exposures to cadmium from food for children aged 12 to 18 months were calculated using occurrence data from both the Infant Metals Survey (FSA, 2016a), and the 2014 TDS (FSA, 2016b). The exposure data derived from the Infant Metals Survey allow estimation of cadmium exposure in infant formula, commercial infant foods and the most commonly consumed adult foods ('other foods') as sold, whereas the results from the TDS are based on analysis of food that is prepared as for consumption. In addition, the Infant Metals Survey included analysis of infant formulae and commercial infant foods which are not included in the TDS. Exposure estimates based on both LB and UB concentrations are provided.

67. The consumption data from the DNSIYC were used for the estimation of exposure for children aged 12 to 18 months (DH, 2013).

Exposure estimates based on the Infant Metals Survey

68. The ranges of total mean and 97.5th percentile exposures (excluding water) to cadmium from infant formula, commercial infant foods and other foods were 0.26 to 0.27 and 0.54 to 0.58 µg/kg bw/day, respectively. As for infants the total mean and 97.5th percentile exposures including water (calculated using the highest median and 97.5th percentile values in Table 3) were equal to those estimated for the total mean exposures excluding water (Table 9).

Table 9. Estimated exposures to cadmium from infant formulae, commercial infant foods and other foods in children aged 12 to 18 months.

Food	**Cadmium Exposure (LB-UB Range) (µg/kg bw/d)**			
	12 to <15 Months (n=670)		**15 to <18 Months (n=605)**	
	Mean	**97.5th**	**Mean**	**97.5th**
Infant formula	0.00010-	0-0.018	0.00010-	0-0.014

	0.0040		0.0023	
Commercial infant foods	0.042-0.043	0.21-0.22	0.022-0.023	0.14-0.14
Other Foods	0.22-0.23	0.54-0.55	0.24-0.25	0.53
Total (excl. water)	0.26-0.27	0.56-0.58	0.26-0.27	0.54

Values rounded to 2 SF
* Determined from a distribution of consumption of any combination of categories rather than by summation of the respective individual 97.5th percentile consumption value for each of the three food categories

Exposure estimates based on the TDS

69. Table 10 shows the estimated cadmium exposures calculated using the TDS data for children aged 12 to 18 months. The cadmium concentration for the tap water group in the TDS was reported to be below the limit of detection (LOD) of 1.2 µg/L. This LOD is higher than that reported for cadmium in tap water by the water authorities across the UK (Table 3). The calculation was therefore also performed using the highest median (0.04 µg/L) and 97.5th percentile (0.40 µg/L) cadmium concentration in tap water reported in Table .3

70. Total mean and 97.5th percentile exposures to cadmium from a combination of all food groups are in the region of 0.29 to 0.55 and 0.60 to 0.93 µg/kg bw/day, respectively (Table 10). These are higher than those estimated from the Infant Metals Survey due to the inclusion of a greater number of foods in the exposure estimate for the TDS. Overall the figures in Table 10 demonstrate that the cadmium content of water has a negligible impact on total dietary exposure to cadmium of young children in the UK.

Table 10. Estimated dietary exposure to cadmium based on the TDS data in children aged 12 to 18 months.

Cadmium concentration in the water	Cadmium Exposure (LB-UB Range) (µg/kg bw/day)			
	12 to <15 Months (n=670)		15 to <18 Months (n=605)	
	Mean	97.5th	Mean	97.5th
0.04 µg/L	0.29-0.50	0.61-0.93	0.32-0.55	0.60-0.90
0.4 µg/L	0.29-0.50	0.61-0.93	0.32-0.55	0.60-0.90

Values rounded to 2 SF

71. In general, the food groups making the highest contribution to cadmium exposure were miscellaneous cereals, bread and potatoes (FSA, 2016b).

Children aged 18 months to 5 years

72. Exposure estimates for these age groups were derived using occurrence data from the 2014 TDS, and consumption data from the NDNS (Bates *et al*., 2014).

73. Table 11 shows the cadmium exposures that were calculated using the TDS data for children aged 18 months to 5 years. Detailed exposure assessments are presented in Annex B As described in paragraph 69, the exposures have been estimated using the TDS water concentration (1.2 µg/L, the LOD), and the highest median (0.04 µg/L) and 97.5th percentile (0.4 µg/L) cadmium concentrations in water reported in Table 3. This results in total mean and 97.5th percentile exposures to cadmium from a combination of all food groups of 0.32 to 0.59 and 0.52 to 0.92 µg/kg bw/day, respectively (Table 11). Overall the figures in Table 11 demonstrate that the cadmium content of water has a negligible impact on total dietary exposure to cadmium of young children in the UK.

Table 11 Estimated dietary exposure to cadmium in children aged 18 months to 5 years.

Cadmium concentration in water	**Cadmium Exposure (LB-UB Range) (µg/kg bw/day)**			
	18 to <24 Months (n=70)		**24 to <60 Months (n=429)**	
	Mean	**97.5th**	**Mean**	**97.5th**
0.04 µg/L	0.34-0.59	0.57-0.92	0.32-0.52	0.52-0.80
0.4 µg/L	0.34-0.59	0.57-0.92	0.32-0.52	0.52-0.80

Values rounded to 2 SF

74. As with the younger children, the food groups making the highest contribution to cadmium exposure in the TDS were miscellaneous cereals, bread and potatoes (FSA, 2016b).

Exposure to cadmium from soya-based infant formulae.

75. Cadmium has been reported in powdered soya formula at a level of 11 µg/kg , which is higher than in other types of infant formulae (3 - 4 µg/kg for first milk infant formula, FSA 2016a). This is because soybean plants concentrate cadmium from the

soil by active uptake (Cataldo *et al*, 1983), even when grown in soils with permitted levels of the metal.(Zhi *et al*, 2015) Therefore exposure to cadmium from consumption of soya formula was considered separately. Using the EFSA default values of 800 and 1200 ml for exclusive consumption of infant formula for the 4 to 6 month age group, exposure estimates for cadmium in soya formula would be 0.17 and 0.26 µg/kg bw/day for average and high level consumers, respectively before taking into account water used in reconstitution, i.e. approximately 3 times the exposure for non-soya formula shown in Table 7.

Dust

76. Potential exposures of UK infants aged 6 to 12 months and young children aged 1 to 5 years to cadmium in dust were calculated assuming ingestion of 30 or 60 mg/day, respectively (US EPA, 2011a). Younger infants, who are less able to move around and come into contact with dust, are likely to consume less dust than children of these age groups. Median and maximum cadmium concentrations in dust of 1.1 and 4.9 mg/kg, respectively, were used to estimate average and high level exposures (paragraph 48) (Table 12).

Table 12. Possible cadmium exposures from dust in infants and young children aged 6 months to 5 years.

Cadmium concentration (mg/kg)	Exposure (µg/kg bw/day)					
	Age (months)					
	6 to <9	9 to <12	12 to <15	15 to <18	18 to <24	24 to <60
1.1 (Median)	0.0038	0.0034	0.0062	0.0059	0.0055	0.0041
4.9 (Maximum)	0.017	0.015	0.028	0.026	0.025	0.018

Values rounded to 2 SF

Soil

77. Potential exposures of UK infants aged 6 to 12 months and young children aged 1 to 5 years to cadmium in soil were calculated assuming ingestion of 30 or 50 mg/day, respectively (US EPA, 2011a). Younger infants, who are less able to move around and come into contact with soil, are likely to consume less soil than children of these age groups. Median and 90th percentile soil concentrations of 0.50 and 1.2 mg/kg respectively were used in these exposure estimations (paragraph 54) (Table 13).

Table 13. Possible cadmium exposures from soil in infants and young children aged 6 months to 5 years.

Cadmium concentration (mg/kg)	Exposure (µg/kg bw/day)					
	Age (months)					
	6 to <9	9 to <12	12 to <15	15 to <18	18 to <24	24 to <60
0.5 (Median)	0.0017	0.0015	0.0023	0.0022	0.0021	0.0016
1.2 (95th percentile)	0.0041	0.0038	0.0057	0.0054	0.0050	0.0037

Values rounded to 2 SF

Air

78. Potential exposures of UK infants aged 0 to 12 months and young children aged 1 to 5 years to cadmium in air were estimated using the body weights shown in Table 4, and by assuming the mean ventilation rates presented in Table 14; these rates have been derived from the US EPA exposure factors handbook (US EPA, 2011b). The resulting exposures are presented in Table 15.

Table 14 Mean ventilation rates used in the estimation of cadmium exposures from air (derived from US EPA, 2011b)

Age group (months)	Ventilation rate (m^3/day)
0 to <4	3.5
4 to <6	4.1
6 to <9	5.4
9 to <12	5.4
12 to <15	8.0
15 to <18	8.0
18 to <24	8.0
24 to <60	10.1

79. The cadmium concentrations used in the exposure calculations were the lowest and highest median values and lowest and highest maximum values of 0.024, 1.2, 2.23 and 56.23 ng/m^3, respectively, from monitoring sites in the UK (paragraph 57).

Table 15. Possible exposures to cadmium in infants and young children from air

Cadmium concentration (ng/m³)	Exposure (µg/kg bw/day)							
	Ages (months)							
	0 to <4	4 to <6	6 to <9	9 to <12	12 to <15	15 to <18	18 to <24	24 to <60
(lowest median value)	0.000014	0.000011	0.000015	0.000013	0.000018	0.000017	0.000016	0.000015
(highest median value)	0.00070	0.00062	0.00073	0.00066	0.00089	0.00084	0.00079	0.00074
(lowest maximum value)	0.000025	0.000022	0.000026	0.000024	0.000032	0.000030	0.000028	0.000026
(highest maximum value)	0.010	0.0088	0.010	0.0095	0.013	0.012	0.011	0.011

Risk characterisation

80. Since the COT previously applied caveats to the use of the use of the EFSA provisional tolerable weekly intake value (PTWI) of 2.5 µg/kg bw/week, (paragraph 32), both that value and the more recent WHO JECFA provisional tolerable monthly intake value (PTMI) of 25 µg/kg bw/month are provided below for comparison and discussion. For the WHO PTMI, a month is taken to be 30 days in the calculations below.

Breast milk

81. Cadmium intake in average and high level exclusively breast-fed UK infants from 0 to < 6 months of age is shown in Table 16 below. Values range from 11 – 67% of the EFSA PTWI of 2.5 µg/kg bw/week (a) or 4.9 to 29% of the WHO JECFA PTMI(b)

Table16. Risk characterisation of cadmium exposure from exclusive breastfeeding in 0 to 6 month old infants, with breast milk. .

a) Intake relative to the EU PTWI

Cadmium concentration (µg/L)	Percentage of EU PTWI (2.5 µg/kg bw/week)			
	Average consumer (800 mL/day)		High consumer (1200 mL/day)	
	0 to <4 months	4 to <6 months	0 to <4 months	4 to <6 months
Mean0.4	15	11	22	17
Max 1.2	45	34	67	50

b) Intake relative to the WHO JECFA PTMI

Cadmium concentration (µg/L)	Percentage of WHO PTMI (25 µg/kg bw/month)			
	Average consumer (800 mL/day)		High consumer (1200 mL/day)	
	0 to <4 months	4 to <6 months	0 to <4 months	4 to <6 months
Mean0.4	6.5	4.9	9.8	7.4
Max 1.2	19	15	29	22

82. Intakes of cadmium for mean and 97.5th percentile breast milk consumers from infants of 4 to < 18 months of age who are fed milk as only part of their diet are shown in Table 17 below. Mean intakes of cadmium were 4.2 to 19 % of the EU PTWI (a) and 97.5th percentile values were 5.9 to 19%. Mean intakes were 1.8 to 8.2% of the WHO PTMI (b) and 97.5th percentile values were 2.5 to 8.2%.

Table 17. Estimated cadmium exposure in 4 to 18 month old infants from breast milk, containing cadmium at 1.2 µg/L.

a) Intake relative to the EU PTW)

	Percentage of EU PTWI (2.5 µg/kg bw/week)				
Breast milk consumption	Age group (months)				
	4 to <6	6 to <9	9 to <12	12 to <15	15 to <18
Mean	10	7.6	4.2	3.4	2.8
97.5th percentile	17	19	13	8.4	5.9

b) Intake relative to the WHO JECFA PTMI

	Percentage of WHO PTMI (25 µg/kg bw/month)				
Breast milk consumption	Age group (months)				
	4 to <6	6 to <9	9 to <12	12 to <15	15 to <18
Mean	4.3	3.3	1.8	1.5	1.2
97.5th percentile	7.3	8.2	5.6	3.6	2.5

Infant formulae and complementary foods

83. Cadmium intake estimates for 0 to 6 month olds fed on infant formula of different make-up are shown in Table 18 below. Average consumer intakes of

cadmium were 0 to 45 % of the EU PTWI (a) and high level consumer intakes were 0 to 92%. Relative to the WHO PTMI (b), average consumer intakes were 0 to 19% and high level consumer intakes were 0 to 39%.

84.

Table 18. Estimated dietary intake of cadmium from exclusive feeding on infant formulae for 0 to 6 month olds relative to HBGV

a) Intake relative to the EU PTWI

Infant Formula	Percentage of EU PTWI (2.5 µg/kg bw/week)			
	0 to <4 months		4 to <6 months	
	Average consumer (800 mL/day)	High level consumer (1200 mL/day)	Average consumer (800 mL/day)	High level consumer (1200 mL/day)
Ready-to-Feed [a]	0-8.4	0-11	0-5.6	0-8.4
Dry Powder [b, c]	17-22	25-34	14-17	20-25
Dry Powder [c] + TDS water of <1.2 µg/L [d]	53-62	84-92	42-45	64-70
Dry Powder [c] + median water of 0.04 µg/L [d]	20-25	28-36	17-20	22-28
Dry Powder [c] + 97.5th percentile water of 0.4 µg/L [d]	31-36	45-53	28-31	34-39

b) Intake relative to the WHO JECFA PTMI

Infant Formula	Percentage of WHO PTMI (25 µg/kg bw/month)			
	0 to <4 months		4 to <6 months	
	Average consumer (800 mL/day)	High level consumer (1200 mL/day)	Average consumer (800 mL/day)	High level consumer (1200 mL/day)
Ready-to-Feed [a]	0-3.6	0-4.7	0-2.4	0-3.6
Dry Powder [b, c]	7.3-9.4	11-15	6.0-7.3	8.6-11
Dry Powder [c] + TDS	23-27	36-39	18-19	27-30

water of <1.2 µg/L [d]				
Dry Powder [c] + median water of 0.04 µg/L [d]	8.6-11	12-15	7.3-8.6	9.4-12
Dry Powder [c] + 97.5th percentile water of 0.4 µg/L [d]	13-15	19-23	12-13	15-17

85. Intakes of cadmium from infant formulae, commercial infant foods, and other foods, for 4 to 12 month olds are shown in Table 19. Mean total intakes were 34 to 78% µg/kg bw/day, and 97.5th percentile total intakes were 130 to 170 % for the EU PTWI (a). Mean total intakes for the WHO PTMI ranged from 15 to 33% and 97.5th percentile intakes were 56 to 73% (b)

86. Intakes of cadmium from exclusive consumption of soya-based infant formulae are 47% and 71% of the EU PTWI or 20 and 30% of the WHO PTM! for the mean and 97.5th percentile consumers respectively.

Table19.Estimated Intake of cadmium from infant formulae, commercial infant foods and other foods for 4 to 12 month olds relative to HBGV.

a) Intake relative to the EU PTWI

	Percentage of PTWI (2.5 µg/kg bw/week)					
Food	**4 to <6 Months (n=116)**		**6 to <9 Months (n=606)**		**9 to <12 Months (n=686)**	
	Mean	**97.5th**	**Mean**	**97.5th**	**Mean**	**97.5th**
Infant formula	0.11-3.9	1.4-7.8	0.14-3.4	0.36-7.6	0.14-2.5	1.5-5.3
Commercial infant foods	15-15	64	22-23	81-84	21-22	90-92
Other foods	17-17	87	39	130	56	150

Total (excl. water)	34-36	130	62-64	150	76-78	170

b) Intake relative to the WHO JECFA PTMI

Food	Percentage of WHO PTMI (25 µg/kg bw/month)					
	4 to <6 Months (n=116)		6 to <9 Months (n=606)		9 to <12 Months (n=686)	
	Mean	97.5th	Mean	97.5th	Mean	97.5th
Infant formula	0..047-1.67	0.60-3.3	0.06-1.5	0.15-3.3	0.06-1.1	0.64-2.3
Commercial infant foods	6.4	27	9.4-9.9	35-36	9.0-9.4	39
Other foods	7.3	37	17	56	24	64
Total (excl. water)	15	56	27	64	33	73

Children aged 12 to 18 months

Intake estimates based on the Infant Metals Survey

87. For the EU PTWI, the ranges of total mean and 97.5th percentile intakes (excluding water) to cadmium from infant formula, commercial infant foods and other foods were 73 to 79 and 150 to160% respectively (a). For the WHO PTMI, the ranges of total mean and 97.5th percentile intakes (excluding water) to cadmium from infant formula, commercial infant foods and other foods were 31 to 33 and 65 to 69 % respectively (b)

Table 20. Estimated dietary intake of cadmium from infant formulae, commercial infant foods and other foods in children aged 12 to 18 months relative to HBGV.

a) Intake relative to the EU PTWI

Food	Percentage of EU PTWI (2.5 µg/kg bw/week)			
	12 to <15 Months (n=670)		15 to <18 Months (n=605)	
	Mean	97.5th	Mean	97.5th
Infant formula	0.028-1.1	0-5	0.028-0.64	0-3.9
Commercial infant foods	12	59-62	6.2-6.4	39
Other Foods	62-64	150-155	67-70	150
Total (excl. water)	73-76	160	73-76	151

b) Intake relative to the WHO JECFA PTMI

Food	Percentage of WHO PTMI (25 µg/kg bw/month)			
	12 to <15 Months (n=670)		15 to <18 Months (n=605)	
	Mean	97.5th	Mean	97.5th
Infant formula	0.012-0.47	0-2.1	0.012-0.27	0-1.7
Commercial infant foods	5.2	25-27	6.22.7	17
Other Foods	27	64-67	29-30	64
Total (excl. water)	31-33	69	31-33	65

88. Relative to the EU PTWI (a), mean intakes were 90 to 170% and 97.5th percentile intakes were 150 to 260%. Relative to the WHO PTMI (b), mean intakes were 38 to 71% and 97.5th percentile intakes were 62 to 110%.

Table 21. Estimated dietary intake to cadmium based on the TDS data in children aged 12 to 18 months relative to HBGV

a) Intake relative to the EU PTWI

Cadmium concentration in the water	Percentage of the EU PTWI (2.5 μg/kg bw/week)			
	12 to <15 Months (n=670)		15 to <18 Months (n=605)	
	Mean	97.5th	Mean	97.5th
0.04 μg/L	81-140	170-260	90-150	170-250
0.4 μg/L	81-140	170-260	90-150	170-250

b) Intake relative to the WHO JECFA PTMI

Cadmium concentration in the water	Percentage of the WHO PTMI (25 μg/kg bw/week)			
	12 to <15 Months (n=670)		15 to <18 Months (n=605)	
	Mean	97.5th	Mean	97.5th
0.04 μg/L	35-60	73-110	39-64	73-110
0.4 μg/L	35-60	73-110	39-64	73-110

Values rounded to 2 SF

Children aged 18 months to 5 years

89. The total mean and 97.5th percentile intake values including water (calculated using the highest median and 97.5th percentile values in Table 3) were equal to those estimated for the total mean exposures excluding water (Table 22).

90. Relative to the EU PTWI (a), mean intakes were 90 to 170% and 97.5th percentile intakes were 150 to 260%. Relative to the WHO PTMI (b), mean intakes were 38 to 71% and 97.5th percentile intakes were 62 to 110%.

Table 22. Estimated dietary intake of cadmium in children aged 18 months to 5 years.

a) Intake relative to the EU PTWI

Cadmium concentration in water	Percentage of the EU PTWI (2.5 μg/kg bw/week)			
	18 to <24 Months (n=70)		24 to <60 Months (n=429)	
	Mean	97.5th	Mean	97.5th
0.04 μg/L	95-170	160-260	90-150	150-220
0.4 μg/L	95-170	160-260	90-150	150-220

b) Intake relative to the WHO JECFA PTMI

Cadmium concentration in water	Percentage of the WHO PTMI (25 μg/kg bw/month)			
	18 to <24 Months (n=70)		24 to <60 Months (n=429)	
	Mean	97.5th	Mean	97.5th
0.04 μg/L	41-71	68-110	38-62	62-96
0.4 μg/L	41-71	68-110	38-62	62-96

Dust

91. Table 23 shows that the median Intakes from dust ingestion were at most 1.1% and the maximum intakes 7.8% of the EU PTWI (a). Intakes relative to the WHO PTMI were at most 0.47% for the median and 3.3% for the maximum (b).

Table 23. Estimated cadmium intakes from dust in infants and young children aged 6 months to 5 years.

a) Intake relative to the EU PTWI

Cadmium concentration (mg/kg)	Percentage of EU PTWI (2.5 μg/kg bw/week)					
	Age (months)					
	6 to <9	9 to <12	12 to <15	15 to <18	18 to <24	24 to <60
1.1 (Median)	0.95	0.95	1.7	1.7	1.5	1.1
4.9 (Maximum)	4.8	4.2	7.8	7.3	7.0	5.0

b) Intake relative to the WHO JECFA PTMI

Cadmium concentration (mg/kg)	Percentage of WHO PTMI (25 μg/kg bw/month)					
	Age (months)					
	6 to <9	9 to <12	12 to <15	15 to <18	18 to <24	24 to <60
1.1 (Median)	0.41	0.41	0.73	0.73	0.64	0.47
4.9 (Maximum)	2.1	1.8	3.3	3.1	3.0	2.1

Soil

92. Intakes in UK infants aged 6 to 12 months and young children aged 1 to 5 years of cadmium in soil are given in Table 24.

93. Relative to the EU PTWI (a), the highest median intake value for cadmium from soil was 0.64% and the highest 95th percentile value was 1.6%. Relative to the WHO PTMI (b), the highest median intake value for cadmium from soil was 0.23% and the highest maximum value was 0.68%.

Table 24 Estimated cadmium intakes from soil in infants and young children aged 6 months to 5 years.

a) Intake relative to the EU PTWI

Cadmium concentration (mg/kg)	**Percentage of EU PTWI (2.5 µg/kg bw/week)**					
	Age (months)					
	6 to <9	**9 to <12**	**12 to <15**	**15 to <18**	**18 to <24**	**24 to <60**
0.5 (Median)	0.48	0.42	0.64	0.62	0.59	0.45
1.2 (95th percentile)	1.1	1.1	1.6	1.5	1.4	1.0

b) Intake relative to the WHO JECFA PTMI

Cadmium concentration (mg/kg)	**Percentage of WHO PTMI (25 µg/kg bw/month)**					
	Age (months)					
	6 to <9	**9 to <12**	**12 to <15**	**15 to <18**	**18 to <24**	**24 to <60**
0.5 (Median)	0.20	0.18	0.23	0.22	0.21	0.16
1.2 (95th percentile)	0.49	0.46	0.68	0.65	0.60	0.44

Air

94. Relative to the EU PTWI (a), the highest median intake value for cadmium from the air was 0.25% and the highest maximum value was 3.6%. Relative to the WHO PTMI (b), the highest median intake value for cadmium from the air was 0.11% and the highest maximum value was 1.5%.

Table 25. Possible exposures to cadmium in infants and young children from air

a) Intake relative to the EU PTWI

Cadmium concentration (ng/m³)	Percentage of the EU PTWI (2.5 mg/kg bw/week)							
	Ages (months)							
	0 to <4	4 to <6	6 to <9	9 to <12	12 to <15	15 to <18	18 to <24	24 to <60
(lowest median value)	0.0039	0.0031	00.0042	0.0036	0.0050	0.0048	0.0045	0.0042
(highest median value)	0.20	0.18	0.20	0.18	0.25	0.24	0.22	0.21
(lowest maximum value)	0.0070	0.0062	0.0073	0.0067	0.0090	0.0084	0.0078	0.0073
(highest maximum value)	2.8	2.5	2.8	2.7	3.6	3.4	3.1	3.1

b) Intake relative to the WHO JECFA PTMI

Cadmium concentration (ng/m³)	Percentage of the WHO PTMI (25 mg/kg bw/month)							
	Ages (months)							
	0 to <4	4 to <6	6 to <9	9 to <12	12 to <15	15 to <18	18 to <24	24 to <60
(lowest median value)	0.0016	0.0013	0.0018	0.0015	0.0021	0.0021	0.0019	0.0018
(highest median value)	0.085	0.077	0.085	0.077	0.11	0.10	0.094	0.090
(lowest maximum value)	0.0030	0.0027	0.0031	0.0029	0.0039	0.0036	0.0033	0.0031
(highest maximum value)	1.2	1.1	1.2	1.2	1.5	1.5	1.3	1.3

Questions on which the views of the Committee are sought

Members are invited to comment on the exposure calculations and to answer the following questions:

i. Does the Committee still agree with their conclusion from 2009 (paragraph 32 of this paper) that the EFSA PTWI, although occasionally exceeded, is appropriate or would they accept the higher JECFA HBGV?

ii. Is the Committee happy with the values used for the level of Cd in breast milk or would they prefer another value?

iii. In the light of the small contribution to the total intake of cadmium by all routes other than food, does the Committee feel it necessary to express aggregate intakes?

References

Adams SV[1], Quraishi SM, Shafer MM, Passarelli MN, Freney EP, Chlebowski RT, Luo J, Meliker JR, Mu L, Neuhouser ML, Newcomb PA. Dietary cadmium exposure and risk of breast, endometrial, and ovarian cancer in the Women's Health Initiative. Environ Health Perspect. 2014 Jun;**122**(6):594-600. doi: 10.1289/ehp.1307054. Epub 2014 Mar 14.

Agency for Toxic Substances and Disease Registry U.S. Department of Health And Human Services Public Health Service Toxicological profile for cadmium. September 2012

Aquino NB, Sevigny MB, Sabagan J, Louie MC. Role of cadmium and nickelin estrogen receptor signalling in breast cancer: Metalloestragens or not? J. Environ.Sci.Health C. Environ.Carcinog, Ecotoxicol. Rev, 2012 **30** (3): 189 – 224.

Bates, B.; Lennox, A.; Prentice, A.; Bates, C.; Page, P.; Nicholson, S.; Swan, G. (2014) National Diet and Nutrition Survey Results from Years 1, 2, 3 and 4 (combined) of the Rolling Programme (2008/2009 – 2011/2012) Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/310995/NDNS_Y1_to_4_UK_report.pdf

Cataldo DA, Garland TR, Wildung RE Cadmium uptake kinetics in intact soybean plants. Plant physiology, 1983 **73**: 844 - 848

Chakraborty PK, Lee W-K, Moliter M, Wolff NA Thrévenod F cadmium induces Wnt signalling to upregulate proliferation and survival genes in sub-confluent kidney proximal tubule cells. Molecular Cancer 2010 **9**: 102 – 116

Chao HH1, Guo CH2, Huang CB1, Chen PC3, Li HC3, Hsiung DY4, Chou YK5. Arsenic, cadmium, lead, and aluminium concentrations in human milk at early stages of lactation Pediatr Neonatol. 2014 Apr;**55**(2):127-34. doi: 10.1016/j.pedneo.2013.08.005. Epub 2013 Nov 11.

Chmielowska-Bąk J, Isbianska K, Deckert J, The toxic Doppelganger: on the ionic and molecular mimicry of cadmium. Acta Biochimica Polonica 2013 **60**(3): 369 – 374.

DH (2013). Diet and Nutrition Survey of Infants and Young Children (DNSIYC), 2011. Available at: http://transparency.dh.gov.uk/2013/03/13/dnsiyc-2011/

Estaban-Vasallo MD, Aragonés N, Pollan M, López-Abente G, Perez-Gomez B Mercury, cadmium and lead levels in human placenta: A systematic review. Environmental Health Perspectives 2012 **120** (10):1369 – 1377.

FSA (2016a). Survey of metals and other elements in infant foods (to be published)

FSA (2016b). Study of metals and other elements in the 2014 Total Diet Study. (to be published)

Gallagher CM, Chen JJ, Kovach JS The relationship between body iron stores and blood and urine cadmium concentrations in US never-smoking, non-pregnant women aged 20-49 years. Environ Res. 2011 Jul;**111**(5):702-7. doi: 10.1016/j.envres.2011.03.007. Epub 2011 Apr 19.

Gao Y, Zhang Y, Yi J, Zhou J, Huang X, Shi X, Xiao S, Lin D. A longitudinal study on urinary cadmium and renal tubular protein excretion of nickel–cadmium battery workers after cessation of cadmium exposure. International Archives of Occupational and Environmental Health (2016), **89**, (7), 1137–1145.

García-Esquinas E1, Pérez-Gómez B, Fernández MA, Pérez-Meixeira AM, Gil E, de Paz C, Iriso A, Sanz JC, Astray J, Cisneros M, de Santos A, Asensio A, García-Sagredo JM, García JF, Vioque J, Pollán M, López-Abente G, González MJ, Martínez M, Bohigas PA, Pastor R, Aragonés N Mercury, lead and cadmium in human milk in relation to diet, lifestyle habits and sociodemographic variables in Madrid (Spain). Chemosphere. 2011 Sep;**85**(2):268-76. doi: 10.1016/j.chemosphere.2011.05.029. Epub 2011 Jun 21.

Golabek T, Darewicz B, Kudelska J, Socha K, Markiewicz-Zukowska R, Chlosta P. Okon K, Borawska M. cadmium in urothelial carcinoma of the bladder. Pol J Pathol 2014 **65**(1): 55 – 59.

Gürbay A1, Charehsaz M, Eken A, Sayal A, Girgin G, Yurdakök M, Yiğit Ş, Erol DD, Şahin G, Aydın A. Toxic metals in breast milk samples from Ankara, Turkey: assessment of lead, cadmium, nickel, and arsenic levels Biol Trace Elem Res. 2012 Oct;**149**(1):117-22. doi: 10.1007/s12011-012-9400-2. Epub 2012 Apr 18.

Harrison RM. Toxic metals in street and household dust. Science of the total environment 1979 **11**(1): 89 – 97.

Jung SY, Kin S, Lee K, Kim JY, Bae WK, Lee K, Han J-S, Kim S. Association between secondhand smoke exposure and blood lead and cadmium concentration in community dwelling women: the fifth Korea national Health and Nutrition Examination Survey (2010 – 2012). BMJ Open 2015 **5**: e008218. doi:10.1136/bmjopen-2015-008218.

Kovar IZ, Strehlow CD, Richmond J, Thompson MG. Perinatal lead and cadmium burden in a British urban population. Arch Dis Child. 1984 Jan;**59**(1):36-9..

Lamas CA. Gollücke APB, Dolder H. Grape juice concentrate (G8000) intake mitigates testicular morphological and ultrastructural damage following cadmium intoxication. International Journal of Experimental Pathology 2015 **96**? 301 – 310.

Lane TW, Morel FM. A biological function for cadmium in marine diatoms

Middleton, DRS, Watts MJ, Lark RM, Milne CJ, Polya DA (2016). Assessing urinary flow rate, creatinine, osmolarity and other hydration adjustment methods for urinary biomonitoring using NHANES arsenic, iodine, lead and cadmium data. Env. Health **15**: 68 – 81.

Nair AR. DeGheselle O, Smeets K, Van Kerkhove E and Cuypers A Cadmium-induced pathologies:where is the oxidative balance lost (or not?) Int.J.Mol.Sci.(2013) **14** 6116 – 6143.

Nawrot TS[1], Martens DS, Hara A, Plusquin M, Vangronsveld J, Roels HA, Staessen JA. Association of total cancer and lung cancer with environmental exposure to cadmium: the meta-analytical evidence**.** Cancer Causes Control. 2015 Sep;**26**(9):1281-8. doi: 10.1007/s10552-015-0621-5. Epub 2015 Jun 25.

Olszowski T1, Baranowska-Bosiacka I2, Rębacz-Maron E3, Gutowska I4, Jamioł D4, Prokopowicz A5, Goschorska M6, Chlubek D6. Cadmium Concentration in Mother's Blood, Milk, and Newborn's Blood and Its Correlation with Fatty Acids, Anthropometric Characteristics, and Mother's Smoking Status. Biol Trace Elem Res. 2016 Nov;**174**(1):8-20. Epub 2016 Apr 4.

Pires VC, Gollücke APB, Ribiero DA, Lungato L, Almeida VD, Aguiar Jr. O. Grape juice concentrate protects reproductive parameters in male rats against cadmium-induced damage: a chronic assay. British Journal of Nutrition 2013 **110**: 2020 – 2029.

Prabu SM, Shagirtha K, Renugadevi J. Amelioration of cadmium-induced oxidative stress, impairment in lipids and plasma lipoproteins by the combined treatment with quercetin and α-tocopherol in rats. J Food Sci. 2010 Sep;75(7):T132-40.
Proc Natl Acad Sci U S A. 2000 Apr 25;**97**(9):4627-31.

Rebeniac M, Wojciechowska-Mazurek M, Mania MSzynal T, Strzelecka A, Starska K. Exposure to lead and cadmium released from ceramics and glassware intended to come into contact with food. Rokz PanstwZaki Hig 2014 **65** 4:301 – 309.

Richter PS, Bishop EE, Wang J, Swahn MH. Tobacco smoke expodureand levels of urinary metals in the US youth and adult population: the national Health and Nutrition Examination Survey (NHANES) 1999 – 2004. Int. J. Environ. Res. Public Health 2009 **6**: 1930 – 1946.

Sangartit W, Kukongviriyapan U, Donpunha W, Pakdeechote P, Kukongviriyapan V[2], Surawattanawan P, Greenwald SE. Tetrahydrocurcumin protects against cadmium-induced hypertension, raised arterial stiffness and vascular remodeling in mice. PLoS One. 2014 Dec 11;**9**(12):e114908. doi: 10.1371/journal.pone.0114908. eCollection 2014.

Santana VP[1], Salles ÉS[2], Correa DE[2], Gonçalves BF[1], Campos SG[3], Justulin LA[1], Godinho AF[1], Scarano WR[4]. Long-term effects of perinatal exposure to low doses of cadmium on the prostate of adult male rats Int J Exp Pathol. 2016 Aug;**97**(4):310-316. doi: 10.1111/iep.12193. Epub 2016 Jul 28.

Scientific opinion of the Panel on Contaminants in the Food Chain on a request from the European Commission on cadmium in food. The EFSA Journal 2009 **980**: 1 – 139.

Turner A, Simmons L. Elemental concentrations and bioaccessability in UK household dust. Science of the total environment 2006 **371**(1 – 3): 74 – 81.

Winiarska-Mieczan A. Cadmium, lead, copper and zinc in breast milk in Poland. Biol Trace Elem Res. 2014 Jan;**157**(1):36-44. doi: 10.1007/s12011-013-9870-x. Epub 2013 Dec 12.

Zhai Q, Tian F, Zhao J, Zhang H, Narbad A, Chen W. Oral administration of probiotics inhibits absorption of the heavy metal cadmium by protecting the intestinal barrier. Applied and Environmental microbiology 2016 **82** (14): 4429 – 4440.

Zhi Y, He K, Sun T, Zhu Y, Zhou Q. Assessment of potential soybean cadmium excluder cultivars at different concentrations of Cd in soils. J Environ Sci (China). 2015 Sep 1;**35**:108-14. doi: 10.1016/j.jes.2015.01.031. Epub 2015 Jun 27.

PubMed search terms

Cadmium AND Breast milk
Toxicology
Toxicokinetics
Food contact
Dust
House dust
Domestic dust
Air
Indoor air
Cancer
Carcinogenesis
Oxidative stress
Second hand smoke
Passive smoke

COMMITTEE ON TOXICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT

Review of potential risks from Cadmium in the diet of infants aged 0 to 12 months and children aged 1 to 5 years

Possible Cadmium exposure from dietary sources in children aged 4 to 18 months

Two surveys were conducted during 2014 which measured the concentrations of elements in food consumed by infants (4 to 18 months) and young children (18 months to 5 years). The first survey was a survey on types of foods eaten by infants (referred to as the Infant Metals Survey), the other was a total diet study (TDS) which focused on sampling foods eaten by young children. Both studies measured the concentrations of Cadmium.

The Infant Metals Survey measured the concentrations of metals and other elements in food 'as sold', in the following categories: infant formula (Table B1) commercial infant foods (Table B2), and groups of food comprising the top 50 most commonly consumed varieties of foods not specifically marketed for infants (Table B3). The results from this survey were used together with food consumption data from the Diet and Nutrition Survey for Infants and Young Children (DNSIYC) (DH, 2013) to estimate dietary exposures for children aged 4 to 18 months.

The TDS consisted of: (i) selecting foods based on food consumption data, to represent as best as possible a typical diet; (ii) their preparation to food as consumed and (iii) the subsequent pooling of related foods before analysing the composite samples for elements. The concentrations of 26 elements, including Cadmium, were measured in the 2014 TDS. The composite samples for 27 food groups (Table B4) were collected from 24 UK towns and analysed for their levels of Cadmium and other elements. Where appropriate, tap water was used in the preparation and cooking of food samples. The results from this survey were also used together with food consumption data from the DNSIYC (DH, 2013) to estimate dietary exposures for children aged 12 to 18 months.

Table B1. Infant formula

Infant Formula	
Dry Powder	**Made Up Formula**
First and Hungrier Milk	First Milk and Hungrier Milk
Follow On Milk	Follow On milk
Growing Up Milk	Growing up Milk
Soy Milk	
Goat Milk	

This is a background paper for discussion.
It does not reflect the views of the Committee and should not be cited.

Organic Milk	
Comfort Milk	

Table B2. Commercial infant foods

Commercial Infant Foods
Cereal Based Foods and Dishes
Dairy Based Foods and Dishes
Fruit Based Foods and Dishes
Meat and Fish Based Foods and Dishes
Snacks (Sweet and Savoury)
Other Savoury Based Foods and Dishes (excluding Meat)
Drinks

Table B3. Other foods commonly eaten by infants.

Other Foods	
Beverages	Fruit Products
Bread	Green Vegetables
Canned Vegetables	Meat Products
Cereals	Milk
Dairy Products	Other Vegetables
Eggs	Potatoes
Fish	Poultry/Chicken
Fresh Fruit	

Table B4. The 27 food groups used for analysis of Cadmium and other elements in the 2014 TDS

TDS Food Groups*	
Bread	Fresh Fruit
Miscellaneous Cereals	Fruit Products
Carcase Meat	Non-alcoholic Beverages
Offal	Milk
Meat Products	Dairy Products
Poultry	Nuts
Fish	Alcoholic Drinks
Fats and Oils	Meat Substitutes
Eggs	Snacks
Sugars	Desserts
Green Vegetables	Condiments
Potatoes	Tap Water
Other Vegetables	Bottled Water
Canned Vegetables	

*Food samples representative of the UK diet are purchased throughout the year in 24 towns covering the UK and 137 categories of foods are combined into 27 groups of similar foods for analysis

Exposure Assessments

Infant Metals Survey

Tables B5, B6 and B7 summarise lower- (LB) and upper-bound (UB) total dietary exposures to Cadmium calculated using results from the infants Metal Survey for ages 4 to 18 months.

Table B5. Estimated Cadmium exposure from infant formula in children aged 4 to 18 months using data from the Infant Metals Survey

Food Groups	Infant Formula Cadmium LB to UB									
	4 to <6		6 to <9		9 to <12		12 to <15		15 to <18	
	Mean	97.5th Percentile	Mean	97.5th Percentile	Mean	97.5th Percentile	Mean	97.5th Percentile	Mean	97.5th Percentile
Comfort	0	0	0	0	0-0.00010	0	0	0	0	0
First Milk: From Birth (Powder)	0.00020	0.0034-0.0046	0.00020-0.00030	0	0.00010	0	0	0	0	0
Follow On Milk: 6 Months (Powder)	0	0	0.00010	0	0.00020	0.0017	0	0	0	0
Growing Up Milk: 12 Months (Powder)	0	0	0	0	0	0	0.00010	0	0	0
Goat Milk Formula	0	0	0-0.00010	0	0	0	0	0	0	0
Hipp Organic	0	0	0	0	0	0	0	0	0	0
Soy	0.0012	0	0.00060	0	0.00060	0	0.00020	0	0.00010	0
First Milk: From	0-0.011	0-0.028	0-0.0047	0-0.021	0-0.0020	0-0.013	0-0.00030	0-0.0056	0-0.00010	0

Birth (Ready to Feed)										
Follow on: 6 Months (Ready to Feed)	0-0.0015	0-0.016	0-0.0056	0-0.019	0-0.0055	0-0.018	0-0.0013	0-0.011	0-0.00070	0-0.0074
Growing up Milk: 12 Months (Ready to Feed)	0	0	0	0	0-0.00020	0	0-0.0021	0-0.017	0-0.0013	0-0.013
Total	0.00040-0.014	0.0050-0.028	0.00050-0.012	0.0013-0.027	0.00050-0.0088	0.0053-0.019	0.00010-0.0040	0-0.018	0.00010-0.0023	0-0.014

Table B6. Estimated Cadmium exposure from commercial infant foods in children aged 4 to 18 months using data from the Infant Metals Survey

Food Groups	**Commercial Infant Foods Cadmium LB to UB**									
	4 to <6		**6 to <9**		**9 to <12**		**12 to <15**		**15 to <18**	
	Mean	**97.5th Percentile**	**Mean**	**97.5th Percentile**	**Mean**	**97.5th Percentile**	**Mean**	**97.5th Percentile**	**Mean**	**97.5th Percentile**
Cereal Based Dishes	0.0043	0.021	0.005	0.025	0.0036	0.023	0.0015	0.015	0.0006	0.0066
Dairy Based Dishes	0.0024	0.023	0.0024	0.022	0.0015	0.016	0.0008	0.011	0.0003	0.0043
Fruit Based Dishes	0.0035-0.0053	0.027-0.041	0.0052-0.0078	0.029-0.044	0.0049-0.0074	0.027-0.040	0.0031-0.0046	0.023-0.034	0.0019-0.0028	0.016-0.025
Meat Based Dishes	0.024	0.16	0.039	0.2	0.037	0.19	0.022	0.15	0.011	0.089
Drinks	0	0	0	0	0	0	0	0	0	0
Other savoury based dishes	0.012	0.081	0.018	0.1	0.019	0.13	0.0075	0.073	0.0037	0.056
Snacks - sweet and savoury	0.0066	0.041	0.0098	0.051	0.0096	0.051	0.0071	0.047	0.0043	0.027
Total	0.053-0.055	0.23	0.080-0.082	0.29-0.30	0.076-0.078	0.32-0.33	0.042-0.043	0.21-0.22	0.022-0.023	0.14-0.14

This is a background paper for discussion.
It does not reflect the views of the Committee and should not be cited.

Table B7. Estimated Cadmium exposure from other foods commonly eaten by children aged 4 to 18 months using data from the Infant Metals Survey

Food Groups	Other Food Cadmium LB to UB									
	4 to <6		6 to <9		9 to <12		12 to <15		15 to <18	
	Mean	97.5th Percentile	Mean	97.5th Percentile	Mean	97.5th Percentile	Mean	97.5th Percentile	Mean	97.5th Percentile
Beverages	0-0.00010	0-0.0012	0-0.00020	0-0.0018	0-0.00020	0-0.0022	0-0.00010	0-0.0017	0-0.00020	0-0.0035
Bread	0.0012	0.017	0.011	0.073-0.074	0.032	0.13	0.048	0.16	0.053	0.18
Canned Vegetables	0.0007	0.009	0.0032	0.034	0.0075	0.054	0.011	0.064	0.0099	0.046
Cereal	0.0021	0.025	0.035	0.19	0.052	0.23	0.064	0.26	0.080	0.28
Dairy Products	0-0.00080	0-0.0046	0-0.0016	0-0.0069	0-0.0020	0-0.0076	0-0.0020	0-0.0073	0-0.0019	0-0.0064
Egg	0	0	0-0.00010	0-0.00080	0-0.00020	0-0.0013	0-0.00030	0-0.0016	0-0.00030	0-0.0017
Fish	0.0003	0.0016	0.0021	0.020	0.0044-0.0045	0.029-0.030	0.0058-0.0059	0.028	0.0051-0.0052	0.027-0.027
Fresh fruit	0.00060-0.0010	0.0040-0.0067	0.0011-0.0019	0.0053-0.0088	0.0017-0.0029	0.0070-0.012	0.0024-0.0039	0.0083-0.014	0.0029-0.0048	0.0084-0.014
Fruit products	0-0.00010	0-0.0016	0-0.00020	0-0.0017	0-0.00020	0-0.0016	0-0.00030	0-0.0024	0-0.00040	0-0.0028
Green vegetables	0.0016	0.013	0.0033	0.016	0.0037	0.025	0.0036	0.018	0.0037	0.018
Meat products	0	0	0.0003	0.0059	0.0008	0.0078	0.0017	0.011	0.0022	0.018
Milk	0-0.00010	0-0.0010	0-0.00050	0-0.0028	0-0.0013	0-0.010	0-0.0052	0-0.015	0-0.0052	0-0.013
Other vegetables	0.036	0.26-0.26	0.047	0.22	0.043	0.18-0.19	0.030	0.13	0.029	0.11
Potato	0.017	0.12	0.037	0.17	0.051	0.21	0.055	0.25	0.050	0.20
Poultry	0	0-0.00030	0-0.00010	0-0.0011	0-0.00020	0-0.0013	0-0.00020	0-0.0011	0-0.00020	0-0.0011
Total	0.059-0.061	0.31	0.14	0.45	0.20	0.52	0.22-0.23	0.54-0.55	0.24-0.25	0.53

This is a background paper for discussion.
It does not reflect the views of the Committee and should not be cited.

Total Diet Study

Table B8 summarise lower- and upper-bound total dietary exposures to Cadmium calculated using the 2014 TDS for ages 12 to 18 months. The data for each food category is reported separately so that the contribution to exposure from each class could be assessed more transparently for the most relevant infant age group. In addition the total exposure from the diet has also been provided.

Table B8. Estimated Cadmium exposure from food eaten by young children aged 12 months to 18 months using data from the TDS Groups.

Food Groups	Exposure-LB-UB (ug/kg bw/day)			
	12 to <15		15<18	
	Mean	97.5th Percentile	Mean	97.5th Percentile
Bread	0.053	0.15	0.060	0.160
Miscellaneous Cereals	0.090	0.28	0.11	0.320
Carcase meat	0-0.0058	0-0.030	0-0.0072	0-0.036
Offal	0.00020	0	0.0016	0
Meat products	0.0067	0.035	0.0082	0.038
Poultry	0-0.0031	0-0.014	0-0.0035	0-0.015
Fish	0.013	0.060	0.012	0.062
Fats and oils	0-0.00080	0-0.0032	0-0.00090	0-0.0035
Eggs	0-0.0020	0-0.011	0-0.0021	0-0.011
Sugars	0.0023	0.014	0.0034	0.017
Green vegetables	0.0061	0.027	0.0067	0.025
Potatoes	0.070	0.26	0.065	0.21
Other vegetables	0.026	0.096	0.027	0.088
Canned vegetables	0.010	0.053	0.010	0.047
Fresh fruit	0-0.034	0-0.12	0-0.042	0-0.12
Fruit products	0-0.0056	0-0.040	0-0.0063	0-0.042
Non-alcoholic beverages	0-0.037	0-0.17	0-0.044	0-0.21
Milk	0-0.079	0-0.22	0-0.079	0-0.19

Dairy products	0-0.030	0-0.16	0-0.025	0-0.11
Nuts	0.0015	0.0066	0.00070	0.0064
Alcoholic drinks	0	0	0	0
Meat substitutes	0.00010	0	0.00040	0.0045
Snacks	0.0088	0.061	0.014	0.095
Desserts	0.0015	0.013	0.0021	0.015
Condiments	0.0037	0.022	0.0041	0.021
Tap water	0-0.012	0-0.045	0-0.014	0-0.054
Bottled water	0-0.00060	0-0.0054	0-0.00080	0-0.012
Total	0.29-0.50	0.61-0.93	0.32-0.55	0.60-0.90

Secretariat
November 2016

References

DH (2013). Diet and Nutrition Survey of Infants and Young Children (DNSIYC), 2011. Available at: http://transparency.dh.gov.uk/2013/03/13/dnsiyc-2011/

This is a background paper for discussion.
It does not reflect the views of the Committee and should not be cited.

COMMITTEE ON TOXICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT

Review of potential risks from Cadmium in the diet of infants aged 0 to 12 months and children aged 1 to 5 years

Possible Cadmium exposure from dietary sources in young children aged 18 to 60 months

A Total Diet Study (TDS) was conducted during 2014 which measured the concentrations of Cadmium by young children (18 months and older).

The TDS consisted of: (i) selecting foods based on food consumption data, to represent as best as possible a typical diet; (ii) their preparation to food as consumed and (iii) the subsequent pooling of related foods before analysing the composite samples for elements. The concentrations of 26 elements, including Cadmium, were measured in the 2014 TDS. The composite samples for 27 food groups (Table C1) were collected from 24 UK towns and analysed for their levels of Cadmium and other elements. Where appropriate, tap water was used in the preparation and cooking of food samples. The results from this survey were also used together with food consumption data from years 1 to 4 of the National Diet and Nutrition Survey Rolling Programme (NDNS) (Bates *et al.,* 2014) to estimate dietary exposures for young children aged 18 months to 5 years.

Table C1. Food groups used for analysis of Cadmium and other elements in the 2014 TDS.

TDS Food Groups*	
Bread	Fresh Fruit
Miscellaneous Cereals	Fruit Products
Carcase Meat	Non Alcoholic Beverages
Offal	Milk
Meat Products	Dairy Products
Poultry	Nuts
Fish	Alcoholic Drinks
Fats and Oils	Meat Substitutes
Eggs	Snacks
Sugars	Desserts
Green Vegetables	Condiments
Potatoes	Tap Water
Other Vegetables	Bottled Water
Canned Vegetables	

*Food samples representative of the UK diet are purchased throughout the year in 24 towns covering the UK and 137 categories of foods are combined into 27 groups of similar foods for analysis

Exposure Assessment

Table C2 summarises lower- and upper-bound total dietary exposures to Cadmium calculated using the 2014 TDS for young children aged 18 months to 5 years. The data for each food category is reported separately so that the contribution to exposure from each class could be assessed more transparently for the most relevant infant age group. In addition the total exposure from the diet has also been provided.

Table C2. Estimated Cadmium exposure from food eaten by young children aged 18 months to 5 years using data from the TDS Groups.

Food Groups	Exposure-LB to UB			
	18 to <24		24 to <60	
	Mean	97.5th Percentile	Mean	97.5th Percentile
Bread	0.063	0.14	0.072	0.17
Miscellaneous Cereals	0.12	0.24	0.095	0.24
Carcase meat	0-0.0079	0-0.041	0-0.0048	0-0.026
Offal	0.00040	0	0.00050	0
Meat products	0.0098	0.045	0.012	0.040
Poultry	0-0.0040	0-0.012	0-0.0034	0-0.015
Fish	0.016	0.064	0.012	0.047
Fats and oils	0-0.0013	0-0.0041	0-0.0011	0-0.0038
Eggs	0-0.0016	0-0.0088	0-0.0016	0-0.0091
Sugars	0.0040	0.019	0.0058	0.025
Green vegetables	0.0057	0.034	0.0059	0.024
Potatoes	0.067	0.14	0.061	0.18
Other vegetables	0.016	0.054	0.017	0.060
Canned vegetables	0.017	0.066	0.011	0.041

Fresh fruit	0-0.051	0-0.13	0-0.037	0-0.097
Fruit products	0-0.014	0-0.055	0-0.013	0-0.062
Non-alcoholic beverages	0-0.060	0-0.25	0-0.057	0-0.17
Milk	0-0.074	0-0.23	0-0.052	0-0.15
Dairy products	0-0.027	0-0.13	0-0.015	0-0.061
Nuts	0.00040	0.00050	0.0011	0.016
Alcoholic drinks	0	0	0	0
Meat substitutes	0.00010	0.0016	0.00040	0.0063
Snacks	0.016	0.097	0.019	0.098
Desserts	0.0032	0.017	0.0035	0.017
Condiments	0.0029	0.014	0.0045	0.024
Tap water	0-0.013	0-0.070	0-0.012	0-0.046
Bottled water	0-0.00040	0-0.0042	0-0.0011	0-0.012
Total	0.34-0.59	0.57-0.92	0.32-0.52	0.52-0.80

References

Bates, B.; Lennox, A.; Prentice, A.; Bates, C.; Page, P.; Nicholson, S.; Swan, G. (2014) National Diet and Nutrition Survey Results from Years 1, 2, 3 and 4 (combined) of the Rolling Programme (2008/2009 – 2011/2012) Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/310995/NDNS_Y1_to_4_UK_report.pdf