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

TOX/2018/32

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

Chromium

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 chromium exposures for infants and young children in the UK aged 0 to 12 months and 1 to 5 years, respectively. There are currently no Government dietary recommendations for infants and young children on chromium.

Background

3. Chromium is a hard, highly lustrous metal that exists in various mineral forms and is present throughout the environment. It is used in a wide variety of processes including tanning, photography, fungicides, ceramics and glass, electroplating, alloy production, paints and pigments, and is present in a wide range of industrial and consumer products, especially stainless steel. Chromium concentrations in the environment reflect both natural and anthropogenic contributions. The most prevalent natural form of chromium is trivalent (Cr^{3+} of Cr(III). Hexavalent chromium (Cr^{6+} or Cr(VI) is present in the environment largely as a result of industrial activity.

4. The general population is primarily exposed to chromium via food and drinking water, with inhalation from ambient air and percutaneous exposure acting as minor sources of exposure. Food, being largely a reducing environment, is considered to be a source of Cr(III), whereas drinking water, which is subject to purification with oxidising agents, is a source of Cr(VI). Workers in the steel industry, such as stainless steel welders can be exposed to high respiratory levels of Cr (VI). Smoking cigarettes also makes a large contribution to inhalation exposure to Cr (VI). (EFSA 2014).

5. Food and breast milk are reducing substances and the digestive tract is a reducing environment, so any Cr(VI) ingested would be expected to be reduced to Cr(III) (De Flora *et al*, 2016, Kirman *et al* 2016).

Toxicology

Acute toxicity

6. Acute effects of ingestion of chromium are nausea and vomiting and ulceration of the gastrointestinal tract. Contact with skin and mucus membranes can lead to localised tissue burns sometimes referred to as chrome holes. Some individuals develop dermatitis from skin exposure to chromium salts and this is exacerbated by dietary and inhalation exposure (ATSDR, 2012).

Chronic effects

7. The International Agency for Research on Cancer (IARC) regard Cr(VI) as a carcinogen in humans by inhalation. There are also chronic non-carcinogenic effects on the hepatic, renal and haematopoietic systems. Cr(III), while possibly the ultimate form of the metal involved in carcinogenic mechanisms, is not regarded as a carcinogen because of its poor cellular penetration (IARC 2012).

8. Oral ingestion of Cr(III) and Cr(VI) in experimental animals has resulted in gastrointestinal cancers, but this has not been shown in humans.

9. UK Governmental advice states that while ingestion and inhalation of Cr (III) and Cr (VI) are associated with acute and chronic health effects, members of the general public not involved in the industrial uses of chromium would not be expected to be exposed to high enough concentrations to cause concern for health.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/338691/Chromium_info_incid_mgment_tox.pdf

HBGV

10. As part of their assessment, the EFSA CONTAM Panel established a TDI of 300 µg Cr(III)/kg b.w. per day from a NOAEL of 286 mg/kg b.w. per day of a long-term rat study, with a default uncertainty factor of 100 to account for species differences and human variability, with an additional uncertainty factor of 10 to allow for inadequate data on reproductive and developmental toxicity. The EFSA CONTAM Panel considered it unlikely that dietary exposure to chromium results in cancer in humans (EFSA, 2014).

Exposure Assessment

Dietary exposure

Human breast milk

18. In general, low levels of chromium are found in breast milk (EFSA, 2014).

19. In the absence of a suitable UK study of chromium in breast milk, data from the German study of Wappenhorst *et al (*2002) have been used in this paper A mean value of 3.1 µg/L. and a 97.5th percentile value of 19.4 µg/L were obtained.

20. Chromium exposures were estimated for exclusively breastfed infants consuming average (800 mL) and high-level (1200 mL) volumes of breast milk (Table 1).

Table 1. Chromium exposure (mg per day) from exclusive breastfeeding estimated for average and high-level consumption of breast milk.

Chromium concentration (mg/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
3.1	0.42	0.32	0.63	0.48
19.4	2.6	2.0	3.9	3.0

Infant exposure is based on consumption of 800 mL or 1200 mL per day, and expressed on a bodyweight (5.9 kg for infants aged 0-4 months and 7.8 kg for infants aged 4 to < 6 months) basis. Values rounded to 2 significant figures (SF)

21. Consumption data (on a body weight basis) for the estimated dietary exposure are from the Diet and Nutrition Survey of Infants and Young Children (DNSIYC) (DH, 2013) and from years 1-6 of the National Diet and Nutrition Survey (NDNS) (Bates et al., 2012 & 2014)

22. Concentrations of chromium have recently been measured in an FSA survey of metals and other elements in infant formula and foods (Infant Metal Survey, FSA 2916a) and in the composite food samples of the 2014 Total Diet Study (TDS, FSA 2016b). Table 2 provides the mean and 97.5th percentile estimated dietary exposures to chromium for children aged 4 to < 12 months and 1 to < 5 years.

Table 2. Estimated mean and 97.5th percentile exposure to chromium (mg per day) in children aged 4 to < 12 months and 1 to < 5 years from infant formula and food.

Age	Exposure (µg / kg bw/day)	
	Mean	97.5th percentile
4 months to < 12 months*	0.62 – 1.0	1.9 – 2.8
1 to < 1.5 years*	0.53 – 0.91	1.4 – 1.9
1.5 to < 2 years**	1.8 – 3.6	3.3 – 5.9

2 to < 3 years**	1.6 – 3.1	2.8 – 5.0
3 to < 4 years**	1.5 – 3.0	2.9 – 4.8
4 to < 5 years**	1.5 – 2.8	2.8 – 4.3

* Exposure assessments for this age group were calculated from concentration data from the Infant Metals Survey, (FSA 2016a) using consumption data from DNSIYC.

** Exposure assessments for this age group were calculated from concentration data from the TDS (FSA, 2016b) using consumption data from NDNS

Risk characterisation

Breast milk

23. Risk characterisation is relative to the EFSA TDI of 300 μg/kg bw/day. These estimates were based on a mean and 97.5th percentile chromium concentrations of 3.1 and 19.4 µg/L. The ranges of exposure to chromium in exclusively breastfed 0 to 6-month olds were 0.11 to 0.87 and 0.21 to 1.3% of the EFSA TDI for Cr(III) in average and high-level consumers respectively (Table 3).

Table 3. Risk characterisation of chromium exposure from exclusive breastfeeding in 0 to 6 month old infants, with breast milk containing chromium at 3.1 and 19.4 µg/L.

Chromium concentration (µg/L)	**Chromium intake as percentage of TDI (300 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**
3.1	0.14	0.11	0.21	0.16
19.4	0.87	0.67	1.3	1.0

Values rounded to 2 significant figures (SF)

24. None of the intake values for chromium in breast milk is greater than 1.3% of the EFSA TDI of 300 μg/kg bw/day.

Food and infant formula

Table 4 Estimated mean and 97.5th percentile exposure to chromium (mg per day) in children aged 4 to < 12 months and 1 to < 5 years from infant formula and food .

Age	**Chromium intake as percentage of TDI (300 µg/kg bw/day)**	
	Mean	97.5th percentile
4 months to < 12 months	0.21 – 0.33	0.63 – 0.39
1 to < 1.5 years	0.18 – 0.30	0.47 – 0.63
1.5 to < 2 years	0.6 – 1.2	1.1 – 2.0
2 to < 3 years	0.53– 1.0	0.93 – 0.83

3 to < 4 years	0.5 – 1.0	0.97 – 1.6
4 to < 5 years	0.5 – 0.93	0.93 – 1.4

25. None of the values for the intake of chromium by infants and children up to 5 years of age is greater than 1.6% of the EFSA TDI of 300 μg/kg bw/day.

Conclusions

26. Estimated dietary exposures for children aged 4 to < 12 months and 1 to < 5 years do not indicate excessive chromium intake, either from breastmilk or other foods and are therefore unlikely to be of toxicological concern.

Questions for the committee:

i) Does the Committee agree that the exposure from dietary chromium is not of toxicological concern?

ii) Does the Committee consider it sufficient to include this brief summary of the important points (exposure, intake, conclusions) in the overarching statement?

iii) Do the members have any other comments?

Secretariat

August 2018

References

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Search terms

Chromium AND Breast milk
Toxicology
Toxicokinetics
Food contact
Dust
House dust
Domestic dust
Air
Indoor air
Cancer
Carcinogenesis

Figure 1. Risk 21 plot of chromium in breast milk (range from low concentration, average consumer to high concentration, high consumer) and in infant formula and food (lowest to highest 97.5th percentile).