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SCIENTIFIC REPORT OF EFSA

Lead dietary exposure in the European population[1]

European Food Safety Authority[2, 3]

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ABSTRACT

Lead is a natural environmental contaminant, but its use in the past in water pipes, paint and petrol increased its general presence. Food is the major source of human exposure to lead. Lead accumulates in the body and most seriously affects the developing central nervous system in young children. There is no recommended tolerable intake level as there is no evidence of thresholds for a number of critical health effects. Legislative measures have been gradually introduced to reduce exposure by removing lead from paint, food cans, water pipes and petrol. The current study examined 144,206 analytical results for lead in food collected during a nine-year period. More than half of the foods tested had levels of lead at less than detection or quantification limits. The mean lead levels varied between 0.3 µg/kg for infant follow-on formulae to 4,300 µg/kg for dietetic products with an overall median across all categories of 21.4 µg/kg. Food lead levels decreased by about 23 % between 2003 and 2010, although this should be interpreted cautiously. Mean lifetime dietary exposure was estimated at 0.68 µg/kg b.w. per day in the European population based on middle bound mean lead occurrence. Exposure was highest for toddlers and other children with 1.32 and 1.03 µg/kg b.w. per day, respectively, while the two infant surveys ranged between 0.83 and 0.91 µg/kg b.w. per day. Adult exposure was estimated at 0.50 µg/kg b.w. per day. The elderly and very elderly population groups had similar profiles to the adult age group, while adolescents had slightly higher estimated dietary exposure. Important food category contributors include bread and rolls (8.5 %), tea (6.2 %), tap water (6.1 %), potatoes and potato products (4.9 %), fermented milk products (4.2%) and beer and beer-like beverages (4.1 %), although this will vary between age groups and surveys.

KEY WORDS

Lead, food, occurrence, dietary exposure

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SUMMARY

Lead is a natural environmental contaminant, but its ubiquitous occurrence is the result of anthropogenic activities like the use in the past of lead in water pipes, paint and petrol. The general population is exposed to lead via food, water, air, soil and dust. Food is the major source of exposure to lead, although for children ingestion of soil and dust can also be an important contributor. Lead accumulates in the body, primarily in the skeleton. Half-life for inorganic lead in blood is approximately 30 days, while in bone it is between 10 and 30 years.

Due to its long half-life in the body, chronic toxicity of lead is of most concern when considering the potential risk to human health. The central nervous system is the main target organ for lead toxicity. In adults, lead-associated neurotoxicity was found to affect central information processing and short-term verbal memory, to cause psychiatric symptoms and to impair manual dexterity. There is considerable evidence demonstrating that the developing brain is more vulnerable to the neurotoxicity of lead than the mature brain. A number of studies in adults have identified an association between blood lead concentration, elevated systolic blood pressure and chronic kidney disease, at relatively low blood lead levels. The International Agency for Research on Cancer (IARC) classified inorganic lead as probably carcinogenic to humans (Group 2A) in 2006.

Legislative control measures have been taken to remove lead from paint, petrol, food cans and water pipes in Europe since the 1970s. Leaded petrol was banned from 2000 with exemptions possible until 2005.

International and European health-based guidance values for lead exposure have been amended several times as new information has come to light. In 2010, the European Food Safety Authority’s (EFSA) Panel on Contaminants in the Food Chain concluded that the provisional tolerable weekly intake (PTWI) of 25 µg/kg b.w. set by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) in 1986 and endorsed by the European Commission’s Scientific Committee for Food (SCF) in 1990 was no longer appropriate and that, as there was no evidence for a threshold for a number of critical endpoints including developmental neurotoxicity and adult nephrotoxicity, it would not be appropriate to derive a PTWI. This conclusion was confirmed by JECFA in 2010, while also expressing a concern that there was potential at current levels of exposure for lead to affect neurodevelopment in infants, children and the foetus of pregnant women.

Using an alternative measure, the 2010 EFSA opinion identified a 95th percentile lower confidence limit of the benchmark dose of 1 % extra risk ($BMDL_{01}$) of 0.50 µg/kg b.w. per day for developmental neurotoxicity in young children. It also lists cardiovascular effects and nephrotoxicity in adults as potential critical adverse health effects of lead with respective $BMDL_{01}$ and $BMDL_{10}$ of 1.50 and 0.63 µg/kg b.w. per day.

In light of the particular concern for lead exposure in children, it is important to better identify major dietary sources of lead. The current report provides updated information on the levels of lead found in a range of foods on the European market and estimates exposure using detailed individual data from the Comprehensive European Food Consumption Database covering seven age groups from infants to the very elderly.

The 144,206 lead occurrence results retained in the current study were sorted into the four different levels of the FoodEx 1 classification system. More than half of the foods tested had levels of lead at less than detection or quantification limits. The mean lead levels varied between 0.3 µg/kg for infant follow-on formulae to 4,300 µg/kg for dietetic products with an overall median across all categories of 21.4 µg/kg. Eighty-two food categories out of 734 at FoodEx level 3 with quantified discrete results had mean lead levels exceeding 100 µg/kg. The highest individual sample maximum of 232,000 µg/kg was found in game meat, followed by 155,000 µg/kg in seaweed, 117,000 µg/kg in edible offal from game animals and 59,900 µg/kg in dietary supplements.

The annual mean results of the analysis of lead in food across Europe can be very much influenced by the type of food tested and the inclusion of special investigations in a particular year. Nevertheless, an attempt was made to evaluate a potential trend in the occurrence of lead in food over the years covered by the data submitted to EFSA. Lead levels were estimated to have been reduced by about 23 % between 2003 and 2010. However, this should only be interpreted as indicative given the caveats mentioned above.

Mean lifetime dietary exposure to lead was estimated to be 0.68 µg/kg b.w. per day in the overall European population based on middle bound mean lead occurrence. Exposure was highest for toddlers and other children with 1.32 and 1.03 µg/kg b.w. per day, respectively, while the two infant surveys ranged between 0.83 and 0.91 µg/kg b.w. per day. Adult exposure was estimated at 0.50 µg/kg b.w. per day in the current study or 31 % lower than the exposure calculations presented in the EFSA opinion of 2010, mainly due to modelling differences and more accurate inputs in the present study. The elderly and very elderly population groups had similar profiles to the adult age group, while adolescents had slightly higher estimated dietary exposure.

The highest individual contributor to dietary lead exposure at FoodEx level 3 was tap water (6.1 %) followed by wheat bread and rolls (3.7 %), regular beer (3.0 %), pastries and cakes (2.8 %), iodised salt (2.4 %) and potatoes consumed boiled (2.2 %). Aggregating products to FoodEx level 2, major contributors included bread and rolls (8.5 %) followed by different tea beverages (6.2 %), tap water (6.1 %), all potatoes and potato products (4.9 %), fermented milk products (4.2%) and beer and beer-like beverages (4.1 %). Looking at the highest level of aggregation of food at FoodEx level 1, the major contributing food category to lead exposure was grains and grain-based products (16.1 %), followed by milk and dairy products (10.4 %), non-alcoholic beverages (10.2 %) and vegetables and vegetable products (8.4 %).

The lower dietary exposure assessment results of the current study compared to the estimates presented in the EFSA opinion of 2010 can be attributed in part to the more accurate calculation methods used and the better matching of occurrence and food consumption results, but also to some extent to the decreasing lead levels in food.

It will be important to confirm the seemingly decreasing lead levels in food by future testing. A standardised data collection system now in place for reporting of European analytical test results of chemicals in food to EFSA will facilitate a future trend analysis.

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BACKGROUND AS PROVIDED BY THE EUROPEAN COMMISSION

In recent years EFSA has adopted many scientific opinions related to undesirable substances in feed and on nitrates, non-dioxin like PCBs and certain mycotoxins in food. For some of these opinions specific data collection exercises have been launched. In the frame of official control and monitoring more occurrence data is being generated. It is appropriate that this data is collected into one database, collated and analysed. Article 23 (and 33) of Regulation (EC) 178/2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety[4], entrusts the European Food Safety Authority with this task.

The integration of newly generated data into existing databases on occurrence data (e.g. dioxins and PCBs) in the field of contaminants in feed and food on a permanent basis will ensure continuity of data collection. This would enable EFSA to access accurate data when quick action is required to handle urgent requests for scientific opinions/statements e.g. in case of contamination incidents and/or requests for scientific opinions where scientific assessments are needed within a short period and separate calls for data would require too much time.

Furthermore, it is expected that the set up of these permanent data collection exercises will stimulate the generation of occurrence data in accordance with the standard sample description for feed and food and the electronic transmission of data in the appropriate reporting format[5].

The permanent data collection exercises could in principle encompass the whole field of contaminants in feed and food. However, to focus the work it is appropriate also for the competent authorities and stakeholder organisations, which have to provide the data, to identify specific topics for which a permanent occurrence data collection exercise is to be set up. Several requests for data collections were already addressed by the Commission to EFSA e.g. on heavy metals, furan, acrylamide in food, etc. In annex to this request, several topics that have not yet been the subject of a specific request are identified with an indication of priority/importance for the Commission services.

TERMS OF REFERENCE AS PROVIDED BY THE EUROPEAN COMMISSION

The following tasks are related to data collection:

- publication of a report on a regular basis (every 2 years) per topic. The report should contain, besides an analysis of the received data, also recommendations for improving data collection on this topic and ensure, in co-operation with the Commission services, the appropriate follow up to these recommendations;

- provide assistance/support/information to the Commission services based on ad hoc requests related to the occurrence data present in the database. Such requests might involve negotiations of timelines should they require the use of significant resources from EFSA.

[4] OJ L 31, 1.2.2002, p. 1
[5] http://www.efsa.europa.eu/en/datexcallsfordata/datexsubmitdata.htm

ANALYSIS

1. Introduction

Lead is a metal that exists both in inorganic and organic forms. In the environment, inorganic lead predominates over organic lead and the former is also the only type found in food. Although it is a natural environmental contaminant, its ubiquitous occurrence is the result of anthropogenic activities like mining and smelting, soldering, battery manufacturing and the use of lead ammunition for hunting, but particularly the use in the past of lead in paint and petrol and for soldering or making of water pipes (ATDSR, 2007). Lead in the environment can easily contaminate food through water or through atmospheric lead deposition on agricultural crops. Control measures have been taken to regulate lead in paint, food cans, water pipes and petrol in Europe since the 1970s. Leaded petrol was banned from use in the European Union in 2000 with exemptions possible until 2005 and continued use only allowed in vintage cars (Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC[6]).

The general population is exposed to lead via food, water, air, soil and dust. Food is the major source of exposure to lead, although for children ingestion of soil and dust can also be an important contributor (WHO, 2007; EFSA, 2010a). Absorption of lead from the gastrointestinal tract depends on host characteristics and on the physicochemical properties of the ingested material. Absorption of ingested soluble lead compounds appears to be higher in children than in adults. Absorption is lower in the presence of food (Alexander et al., 1974; Ziegler et al., 1978; Heard and Chamberlain, 1982; James et al., 1985; Rabinowitz et al., 1980). Absorption of inhaled sub-micron sized particles occurs in the respiratory tissues whereas larger-sized particles are transferred into the pharynx and are then swallowed (Hursh and Mercer, 1970; Hursh et al., 1969; Morrow et al., 1980). Lead can accumulate in the body, primarily in the skeleton. From the skeleton, it is released gradually back into the blood stream, particularly during physiological or pathological periods of bone demineralisation such as pregnancy, lactation and osteoporosis, even if lead exposure has already ceased. Maternal transfer of lead occurs through the placenta and subsequently during breast feeding. Half-life for inorganic lead in blood is approximately 30 days and for bone it is between 10 and 30 years (Rabinowitz, 1991).

Although the acute toxicity of lead is low, chronic oral exposure to inorganic lead by experimental animals and observations in occupationally exposed humans have been shown to affect multiple organs. Due to its long half-life in the body, chronic toxicity of lead is of most concern when considering the potential risk to human health. The central nervous system is the main target organ for lead toxicity. In adults, lead-associated neurotoxicity was found to affect central information processing and short-term verbal memory, to cause psychiatric symptoms and to impair manual dexterity. There is considerable evidence demonstrating that the developing brain is more vulnerable to the neurotoxicity of lead than the mature brain and this is of particular concern even at relatively low lead exposure. In adults, a number of studies have also identified an association between blood lead concentration, elevated systolic blood pressure and chronic kidney disease at relatively low blood lead levels (IARC, 2006; ATDSR, 2007). The International Agency for Research on Cancer (IARC) classified inorganic lead as probably carcinogenic to humans (Group 2A) in 2006 (IARC, 2006).

International and European health-based guidance values for lead exposure have been amended several times as new information has come to light. In 2010, the European Food Safety Authority's (EFSA) Panel on Contaminants in the Food Chain concluded that the provisional tolerable weekly intake (PTWI) of 25 µg/kg b.w. set by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) in 1986 and endorsed by the European Commission's Scientific Committee for Food (SCF) in 1989 was no longer appropriate and that, as there was no evidence for a threshold for a number of critical endpoints including developmental neurotoxicity and adult nephrotoxicity, it would not be appropriate to derive a PTWI (EFSA, 2010a; WHO, 1986; EC, 1992). This conclusion was confirmed

[6] OJ L 350, 28/12/1998, pp. 0058 – 0068.

by JECFA in 2010 (WHO, 2011). Both organisations concluded that the risk of clinically important effects on either the cardiovascular system or kidneys of adult consumers at current levels of lead exposure was low to negligible. However, in infants and children, and for the foetus of pregnant women, there was potential concern for effects on neurodevelopment at current levels of exposure to lead. Therefore, JECFA concluded that in populations with prolonged high dietary exposure to lead, measures should be taken to identify major contributing sources and foods and potentially identify methods of reducing dietary exposure.

In light of the particular concern for lead exposure in children, it was considered important to better identify major dietary sources of lead in Europe. The current report provides updated information on the levels of lead found in a range of foods on the European market and estimates dietary exposure using detailed individual data from the Comprehensive European Food Consumption Database (hereinafter called the Comprehensive Database) covering seven age groups from infants to the very elderly.

2. Materials and Methods

2.1. Occurrence data

EFSA has been collecting lead occurrence data in food and feed first through a specific call issued in 2008 and subsequently through annual data submissions as part of a European Commission mandate for regular contaminant data collection activities. Only the food data are covered in this report. A total of 145,370 lead occurrence results were submitted to EFSA by 20 EU Member States and Norway (Figure 1). A previous subset of the data was used for the lead opinion published by the Panel on Contaminants in the Food Chain (EFSA, 2010a).

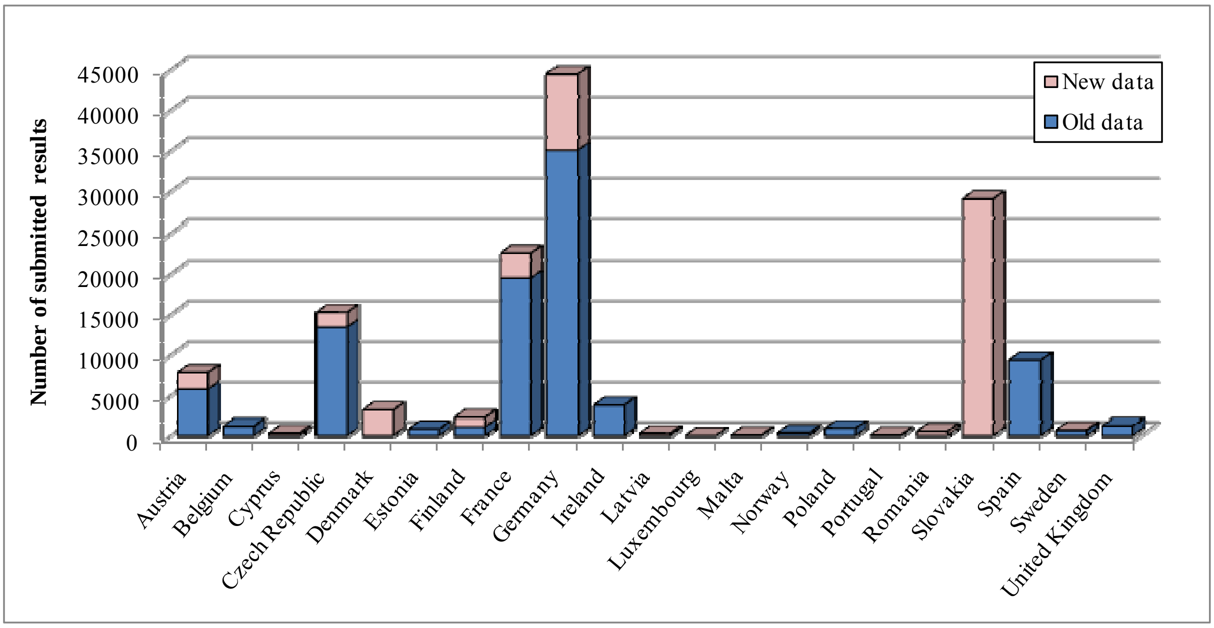

Figure 1: The number of analytical results on lead submitted by the respective country to EFSA in relation to the specific call (old data) or through annual data submissions (new data).

Most analytical results for the presence of lead in food originated from Germany followed by Slovakia, France, Czech Republic, Spain and Austria. A majority of results for lead in food were submitted in response to the specific call for lead data issued in 2008. The range of countries covered was expanded with the new annual data submissions adding Cyprus, Latvia, Luxembourg, Malta, Portugal, Romania and Slovakia to the previous countries. However, the uneven sample coverage of Europe is clear from Figure 1, introducing a possible bias in the representativeness of the results.

A majority of results for lead in food were analysed in 2003 to 2007 and submitted in response to the open call for lead data issued in 2008. Results received after the call equally covered the period before and after the 2008 call (Figure 2).

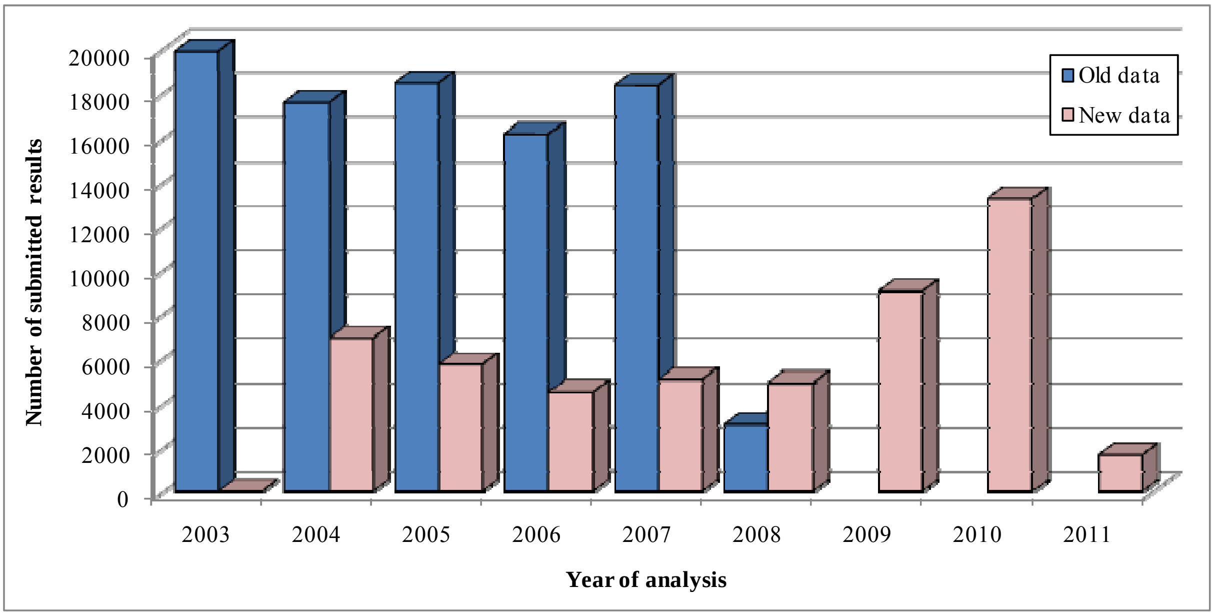

Figure 2: The number of submitted analytical results for lead distributed over the year of analysis through the specific call (old data) or through annual data submissions (new data).

Foods were grouped according to the FoodEx version 1 food classification system (EFSA, 2010b, 2011a). FoodEx is a food classification system developed by EFSA in 2009 with the objective of simplifying the linkage between occurrence and food consumption data when assessing the exposure to hazardous substances. It contains 20 main food groups (first level), which are further divided into subgroups having around 150 items at the second level, 1,261 items at the third level and reaching about 1,800 endpoints (food names or generic food names) at the fourth level. A few results could not be sorted into food categories and this resulted in the exclusion of 46 results that were mainly food processing aids and not consumed as such.

As part of the process of checking results for accuracy and completeness the reporting of left-censoring limits was reviewed. Figure 3 provides an overview of the reported limits distributed over level 1 of the FoodEx food categories in a box plot with the boxes bounded at the 25th and 75th percentiles, a line at the 50th percentile and whiskers showing the 5th and 95th percentiles.

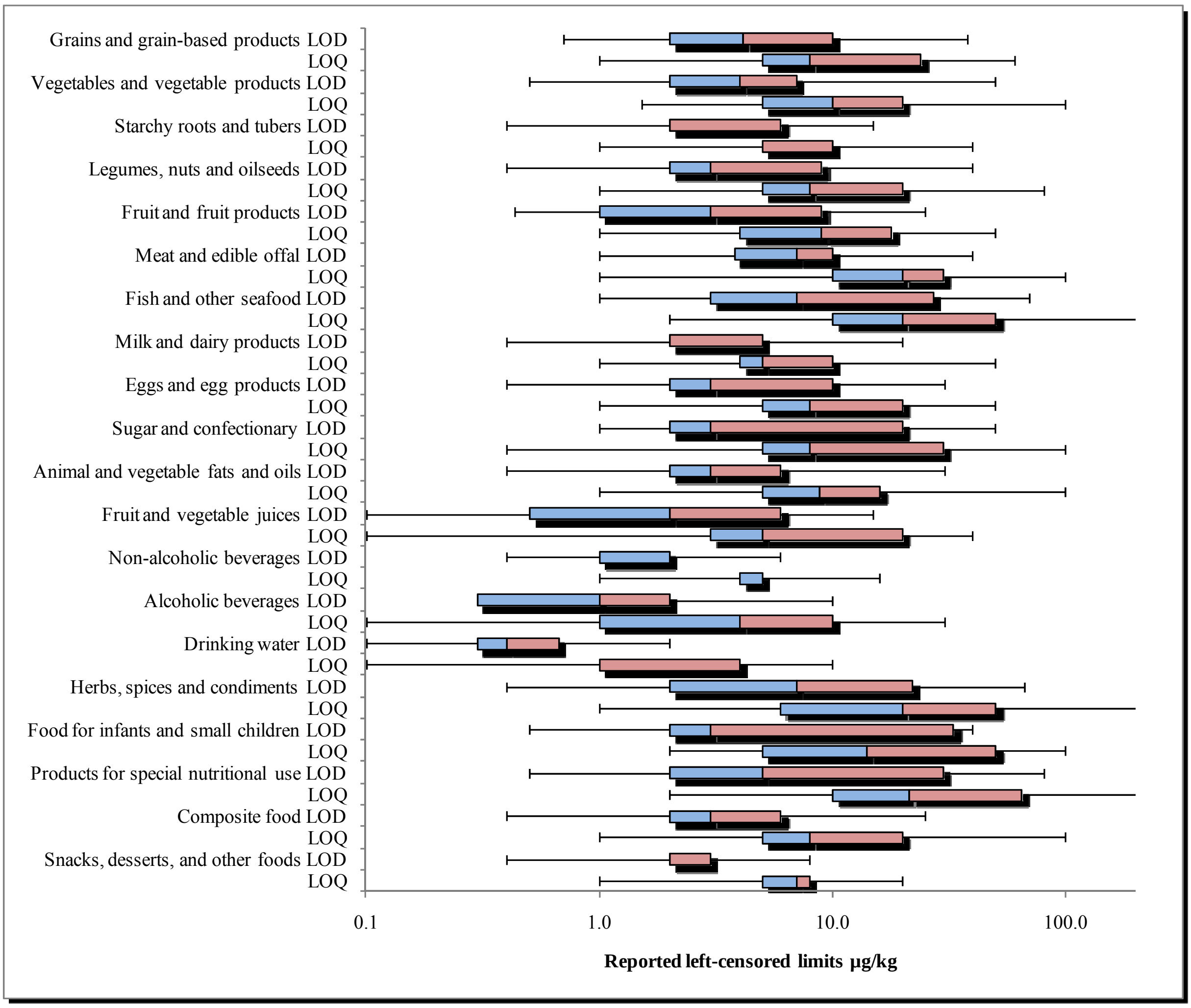

Figure 3: Box plot (5th, 25th, 50th, 75th and 95th percentiles) illustrating food category distribution of reported left-censoring limits for the submitted analytical results for lead (note that a logarithmic scale is used).

More than half of the reported results were below left-censoring limits with 11 % below the limit of detection (LOD) and 46 % below the limit of quantification (LOQ). The minimum reported LOD was 0.0004 µg/kg for liquid milk using inductively coupled plasma mass spectrometry and the maximum 1,000 µg/kg for a maize sample using hydride generation atomic absorption spectrometry. The minimum reported LOQ was 0.001 µg/kg for the same liquid milk sample as above and the maximum 5,000 µg/kg for a mineral supplement tablet without indication of the analytical method used. The left-censoring limit of the analytical method was not given for 7,963 quantified results. To avoid biasing the data collection, both left-censored and quantified results with a nominated LOD of more than 100 µg/kg or an LOQ of more than 300 µg/kg were excluded from the analysis. Stricter criteria for rejection would have excluded a number of high results where obviously a low left-censoring limit was not needed. Instead left-censored results higher than any quantified result in the respective level 3 FoodEx food category were excluded. A total of 989 results were excluded due to left-censoring limits.

There is a common routine among laboratories to only report the LOQ to indicate left-censored results that in many cases might also be below the LOD. This is fine for use in the food control but provides an overestimation when used for calculating exposure. In the present data collection, 22 % and 3 % of the left-censored results included only LOQ or LOD, respectively. In reviewing the use of left-censoring limits it was decided that dividing the numerical values indicted for LOQ entries by two would better reflect the underlying distributions. Since the LOQ on average was 3.8 times higher than the LOD, this produced an LOQ close to twice the LOD, which is the indicated ratio specified in the legislation[7].

An outlier analysis was performed to eliminate some of the very high results from targeted suspect sampling or special projects. These could include measurement of contamination from lead ammunition, lead soldered water pipes, lead paint and industrial pollution. Extreme outliers were first identified by Tukey's method (Tukey, 1977), which identifies as outlier a value greater than the 75th percentile plus 1.5 times the interquartile distance, or less than the 25th percentile minus 1.5 times the inter-quartile distance, and then reviewed for plausibility. This resulted in 129 results being deleted as illustrated in Figure 4.

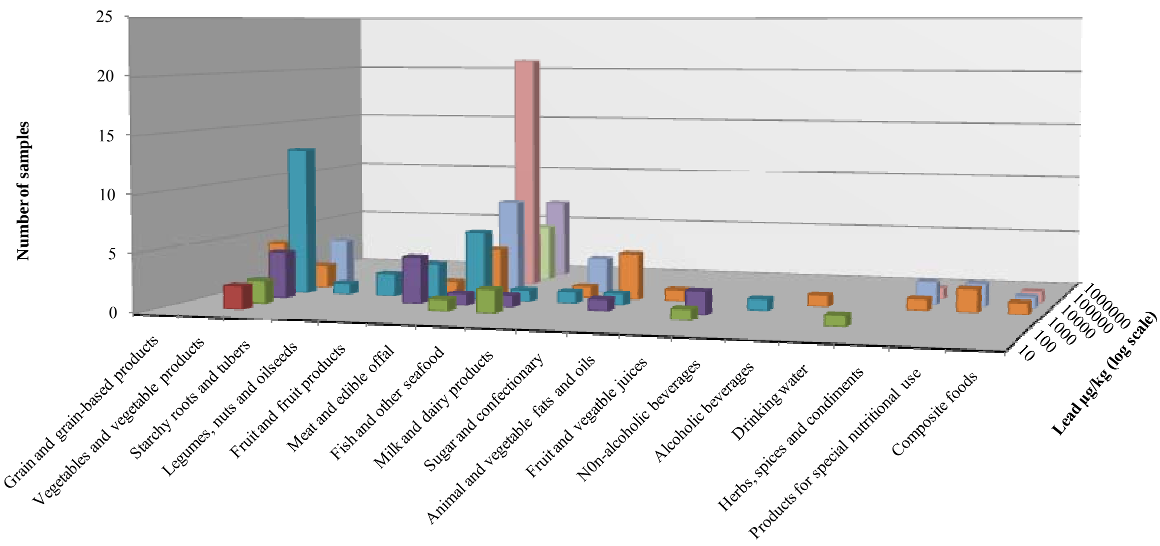

Figure 4: The number of results in broad food categories deleted after identification as extreme outliers (colour used only for ease of identification).

Most deleted results belonged to the broad food categories "vegetables and vegetable products", mainly different root vegetables, and "meat and edible offal", mainly game animal and bird species.

In total, 1,164 results were excluded from the detailed analysis giving a final data set comprised of 144,206 results. The number of submitted analytical results, their proportion for each food category and the left-censored proportion of the total number are shown in Table 1 for the FoodEx level 1 food categories. Most results were submitted for the food category "meat and edible offal", followed by "vegetables and vegetable products", "fish and other seafood", "grains and grain-based products", "drinking water" and "milk and dairy products". "Eggs and egg products" had the highest proportion of left-censored data at close to 75 % followed by "milk and dairy products" at about 69 % while "herbs, spices and condiments", "products for special nutritional use" and "non-alcoholic beverages" had the highest proportions of quantified results at around 70 %.

[7] Commission Regulation (EC) No 333/2007. OJ L 88, 29.3.2007.

Table 1: The number and proportion of analytical results (N, N %) for lead submitted for each of the FoodEx Level 1 food categories and their proportion of left-censored data (LC %).

FoodEx Level 1	N	N %	LC %
Grains and grain-based products	9,937	6.9	50.1
Vegetables and vegetable products	17,269	12.0	49.8
Starchy roots and tubers	2,358	1.6	50.4
Legumes, nuts and oilseeds	4,071	2.8	46.9
Fruit and fruit products	6,931	4.8	59.4
Meat and edible offal	51,455	35.7	65.8
Fish and other seafood	16,204	11.2	60.4
Milk and dairy products	6,468	4.5	69.1
Eggs and egg products	1,259	0.9	74.7
Sugar and confectionary	3,409	2.4	47.9
Animal and vegetable fats and oils	1,731	1.2	64.0
Fruit and vegetable juices	2,231	1.5	54.9
Non-alcoholic beverages	1,520	1.1	31.3
Alcoholic beverages	3,534	2.5	37.2
Drinking water	7,119	4.9	52.4
Herbs, spices and condiments	2,337	1.6	28.7
Food for infants and small children	2,065	1.4	50.5
Products for special nutritional use	2,864	2.0	29.5
Composite food	565	0.4	44.8
Snacks, desserts, and other foods	879	0.6	41.5

Mean and percentile distribution of lower (LB), middle (MB) and upper (UB) bound lead occurrence were calculated for each food category by setting left-censored results to zero, half the adjusted left-censoring limit or the adjusted left-censoring limit, respectively.

2.2. Consumption data

During 2010, the EFSA Comprehensive European Food Consumption Database (Comprehensive Database) was built from existing national information on food consumption at a detailed level. Competent organisations in the European Union Member States provided EFSA with data from the most recent national dietary survey in their country at the level of consumption by the individual consumer. Survey results for children were mainly obtained through the EFSA Article 36 project "Individual food consumption data and exposure assessment studies for children" through the EXPOCHI consortium (Huybrechts et al., 2011). Results from a total of 32 different dietary surveys carried out in 22 different Member States covering more than 67,000 individuals are included in the Comprehensive Database version 1 as published (EFSA, 2011b).

Although the food consumption data in the Comprehensive Database are the most complete and detailed currently available in the EU, different methodologies were used between surveys to collect the data and thus direct country-to-country comparisons can be misleading. Only surveys covering more than one day, and thus appropriate for calculating chronic exposure, were selected as described in Table 2. Dietary surveys with only one day per subject are considered not adequate to assess chronic exposure because the number of assessment days of a survey affects the distribution of consumption, particularly at the upper tails (EFSA, 2007).

Table 2: Surveys included from the Comprehensive Database version1 for calculating exposure.

Country	Survey	N	Method	Days	Age	Year
Belgium	Regional Flanders	661	Dietary record	3	2-6	2003
Belgium	Diet National 2004	3,245	24-h dietary recall	2	15-105	2004
Bulgaria	NUTRICHILD	1,723	24-h dietary recall	2	0.1-5	2007
Cyprus	Childhealth	303	Dietary record	3	11-18	2003
Czech Republic	SISP04	1,751	24-h dietary recall	2	4-64	2004
Denmark	Danish Dietary Survey	4,118	Food record	7	4-75	2001
Finland	DIPP	1,448	Dietary record	3	1-6	2005
Finland	STRIP	250	Dietary record	4	7-8	2000
Finland	FINDIET 2007	2,038	48-h dietary recall	2	25-74	2007
France	INCA2	4,079	Dietary record	7	3-79	2006
Germany	DONALD 2006	303	Dietary record	3	1-10	2006
Germany	DONALD 2007	311	Dietary record	3	1-10	2007
Germany	DONALD 2008	307	Dietary record	3	1-10	2008
Germany	National Nutrition Survey II	13,926	24-h dietary recall	2	14-80	2006
Greece	Regional Crete	874	Dietary record	3	4-6	2005
Hungary	National Representative Survey	1,360	Dietary record	3	18-96	2003
Ireland	NSIFCS	958	Dietary record	7	18-64	1998
Italy	INRAN SCAI 2005/06	3,323	Dietary record	3	0.1-98	2006
Latvia	EFSA TEST	2,070	24-h dietary recall	2	7-66	2008
Netherlands	VCP kids	1,279	Dietary record	3	2-6	2006
Netherlands	DNFCS 2003	750	24-h dietary recall	2	19-30	2003
Spain	enKid	382	24-h dietary recall	2	1-14	2000
Spain	NUT INK05	760	24-h dietary recall	2	4-18	2005
Spain	AESAN	418	24-h dietary recall	2	18-60	2009
Spain	AESAN FIAB	1,068	Dietary record	3	17-60	2001
Sweden	NFA	2,495	24-h dietary recall	4	3-18	2003
Sweden	Riksmaten 1997/98	1,210	Dietary record	7	18-74	1997
United Kingdom	NDNS	1,724	Dietary record	7	19-64	2001

Individuals were categorised into seven age groups covering infants (<1 year), toddlers (1-<3 years), other children (3-<10 years), adolescents (10-<18 years), adults (18-<65 years), elderly (65-<75 years) and the very elderly (≥75 years) (EFSA, 2011b).

2.3. Exposure calculation

Lead results at different levels of aggregation were inspected for homogeneity. Dietary exposure was calculated using overall European lower, middle and upper bound mean occurrence of lead mainly at level 3 of the FoodEx food categories, as presented in Tables 3 to 21. They were matched with survey specific reported food consumption and body weight for each individual at that same level. Categories for which there were less than ten or no observations were in many cases approximated using the average of the level 2 occurrence to which the category belonged, and matched with level 3 consumption information. Exceptions were food categories with very different results to companion foods or when the food type was very different. Food consumption amounts reported only at FoodEx levels 1 or 2 were matched with the average aggregated lead occurrence at the respective level.

Dilution factors were used before matching some dry ingredient lead concentrations with their respective liquid consumption amounts. An average dilution factor of 18 was used for coffee beans, 60 for instant coffee powder, 60 for all tea and herbal leaf varieties, 8 for cocoa powder and infant formulae, and finally 50 for stock cubes.

The 95th percentile exposure estimates were only calculated for surveys that included 60 or more subjects. Middle bound mean exposure was used to establish a relative ranking for the contributions of the different food groups.

2.4. Statistical software

The PASW statistical package version 17.0.3 (International Business Machines Corp.) was used for the data analysis and the presentation of the occurrence results while the SAS statistical package version 9.2 (SAS Institute Inc.) was used for the analysis of food consumption information and for the calculation of exposure. The trend analysis was performed in Excel using the SLOPE function to determine the slope of the linear regression line through the respective data points for each of the years covered.

3. Results

3.1. Lead occurrence

Lead occurrence is presented at FoodEx level 3 for the categories with matching occurrence and consumption results in the following tables. The number of consumption occasions (N^c) recorded in the Comprehensive database for the respective food is provided in the tables to give a relative ranking of the commonality of their consumption. If consumption information was unspecified at level 3, in most cases an average of all the level 3 food category results without any weighting (including unspecified occurrence results and occurrence results without matching consumption not shown as a separate entry) was calculated for level 2 or, if necessary, for level 1 to match the consumption entry. If there was no matching occurrence result to a specific level 3 consumption entry, the aggregated level 2 food category was entered as a level 3 result. Such food categories are listed just below the level 2 aggregated information (in light brown) with their respective number of consumption occasions in brackets. On a few occasions, when there was great disparity between the lead levels of the level 3 foods, subgroups were created to match level 3 consumption entries.

3.1.1. Grains and grain-based products

There were 9,937 analytical results reported for the "grains and grain-based products" food categories with the most results at FoodEx level 3 belonging to "wheat grain", "wheat milling products" and "rice" (Table 3). Mean (MB) lead concentrations varied between 7 µg/kg in "pasta, gluten free" to 50 µg/kg in "other grains". The maximum retained lead concentration of 1,650 µg/kg was recorded in a wheat grain sample. There were 530 results (5 %) with lead concentrations above 100 µg/kg of which 8 were left-censored data. The highest number of consumers was reported for "wheat bread and rolls" followed by "mixed wheat and rye bread and rolls" and "wheat milling products".

Table 3: The number of occurrence samples (N^o), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "grains and grain-based products" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Grains and grain-based products	Occurrence						Consumers
	N^o	LC %	Mean µg/kg		P95 µg/kg		N^c
			MB	(LB-UB)	MB	(LB-UB)	
Grains and grain-based products	*9,937*	*50*	*29*	*(25-33)*	*105*	*(105)*[1]	103
Grains for human consumption	*4,936*	*48*	*31*	*(27-35)*	*109*	*(109)*	41
Wheat grain	1,932	44	31	(28-35)	101	(101-102)	777
Barley grain	543	29	41	(39-42)	145	(145)	398

Grains and grain-based products	Occurrence						Consumers
	Nº	LC %	Mean µg/kg		P95 µg/kg		N[c]
			MB (LB-UB)		MB (LB-UB)		
Corn grain	330	45	29	(27-32)	99	(99-100)	479
Rye grain	665	51	32	(27-37)	119	(119)	10
Spelt grain	60	47	24	(21-28)	65	(65)	19
Buckwheat grain	69	57	21	(18-24)	124	(124)	35
Millet grain	26	58	27	(19-35)	82	(82)	45
Oats, grain	76	37	44	(40-47)	170	(170)	69
Rice	1,168	64	26	(20-32)	100	(100)	34,738
Other grains	39	49	50	(43-56)	176	(176)	70
Grain milling products	*1,842*	*54*	*29*	*(26-33)*	*117*	*(117)*	169
Wheat milling products	1,323	52	31	(28-35)	120	(120)	119,421
Rye milling products	251	50	30	(26-33)	120	(120)	16,550
Buckwheat milling products	38	50	28	(23-33)	55	(55)	528
Corn milling products	37	57	30	(25-34)	140	(140)	5,347
Oat milling products	46	93	8	(1-15)			11,120
Rice milling products	16	50	15	(14-17)			1,386
Spelt milling products	32	69	17	(12-21)	60	(60)	51
Other milling products	35	60	16	(12-20)	55	(55)	1,985
Bread and rolls	*1,192*	*44*	*29*	*(25-33)*	*98*	*(98)*	15,947
Wheat bread and rolls	333	53	20	(16-24)	74	(74)	332,932
Rye bread and rolls	189	38	25	(23-28)	59	(59)	90,427
Mixed wheat and rye bread and rolls	115	24	37	(35-40)	120	(120)	132,793
Multigrain bread and rolls	53	57	37	(30-43)	163	(163)	12,791
Unleavened bread, crisp bread and rusk	142	49	28	(24-33)	103	(103)	25,524
Other bread	27	30	28	(27-30)	76	(76)	4,719
Bread products	46	52	24	(22-27)	67	(67)	18,919
Pasta (raw)	*381*	*51*	*24*	*(21-27)*	*89*	*(89-91)*	14,873
Used for level 3 categories: Noodle, rice (42), Pasta, wheat flour, filled (313), Pasta, mixed cereal flour (8), Pasta, rye flour (31), Pasta, spelt wholemeal (11), Pasta, wheat wholemeal, with eggs (9)							
Glass noodle	5	60	15	(15-16)			334
Noodle, wheat flour, with eggs	37	57	21	(19-22)	89	(89)	585
Noodle, wheat flour, without eggs	19	53	19	(17-20)			711
Pasta, wheat flour, with eggs	83	51	19	(18-20)	66	(66)	6,379
Pasta, wheat flour, without eggs	116	54	26	(23-30)	130	(130)	15,309
Pasta, wheat wholemeal, without eggs	5	20	16	(14-19)			9,245
Pasta, gluten free	5	40	7	(6-9)			23
Breakfast cereals	*789*	*60*	*25*	*(19-30)*	*80*	*(80-90)*	2,647
Used for level 3 category: Mixed breakfast cereals (1,151)							
Cereal flakes	336	64	16	(11-22)	60	(60-69)	27,015
Muesli	212	74	20	(11-28)	65	(65)	7,667
Cereal bars	25	52	23	(19-27)	43	(43)	1,632
Popped cereals	8	75	19	(7-31)			2,268
Grits	65	43	20	(16-24)	50	(49-65)	215
Porridge	18	61	20	(17-23)			4,949
Fine bakery wares	*675*	*52*	*25*	*(21-28)*	*80*	*(80-86)*	142
Pastries and cakes	295	46	26	(22-22)	84	(84-98)	76,396
Biscuits (cookies)	357	57	20	(16-23)	69	(69-70)	43,840

[1] The 95[th] percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.2. Vegetables and vegetable products

There were 17,269 analytical results reported for the "vegetables and vegetable products" food categories with the most results at FoodEx level 3 belonging to "leaf vegetables", "fruiting vegetables" and "root vegetables" (Table 4). Mean (MB) lead concentrations varied between 2 µg/kg in "Brussels sprouts" to 961 µg/kg in "boletus". The maximum retained lead concentration of 155,000 µg/kg was recorded in the seaweed "wakame" (influencing the mean for seaweed overall). There were 1,511 results (9 %) with lead concentrations above 100 µg/kg of which 224 were left-censored data. The highest number of consumers was reported for "onions" followed by "tomatoes", "carrots", "cucumbers" and sweet "peppers" (bell peppers).

Table 4: The number of occurrence samples (N^o), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "vegetables and vegetable products" food categories at FoodEx level 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Vegetables and vegetable products	Occurrence				Consumers
	N^o	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	N^c
Root vegetables	*2,350*	*40*	*19 (18-21)*	*60 (60)*[1]	325
Used for level 3 category: Arrowroot (41)					
Beetroot	254	54	13 (10-16)	44 (44-50)	6,470
Carrots	1,305	35	20 (18-21)	57 (57-58)	67,088
Celeriac	274	43	12 (10-13)	41 (41)	9,869
Horseradish	5	20	88 (88-89)		281
Parsley root	88	28	23 (22-23)	84 (84)	4,774
Parsnips	50	10	37 (36-37)	98 (98)	1,113
Radishes	259	55	14 (12-16)	59 (52-59)	2,198
Salsify	25	20	146 (144-147)	479 (479)	434
Swedes	21	81	16 (8-25)	75 (16-120)	1,098
Turnips	34	74	20 (13-26)	70 (70)	7,629
Bulb vegetables	*799*	*58*	*31 (29-33)*	*64 (61-69)*	29
Garlic, bulb	117	50	98 (95-100)	158 (158)	26,542
Onions, bulb	552	62	15 (12-17)	53 (50-60)	101,655
Shallots, bulb	35	69	17 (13-20)	80 (80)	843
Spring onions, bulb	77	39	55 (54-57)	64 (64)	2,934
Chives, bulb	7	57	43 (41-44)		259
Fruiting vegetables	*2,891*	*71*	*11 (7-14)*	*45 (39-50)*	6
Used for level 3 category: Okra, lady's fingers (32)					
Tomatoes	708	68	12 (8-16)	50 (50)	99,912
Peppers, paprika	830	71	8 (6-11)	32 (32-37)	46,434
Chilli pepper	50	72	45 (26-63)	91 (91-150)	1,501
Aubergines (egg plants)	154	69	8 (5-11)	23 (20-33)	3,367
Cucumbers	533	72	10 (8-13)	45 (45-50)	46,649
Gherkins	12	67	5 (3-6)		8,123
Courgettes (Zucchini)	301	77	9 (5-14)	31 (30-50)	6,536
Melons	128	83	6 (3-8)	23 (23-27)	4,198
Pumpkins	19	53	14 (12-16)		2,060
Watermelons	16	25	20 (18-21)		2,754
Sweet corn	99	62	13 (11-14)	60 (60)	9,930
Brassica vegetables	*1,977*	*62*	*13 (10-16)*	*50 (50)*	283
Broccoli	180	59	10 (7-12)	30 (30-30)	5,836
Cauliflower	262	62	9 (7-11)	28 (28-46)	12,982
Brussels sprouts	32	97	2 (0-5)	5 (0-10)	2,025
Head cabbage	829	60	14 (11-17)	51 (51-58)	15,940
Chinese cabbage	167	60	11 (9-13)	36 (36)	1,826
Kale	138	32	31 (30-33)	138 (138)	792
Kohlrabi	362	77	10 (6-14)	40 (40-50)	1,069
Leaf vegetables	*3,122*	*44*	*41 (37-44)*	*101 (101-130)*	7,597
Used for level 3 categories: Land cress (15), Purslane (2), Garden orache (1), Dandelion leaf (42), Nettle (69), Sorrel (151), Alfalfa spouts, fresh (37)					

Vegetables and vegetable products	Occurrence N[o]	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	Consumers N[c]
Lamb's lettuce	260	20	47 (46-48)	135 (135)	1,057
Lettuce, excluding Iceberg-type lettuce	1149	51	38 (34-42)	89 (89-120)	32,732
Iceberg-type lettuce	317	68	10 (7-14)	32 (29-32)	4,294
Endive, scarole (broad-leaf endive)	135	63	73 (66-81)	380 (380)	1,113
Cress	3	33	5 (4-6)		117
Rocket, Rucola	491	35	30 (29-32)	110 (110)	291
Spinach (fresh)	334	22	59 (55-63)	170 (170)	2,238
Spinach , preserved, deep-frozen or frozen	236	45	18 (16-21)	56 (56-65)	3,987
Beet leaves	96	40	152 (139-165)	450 (450)	1,787
Vine leaves (grape leaves)	17	24	70 (69-72)		35
Water cress	6	67	27 (23-30)		159
Witloof	21	76	9 (7-11)	30 (30)	3,198
Legume vegetables	*77*	*49*	*26 (22-30)*	*81 (81)*	115
Beans, with pods	60	42	27 (22-32)	78 (78)	7,639
Peas, with pods	12	67	29 (27-31)		158
Stem vegetables (fresh)	*1,267*	*60*	*21 (17-25)*	*75 (59-78)*	15
Used for level 3 category: Cardoons (17)					
Asparagus	419	80	7 (4-10)	25 (24-50)	2,320
Celery	146	51	19 (13-26)	62 (42-75)	8,646
Fennel	35	43	13 (12-15)	23 (23)	2,809
Globe artichokes	80	65	15 (11-19)	49 (49-50)	1,419
Leek	303	63	41 (34-47)	89 (89-150)	16,010
Rhubarb	249	36	24 (22-25)	53 (53)	954
Bamboo shoots	29	10	48 (47-48)	111 (111)	287
Palm hearts	4	25	16 (4-29)		124
Sugar plants					
Chicory roots	1	100	4 (0-8)		540
Sea weeds	*66*	*27*	*2,677 (2663-2692)*	*1,100 (1,100)*	32
Used for level 3 category: Laver (1)					
Kombu	20	35	405 (379-432)	1,300 (1,300)	22
Wakame	1	0	155,000 (155,000)		10
Tea and herbs for infusions (solid)	*473*	*42*	*355 (353-358)*	*1,530 (1,530)*	2,239
Used for level 3 category: Ginseng root (1)					
Tea (dried leaves and stalks)	252	68	177 (174-180)	1,079 (1,079)	1,761
Peppermint	33	27	442 (442-443)	2,180 (2,180)	45
Cocoa beans and cocoa products					
Cocoa powder	349	13	139 (138-139)	382 (382)	10,704
Cocoa beverage-preparation, powder	51	8	81 (81)	221 (221)	7,262
Cocoa mass	5	20	54 (53-56)		1
Coffee beans and coffee products (solid)					
Coffee beans	13	46	43 (41-46)		1,220
Coffee beans, roasted	50	16	45 (45-46)	240 (240)	10
Coffee beans, roasted and ground	208	24	52 (50-53)	170 (170)	1,953
Instant coffee, powder	72	33	66 (65-68)	337 (337)	3,229
Instant coffee, powder, decaffeinated	10	100	8 (0-16)		434
Coffee imitates (solid)	*16*	*13*	*224 (223-224)*		100
Used for level 3 categories: Malt coffee (53), Chicory coffee (318), Wheat coffee (2), Barley coffee (140)					
Mixture of coffee imitates	13	15	256 (255-257)		103
Vegetable products	*427*	*27*	*30 (30-31)*	*105 (105)*	1,750
Used for level 3 categories: Mixed vegetable purée (286), Mushy peas (271), Garlic purée (172), Chestnut purée (104), Sesame paste (Tahini) (131)					
Tomato purée	84	26	24 (24-25)	100 (100)	14,782

Vegetables and vegetable products	Occurrence				Consumers
	N^o	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	N^c
Pickled vegetables	146	37	22 (21-22)	76 (76)	6,372
Sauerkraut	76	12	18 (18-18)	52 (52)	2,723
Sun-dried tomatoes	6	17	61 (60-62)		93
Mashed vegetables	15	13	31 (31-31)		468
Coconut milk	3	100	5 (0-9)		190
Fungi, cultivated	*1722*	*50*	*57 (53-60)*	*194 (194)*	2,079
Cultivated mushroom	1227	53	59 (56-62)	180 (180)	14,962
Oyster mushroom	209	55	23 (20-25)	90 (90-107)	12
Shiitake mushroom	147	22	112 (108-115)	299 (299)	12
Fungi, wild, edible	*786*	*23*	*491 (478-503)*	*2700 (2,700)*	454
Used for level 3 categories: Honey mushroom (1), Morel (6), Truffle (9), Orange agaric (8)					
Boletus	303	28	961 (941-980)	6,050 (6,050)	392
Cantharelle	256	21	116 (103-128)	417 (417)	99

[1] The 95^{th} percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.3. Starchy roots and tubers

There were 2,358 analytical results reported for the “starchy roots and tubers” food categories with the most results at FoodEx level 3 belonging to “main-crop potatoes” and “sweet potatoes” (Table 5). Mean (MB) lead concentrations varied between 5 µg/kg in “French fries” to 181 µg/kg in “cassava root”. The maximum retained lead concentration of 840 µg/kg was recorded in “main-crop potato”. There were only 35 results (1 %) with lead concentrations above 100 µg/kg of which 7 were left-censored data. The highest number of consumers was reported for “potato boiled” followed by “main-crop potatoes” and “French fries”.

Table 5: The number of occurrence samples (N^o), left-censored proportion (LC %), mean and 95^{th} percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for “starchy roots and tubers” food categories at FoodEx level 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Starchy roots and tubers	Occurrence				Consumers
	N^o	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	N^c
Potatoes and potato products	*1,370*	*56*	*19 (16-22)*	*64 (60-66)*	31,758
Used for level 3 categories: Potato flakes (706), Potato boiled (47,849), Potato baked (3,743), Potato croquettes (546), Potato flour (2,186)					
New potatoes	18	89	5 (2-7)		4,718
Main-crop potatoes	1,028	49	20 (18-23)	64 (60-65)	13,380
French fries	27	37	5 (5-6)	13 (13-13)	13,253
Mashed potato powder	126	83	30 (22-38)	182 (182)	5,433
Potato fried	20	70	14 (13-15)	73 (73)	6,219
Potato starch	13	62	20 (18-22)		3,706
Other starchy roots and tubers	*984*	*43*	*17 (16-18)*	*60 (60)*	188
Used for level 3 categories: Yam tubers (21)					
Sweet potatoes	967	44	15 (14-16)	58 (58)	98
Cassava root	10	0	181 (181)		52
Tapioca	2	50	128 (115-140)		11
Jerusalem artichokes tubers	4	0	26 (26)		23

[1] The 95^{th} percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.4. Legumes, nuts and oilseeds

There were 4,071 analytical results reported for the "legumes, nuts and oilseeds" food categories with the most results at FoodEx level 3 belonging to "peanuts", "peas, green without pods" and "beans" (Table 6). Mean (MB) lead concentrations varied between 6 µg/kg in "chick peas" to 90 µg/kg in "mustard seeds". The maximum retained lead concentration of 939 µg/kg was recorded in "chestnuts". There were 280 results (7 %) with lead concentrations above 100 µg/kg of which 4 were left-censored data. The highest number of consumers was reported for "peas, green without pods" followed by "beans, green without pods" and "beans".

Table 6: The number of occurrence samples (N^o), left-censored proportion (LC %), mean and 95[th] percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "legumes, nuts and oilseeds" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Legumes, nuts and oilseeds	Occurrence				Consumers
	N^o	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	N^c
Legumes, nuts and oilseeds	*4,071*	*47%*	*34 (30-38)*	*79 (79)*	115
Legumes, beans, green, without pods	*610*	*62%*	*16 (13-20)*	*64 (64-72)*	4
Beans, green without pods	226	63%	13 (8-18)	50 (39-65)	6,351
Peas, green without pods	358	61%	18 (15-20)	74 (74)	20,234
Lentils, green	25	68%	31 (25-37)	150 (150)	22
Legumes, beans, dried	*1,395*	*39*	*34 (30-38)*	*122 (122-124)*	19
Used for level 3 categories: Black eye bean (142), Chick pea flour (20), Lima bean (43), Mung bean (1,574), Scarlet runner bean (151), Pigeon pea (1)					
Beans	345	30	32 (29-35)	102 (102)	5,276
Lentils	218	35	33 (29-37)	94 (94-100)	2,745
Peas	157	41	27 (23-31)	100 (100)	1,927
Chick peas	34	82	6 (3-9)	20 (20)	870
Broad bean	15	67	13 (11-15)		438
Soya beans	189	32	29 (28-30)	100 (100)	584
Soya beans flour	20	30	49 (48-49)	176 (176)	382
Peanut	377	46	46 (40-51)	183 (183)	3,083
Tree nuts	*983*	*58*	*33 (26-39)*	*110 (110-111)*	537
Used for level 3 categories: Almond, bitter (187), Pecans (27)					
Almond, sweet	170	58	27 (21-33)	78 (78-88)	3,072
Brazil nuts	24	21	81 (81)	190 (190)	135
Cashew nuts	106	75	20 (9-31)	53 (53-59)	491
Chestnuts	58	83	80 (73-86)	640 (640)	300
Coconuts	125	41	26 (24-27)	99 (99-100)	1,286
Hazelnuts	126	46	31 (26-36)	93 (93-100)	2,160
Macadamia	80	94	19 (5-32)	20 (13-40)	40
Pine nuts	25	56	53 (43-64)	220 (220)	320
Pistachios	101	53	38 (31-45)	96 (96)	359
Walnuts	164	51	31 (26-36)	89 (89-100)	2,678
Oilseeds	*1,036*	*38*	*46 (43-48)*	*171 (171)*	49
Used for level 3 category: Borage (2)					
Linseed	161	55	40 (35-46)	135 (135)	719
Poppy seeds	276	32	40 (37-42)	140 (140)	186
Sesame seeds	122	57	25 (21-30)	88 (88-89)	648
Sunflower seeds	216	32	37 (34-39)	115 (115-122)	1,978
Mustard seed	12	17	90 (87-92)		114
Pumpkin seeds	55	31	36 (32-40)	93 (93)	178
Other seeds	19	53	87 (80-93)		1

[1] The 95[th] percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.5. Fruit and fruit products

There were 6,931 analytical results reported for the "fruit and fruit products" food categories with the most results at FoodEx level 3 belonging to "apples", "strawberries" and "plums" (Table 7). Mean (MB) lead concentrations varied between 5 µg/kg in "cranberries" to 84 µg/kg in "fruit in vinegar, oil or brine". The maximum retained lead concentration of 670 µg/kg was recorded in red currants. There were 92 results (1 %) with lead concentrations above 100 µg/kg of which one was left-censored data. The highest number of consumers was reported for "apples" followed by "jam", "bananas" and "oranges".

Table 7: The number of occurrence samples (N^o), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "fruit and fruit products" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Fruit and fruit products	Occurrence				Consumers
	N^o	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	N^c
Fruit and fruit products	*6,931*	*59*	*15 (12-17)*	*80 (80)*	274
Citrus fruits	*548*	*62*	*12 (9-14)*	*46 (41-50)*	3,427
Used for level 3 categories: Limes (45), Pomelo (20)					
Grapefruit	26	73	11 (8-14)	37 (37-54)	1,592
Oranges	316	63	10 (8-13)	41 (40-41)	13,130
Lemons	89	60	14 (12-17)	62 (62)	5,922
Mandarins	80	63	14 (12-16)	55 (55)	9,688
Pome fruits	*1,195*	*60*	*12 (10-15)*	*50 (50)*	
Used for level 3 categories: Medlar (18), Loquat (82), Rowan (1), Nashi pear (1)					
Apple	913	57	13 (10-15)	50 (50-53)	61,077
Pear	279	69	11 (7-14)	47 (47-50)	11,963
Quince	3	0	32 (32)		43
Stone fruits	*826*	*65*	*12 (9-16)*	*50 (44-50)*	93
Used for level 3 categories: Damson plum (42), Mirabelle (83), Greengage (322)					
Apricots	109	32	21 (17-26)	50 (48-100)	2,424
Plums	329	78	8 (5-11)	29 (29-50)	2,685
Sweet cherry	53	55	26 (21-31)	75 (75-124)	1,773
Sour cherry	29	24	15 (14-15)	50 (50)	782
Peaches	291	70	11 (7-15)	48 (45-50)	8,914
Berries and small fruits	*1,919*	*60*	*15 (12-17)*	*53 (53)*	1,401
Used for level 3 categories: Elderberries (3), Loganberries (1), Mulberries (12), Azarole (Mediterranean medlar) (14), Physalis (11), Rose hips (344), Sea buckthorn (50)					
Table grapes	216	40	32 (29-35)	189 (189)	5,680
Wine grapes	302	78	7 (5-10)	23 (23)	1,710
Strawberries	723	70	8 (5-12)	27 (27)	7,632
Blackberries	32	66	11 (10-12)	27 (27)	168
Raspberries	240	63	13 (10-16)	52 (52)	2,420
Blueberries	95	40	13 (12-15)	44 (44)	1,362
Cranberries	27	41	33 (32-35)	150 (150)	136
Currants (red, black and white)	130	33	28 (26-29)	140 (140)	866
Gooseberries	26	42	10 (10-11)	60 (60)	343
Cloudberry	11	18	17 (16-17)		129
Bilberry or whortleberry	18	50	21 (20-23)		269
Cranberry	4	25	5 (5-6)		15
Lingonberry	46	28	19 (19)	73 (73)	1,032
Oilfruits					
Olives for oil production	5	40	16 (15-16)		26
Miscellaneous fruits	*1,264*	*70*	*11 (8-15)*	*45 (45-50)*	415
Used for level 3 categories: Carambola (3), Kumquats (2), Passion fruit (40), Avocados (1,343), Pomegranate (61),					

Fruit and fruit products	Occurrence				Consumers
	Nº	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	Nᶜ
Guava (4), Prickly pear (cactus fruit) (21), American persimmon (1), Bread fruit (jackfruit) (1), Pawpaw (10)					
Dates	19	74	21 (19-24)		75
Figs	16	25	25 (23-27)		305
Table olives	53	9	61 (60-62)	169 (169)	5,412
Persimmon (Sharon fruit)	71	90	6 (3-10)	24 (24-25)	418
Kiwi	291	72	10 (6-14)	38 (38-50)	6,119
Lychee (Litchi)	27	37	21 (17-24)	67 (67)	205
Bananas	312	69	7 (4-9)	23 (23-31)	34,197
Mangoes	97	72	9 (6-12)	33 (33-34)	526
Papaya	10	30	7 (7)		176
Cherimoya	262	83	7 (4-10)	45 (45-50)	21
Pineapples	262	83	7 (4-10)	30 (26-31)	2,093
Dried fruits	*285*	*44*	*25 (23-28)*	*84 (84)*	334
Used for level 3 categories: Dried dates (391), Dried pears (5), Dried apples (410), Dried bananas (155), Dried mangoes (3), Mixed dried fruits (91)					
Dried vine fruits (currants, raisins and sultanas)	115	49	20 (18-22)	65 (65)	7,833
Dried figs	12	42	28 (25-30)		294
Dried prunes	21	52	17 (16-19)	65 (65)	1,702
Dried apricots	99	35	35 (33-38)	100 (100)	468
Jam, marmalade and other fruit spreads	*147*	*51*	*17 (16-19)*	*75 (75)*	75
Used for level 3 category: Marmalade (3,759)					
Jam	92	45	16 (15-17)	75 (75)	48,964
Other fruit spreads	40	68	11 (10-12)	42 (42)	1,296
Other fruit products (excluding beverages)	*716*	*39*	*23 (20-25)*	*76 (76)*	414
Used for level 3 categories: Candied fruit (773), Fruit salad (1,151), Fruit cocktail (173), Fruit fillings for pastries (7),					
Fruit, purée	56	34	25 (24-25)	100 (100)	772
Fruit, canned	305	40	21 (17-25)	60 (60)	4,360
Fruit compote	258	38	22 (21-23)	78 (78-79)	6,021
Fruit in vinegar, oil or brine	13	0	84 (84)		4
Fruit, chocolate coated	8	25	35 (35)		6

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.6. Meat and edible offal

There were 51,455 analytical results reported for the "meat and edible offal" food categories with the most results at FoodEx level 3 belonging to "beef", "pork/piglet meat" and "cattle liver" (Table 8). Mean (MB) lead concentrations varied between 3 µg/kg in "mixed poultry meat" to 1,143 µg/kg in "wild boar meat". Also, the maximum retained lead concentration of 232,000 µg/kg was recorded in "wild boar meat". There were 2,623 results (5 %) with lead concentrations above 100 µg/kg of which 13 were left-censored data. Particularly high results were recorded for wild boar meat and pheasant meat, presumably associated with the use of lead ammunition. The many high results for wild boar meat skewed the distribution for this food category so that the mean exceeded the 95th percentile. The highest number of consumers was reported for "pork/piglet meat" followed by "beef", "ham" and "chicken meat". Only few consumers reported eating game meat.

Table 8: The number of occurrence samples (N^o), left-censored proportion (LC %), mean and 95[th] percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "meat and edible offal" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Meat and edible offal	Occurrence				Consumers
	N^o	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	N^c
Unspecified meat and meat products	*130*	*62*	*16 (12-19)*	*57 (57)*	4,971
Livestock meat	*18,193*	*78*	*16 (11-20)*	*60 (60)*	2,471
Beef	7,434	73	17 (13-21)	70 (70)	63,242
Veal	102	94	6 (2-11)	10 (9-20)	12,203
Pork/piglet meat	6,755	82	11 (7-16)	46 (46-60)	71,893
Mutton/lamb meat	1,989	80	17 (12-21)	66 (66-70)	4,544
Goat/kid meat	100	91	7 (2-12)	19 (18-25)	35
Horse, asses, mules or hinnies meat	1,074	89	9 (5-14)	30 (30-34)	309
Rabbit meat	517	70	20 (17-24)	88 (88)	930
Poultry	*4,674*	*79*	*15 (10-20)*	*52 (52-60)*	1,236
Chicken meat	2,543	80	12 (7-17)	50 (50-54)	42,745
Turkey meat	894	85	11 (5-16)	50 (50-60)	10,444
Duck meat	595	74	36 (32-41)	92 (92)	1,559
Goose meat	274	78	13 (9-18)	55 (55)	922
Pigeon meat	46	76	18 (15-21)	64 (64)	43
Guinea fowl meat	23	87	8 (4-12)	34 (34)	30
Ostrich meat	72	90	6 (2-10)	13 (10-25)	19
Game mammals	*3,532*	*51*	*966 (963-969)*	*330 (330)*	101
Boar meat (wild pig)	966	47	1,143 (1,140-1,146)	670 (670)	114
Venison meat	733	35	48 (47-49)	124 (124)	218
Elk meat	47	83	15 (13-17)	46 (46)	512
Reindeer meat)	490	66	61 (55-66)	150 (150)	153
Hare meat	149	59	155 (149-162)	475 (475)	43
Game birds	*596*	*51*	*267 (264-270)*	*800 (800)*	13
Used for level 3 category: Partridge meat (1), Ptarmigan meat (1)					
Pheasant meat	426	49	344 (342-347)	982 (982)	45
Quail meat	80	80	10 (5-15)	34 (26-45)	67
Mixed meat	*162*	*81*	*5 (3-7)*	*20 (20)*	69
Mixed beef and pork meat	23	35	12 (12-13)	34 (34)	5,848
Mixed poultry meat	17	94	3 (1-5)		4
Edible offal, farmed animals	*20,571*	*58*	*41 (36-46)*	*125 (125)*	903
Used for level 3 categories: Brain (calf, lamb, pig) (13), Lungs (cattle) (3), Stomach (cattle) (100), Spleen (cattle, pig) (18), Thymus (calf, lamb) (9), Marrowbone (cattle) (2,338), Tail (cattle, pig, lamb) (106), Trotters and feet (calf, pig) (122)					
Cattle liver	4,359	44	38 (33-42)	120 (120)	410
Calf liver	72	68	23 (16-30)	75 (75-100)	320
Pig liver	4,322	76	21 (14-28)	80 (80-87)	696
Sheep/lamb liver	915	41	47 (43-51)	150 (150)	141
Chicken liver	2,089	83	18 (11-25)	77 (77-78)	201
Turkey liver	810	87	12 (6-18)	38 (38-53)	8
Duck liver	160	71	23 (18-28)	86 (86-91)	1
Goose liver	17	65	23 (19-27)		85
Cattle kidney	1,929	26	133 (129-136)	180 (180)	34
Calf kidney	13	46	22 (20-23)		3
Pig kidney	4,355	59	21 (17-26)	80 (80-81)	33
Sheep/lamb kidney	172	45	56 (46-66)	170 (170)	116
Tongue (cattle, calf, sheep, lamb, pig)	2	0	28 (28)		227
Heart (cattle, calf, sheep, lamb, pig)	12	83	4 (2-6)		90
Giblets (chicken, turkey, duck, goose)	76	89	5 (2-8)	12 (12-20)	279
Preserved meat	*470*	*41*	*23 (21-25)*	*87 (87)*	4,815

Meat and edible offal	Occurrence				Consumers
	Nº	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	Nᶜ
Used for level 3 categories: Ham, beef (113), Pork, dried (43), Ham, turkey (603), Corned beef (584), Corned pork (406), Pastrami, pork (1,080), Pastrami, beef (13), Pastrami, lamb (1), Preserved poultry (395)					
Ham, pork	49	37	21 (16-27)	46 (46-50)	56,574
Beef, dried	3	67	12 (10-15)		329
Bacon	63	65	11 (7-15)	22 (22-25)	11,772
Luncheon meat	54	24	40 (39-40)	128 (128)	891
Sausages	*1,810*	*67*	*17 (11-22)*	*63 (63)*	10,646
Fresh and lightly cooked sausage	97	75	12 (8-16)	56 (56)	13,598
Uncooked smoked sausage	51	71	10 (6-14)	29 (29)	4,437
Cooked sausage	182	72	18 (7-29)	25 (21-50)	6,892
Cooked smoked sausage	164	68	9 (5-14)	19 (19-24)	18,980
Semi-dry sausage	73	34	28 (27-28)	76 (76)	8,748
Dry sausage	412	62	19 (13-24)	70 (70)	20,075
Meat specialties	*47*	*30*	*14 (14-15)*	*39 (39)*	924
Used for level 3 categories: Pork meat loaf (937), Beef loaf (66), Meat in aspic (77), Ham and cheese loaf (4), Liver cheese or liver loaf(196), Sulze (137)					
Head cheese (Brawn)	26	31	9 (9-10)	17 (17)	738
Pastes, pâtés and terrines	*292*	*33*	*34 (32-35)*	*100 (100)*	1,643
Used for level 3 categories: Pate, chicken liver (499), Pate, pork liver (10,854), Pate, goose liver (535), Terrine (1,924)					
Meat paste	247	27	28 (28-29)	91 (91)	289
Meat imitates	*24*	*29*	*42 (42-43)*	*100 (100)*	71
Used for level 3 category: Quorn (mycoprotein) (141)					
Textured soy protein	16	38	21 (21-22)		697

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.7. Fish and other seafood

There were 16,204 analytical results reported for the "fish and other seafood" food categories with the most results at FoodEx level 3 belonging to "mussels", "salmon and trout" and "prawns" (Table 9). Mean (MB) lead concentrations varied between 3 µg/kg in "whitefish" and "anglerfish" to 244 µg/kg in "winkle". The maximum retained lead concentration of 4,060 µg/kg was recorded in "clams". There were 2,078 results (13 %) with lead concentrations above 100 µg/kg of which 41 were left-censored data. The highest number of consumers was reported for "tuna" followed by "salmon and trout", "mackerel", "herring" and "shrimps".

Table 9: The number of occurrence samples (Nº), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (Nᶜ) for "fish and other seafood" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Fish and other seafood	Occurrence				Consumers
	Nº	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	Nᶜ
Fish and other seafood	*16,204*	*60*	*58 (50-56)*	*266 (266)*	890
Fish meat	*9,433*	*68*	*22 (16-28)*	*80 (80-100)*	7,322
Used for level 3 categories: Flounder (19), Babel (1), Smelt (1), Selachoidei (2), Anglerfish (121)					
Herring	575	66	21 (17-25)	117 (117)	5,829
Sprat	80	38	31 (25-37)	85 (85-94)	77
Sardine and pilchard	396	58	38 (25-52)	93 (93-110)	844
Anchovy	76	76	40 (17-63)	129 (129)	1,143
Salmon and trout	1,239	77	13 (8-17)	45 (43-60)	10,092
Char	70	86	9 (5-14)	30 (30-40)	2
Whitefish	30	67	3 (2-4)	11 (11)	107

Fish and other seafood	Occurrence						Consumers
	N°	LC %	Mean µg/kg		P95 µg/kg		N^c
			MB	(LB-UB)	MB	(LB-UB)	
Perch	274	82	9	(7-12)	36	(36-44)	366
Bass	69	81	10	(6-14)	33	(33-40)	215
Mackeral	504	58	30	(21-39)	94	(94-111)	5,850
Tuna	727	79	17	(9-25)	50	(48-75)	11,142
Sea catfish and wolf-fish	110	74	15	(10-19)	50	(50)	10
Grey mullet	17	71	52	(20-83)			45
Cod and whiting	323	71	21	(11-32)	66	(66-100)	5,716
Hake	256	86	31	(12-50)	82	(82-100)	844
Halibut	136	85	12	(9-15)	44	(44-50)	74
Plaice	31	71	7	(4-11)	29	(29)	1,854
Sole	118	67	38	(28-48)	220	(220)	599
Carp	884	67	21	(16-26)	85	(85)	234
Bream	137	53	20	(17-24)	92	(92)	236
Eels	218	67	16	(12-20)	50	(48-53)	4,147
Rays	43	77	26	(20-32)	160	(160)	81
Fish products	*170*	*45*	*26*	*(23-28)*	*102*	*(102)*	393
Used for the level 3 category: Fish balls (458), Fish cakes (1,086)							
Fish fingers	45	60	15	(10-19)	40	(40-44)	1,616
Fish paste	24	38	45	(41-49)	125	(125)	153
Fish pâté	12	50	33	(27-38)			334
Fish offal							
Fish roe	14	64	43	(41-45)			2,218
Other fish offal	72	56	30	(28-33)	93	(93)	17
Crustaceans	*2,135*	*74*	*33*	*(18-48)*	*90*	*(90-100)*	466
Crab	332	61	37	(31-42)	150	(150)	421
Lobster	40	58	29	(25-34)	120	(120-130)	104
Norway lobster	23	61	32	(13-52)	45	(44-99)	177
Prawns	927	95	36	(8-65)	35	(9-70)	1,340
Shrimps	599	68	22	(17-28)	80	(80-99)	5,765
Crawfish	13	46	66	(59-74)			2
Crayfish	12	67	62	(48-76)			59
Water molluscs	*3,478*	*36*	*182*	*(171-192)*	*600*	*(600)*	52
Squid	172	83	28	(14-41)	66	(66-99)	1,219
Octopus	174	72	37	(22-52)	90	(90-99)	287
Cuttlefish	106	76	49	(39-59)	184	(184)	406
Clam	396	64	167	(145-188)	600	(600)	494
Cockle	241	56	143	(123-163)	540	(540)	25
Mussel	1,528	21	225	(216-234)	670	(670)	1,036
Oyster	293	12	103	(99-107)	242	(242)	206
Scallop	96	34	128	(126-130)	890	(890)	245
Whelk	29	21	53	(49-58)	120	(120)	35
Winkle	11	9	244	(240-249)			2
Amphibians, reptiles, snails, insects	*31*	*32*	*44*	*(41-47)*	*100*	*(100)*	17
Used for the level 3 category: Frogs legs (17), Snails (111)							

[1] The 95[th] percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.8. Milk and dairy products

There were 6,468 analytical results reported for the "milk and dairy products" food categories with the most results at FoodEx level 3 belonging to "cow milk", "dried milk" and "cream" (Table 10). Mean (MB) lead concentrations varied between 3 µg/kg in "goat milk" to 54 µg/kg in "sour milk". The maximum retained lead concentration of 700 µg/kg was recorded in "casein powder". There were 88 results (1 %) with lead concentrations above 100 µg/kg of which none was left-censored data. The highest number of consumers was reported for "cow milk" followed by "cream" and "Danbo cheese". Nine surveys reported consumption of human milk by a total of 822 individuals. No data were reported for the concentration of lead in human milk so the level of 4 µg/kg for liquid milk was used. A systematic literature review indicated that reported mean lead levels in human milk varied from 0.15 to 6.1 µg/L (Koyashiki et al, 2010) confirming that the level chosen is within a reasonable range.

Table 10: The number of occurrence samples (N^o), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "milk and dairy products" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Milk and dairy products	**Occurrence**						**Consumers**
	N^o	**LC %**	**Mean µg/kg**		**P95 µg/kg**		**N^c**
			MB	**(LB-UB)**	**MB**	**(LB-UB)**	
Milk and dairy products	*6,468*	*69*	*10*	*(8-12)*	*39*	*(39-40)*	17
Liquid milk	*4,043*	*76*	*4*	*(3-5)*	*15*	*(14-15)*	2,308
Used for level 3 categories: Buffalo milk (5), Ass milk (1), Human milk (822)							
Cow milk	3,209	76	4	(2-5)	15	(15)	291,333
Sheep milk	195	66	4	(3-5)	15	(15)	31
Goat milk	123	89	3	(1-5)	13	(13-17)	375
Milk based beverages	*27*	*48*	*29*	*(27-31)*	*167*	*(167)*	318
Used for the level 3 category: Milkshakes (699)							
Flavoured milk	27	48	29	(27-31)	167	(167)	8,386
Concentrated milk	*296*	*44*	*23*	*(22-24)*	*71*	*(71)*	3
Evaporated milk	26	50	9	(8-10)	28	(28)	7,303
Condensed milk	60	65	11	(10-12)	60	(60)	605
Dried milk	207	37	28	(27-29)	100	(100)	6,748
Whey and whey products	*8*	*38*	*12*	*(12-13)*			266
Used for the level 3 category: Whey liquid (424), Whey dried (1,834)							
Cream and cream products	*268*	*69*	*8*	*(6-10)*	*29*	*(29-31)*	1,096
Used for level 3 category: Coffee cream (3,766)							
Cream	201	69	9	(7-10)	29	(29-38)	39,668
Sour cream	37	65	8	(6-9)	31	(31-31)	5,008
Crème fraîche	10	70	8	(3-14)			12,628
Fermented milk products	*455*	*64*	*17*	*(14-20)*	*77*	*(77)*	8,312
Used for the level 3 categories: Yoghurt, sheep milk (180), Yoghurt, goat milk (2), Kefir (1,203), Sour milk (924), Acidophilus milk (750), Buttermilk (8,455), Filmjölk (2,884), Viili (848)							
Yoghurt, cow milk, plain	169	70	13	(8-17)	47	(47)	24,333
Yoghurt, cow milk, with fruit	148	66	21	(18-24)	102	(102)	21,521
Milk derivatives	*455*	*64*	*17*	*(14-20)*	*77*	*(77)*	
Used for level 3 categories: Lactose (550), Milk protein (1,395)							
Cheese	*1,262*	*56*	*21*	*(17-25)*	*83*	*(83)*	35,649
Used for level 3 categories: Appenzeller (148), Arzua Ulloa (12), Asiago (2), Bavarian Blue (20), Beaufort (92), Bleu d'Auvergne (345), Blue Castello (117), Boursin (694), Brie (3,198), Buche de Chevre (1,845), Burrata (4), Butterkase (226), Cabrales (1), Caciocavallo (31), Caerphilly (4), Cantal (191), Capra (14), Chaource (27), Cheddar (6,639), Cheese, processed, with ham (131), Cheese, processed, with mushrooms (1), Cheese, processed, with pepper herbs (1), Cheese, processed, with walnuts (20), Cheese, processed, low fat (554),Cheshire (56), Chevres (139), Chimay (14), Comte (818), Coulommiers (1,126), Danbo (35,315), Double Gloucester (49), Epoisses (9), Esrom (32), Fontina (184), Fourme d'Ambert (41), Gorgonzola (222), Gräddost (3), Grana Padano (697), Gruyere (4,037), Harzer (211), Idiazabal (67), Juustoleipa (8), Kefalotyri (6), Lancashire (24), Langres (1), Leicester (142), Leyden (1), Limburger (85), Livarot (22), Maasdam (383), Mahon (55), Manchego (590), Mascarpone (105), Mimolette (466), Mizithra (29), Morbier (87), Munster (142), Nagelkaas (2), Oltermanni (294), Parmigiano Reggiano (7,313), Passendale (30), Pecorino Romano (10), Pont L'Eveque (26), Pouligny-Saint-Pierre (2), Provolone (121), Quark with fruit (3,099), Raclette (287), Reblochon (312), Ricotta (960), Robiola (24), , Saint Marcellin (52), Saint Nectaire (319), Saint Paulin (113), Scamorza (119), Stilton (56), Tetilla (6), Tilsit (9,342), Tomme de Savoie (524), Torta del Casar (3), Trappist (918), Vacherin Mont d'Or (41), Wensleydale (35), White Stilton (13)							
Quark	199	51	18	(17-19)	82	(82)	16,015
Cheese, processed, sliceable	13	54	11	(10-13)			16,948

Milk and dairy products	N[o]	LC %	Occurrence Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	Consumers N[c]
Cheese, processed spreadable	14	64	7 (5-8)		7,109
Cheese, processed, with condiments	63	76	8 (6-9)	33 (33)	32
Cheese, processed, plain	180	28	27 (26-28)	90 (90)	3,054
Cheese, Camembert	91	60	32 (22-42)	130 (130)	5,811
Cheese, Edam	56	32	21 (20-21)	127 (127)	8,562
Cheese, Emmental	8	38	37 (35-40)		8,236
Cheese, Feta	66	77	23 (14-32)	90 (90)	4,973
Cheese, Gouda	6	50	44 (41-48)		12,833
Cheese, Mozzarella	14	71	29 (26-31)		6,731
Cheese, Roquefort	10	30	10 (10-11)		2,605
Milk and milk product imitates	*52*	*62*	*15 (12-17)*	*52 (52)*	372
Used for level 3 categories: Imitation cream (335), Non dairy coffee creamer (52), Oats drink (176), Rice drink (76), Soya yoghurt (430)					
Soya cheese	8	25	29 (28-29)		13
Soya drink	8	38	8 (7-8)		1,274
Tofu	13	69	20 (14-26)		180

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.9. Eggs and egg products

There were 1,259 analytical results reported for the "eggs and egg products" food categories with the most results at FoodEx level 3 belonging to "whole eggs, chicken". Mean (MB) lead concentrations varied between 10 µg/kg in "dried egg, whole" to 13 µg/kg in "egg yolk, chicken". The maximum retained lead concentration of 205 µg/kg was recorded in "dried egg, whole". There were 7 results (1 %) with lead concentrations above 100 µg/kg of which none was left-censored data.

Table 11: The number of occurrence samples (N[o]), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N[c]) for "eggs and egg products" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Eggs and egg products	N[o]	LC %	Occurrence Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	Consumers N[c]
Eggs and egg products	*1,259*	*75*	*12 (8-15)*	*49 (49-50)*	66
Eggs, fresh	*1,194*	*74*	*11 (8-14)*	*48 (48)*	1,175
Used for level 3 categories: Egg yolk, chicken (4,866), Egg white, chicken (2,848), Duck eggs (14), Goose eggs (1), Quail eggs (5)					
Whole egg, chicken	1,009	72	12 (9-15)	48 (48-49)	84,056
Eggs, powder	*9*	*78*	*14 (13-15)*		1
Used for level 3 category: Dried egg, whole (244), Dried egg white (6)					

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.10. Sugar and confectionary

There were 3,409 analytical results reported for the "sugar and confectionary" food categories with the most results at FoodEx level 3 belonging to "honey, polyfloral" and "white sugar" (Table 12). Mean (MB) lead concentrations varied between 10 µg/kg in "white sugar" to 406 µg/kg in "chocolate, cream". The maximum retained lead concentration of 2,140 µg/kg was recorded in "honey". There were 252 results (7 %) with lead concentrations above 100 µg/kg of which 15 were left-censored data. The highest number of consumers was reported for "white sugar" followed by "milk chocolate" and "bitter chocolate".

Table 12: The number of occurrence samples (N°), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "sugar and confectionary" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Sugar and confectionary	Occurrence				Consumers
	N°	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	N^c
Sugar and confectionary	*3,409*	*48%*	*38 (34-42)*	*128 (128-140)*	7
Sugars	*181*	*66*	*13 (12-14)*	*50 (50)*	5,525
Used for level 3 categories: Brown sugar (4,653), Cane sugar (675), Sugar, icing (658), Fructose (2,462), Glucose (1,157)					
White sugar	144	67	10 (9-11)	43 (43)	135,253
Flavoured sugar	10	50	66 (64-68)		673
Sugar substitutes	*33*	*61*	*28 (25-31)*	*100 (100)*	1,704
Nutritive sweeteners	9	22	32 (32-33)		2,454
Non-nutritive sweeteners	15	73	24 (20-27)		5,469
Chocolate (cocoa) products	*723*	*19*	*55 (53-57)*	*163 (163)*	14,314
Used for level 3 categories: Pralines (1,092), Dietetic chocolate (73), Chocolate substitutes (9)					
Bitter chocolate	28	7	45 (45)	120 (120)	12,870
Bitter-sweet chocolate	36	3	106 (106)	351 (351)	1,479
Chocolate bar	20	40	32 (25-38)	158 (158)	4,774
Chocolate, cream	7	14	406 (396-417)		1,397
Chocolate with nuts or fruits	19	21	28 (26-30)	126 (126)	1,962
Chocolate coated confectionery	57	9	30 (30-31)	82 (8)	3,091
Filled chocolate	*723*	*19*	*55 (53-57)*	*163 (163)*	3,146
Milk chocolate	109	28	37 (36-39)	160 (160)	18,779
White chocolate	*723*	*19*	*55 (53-57)*	163 (163)	398
Cooking chocolate	*723*	*19*	*55 (53-57)*	316 (316)	23
Confectionery (non-chocolate)	*398*	*60*	*37 (32-43)*	*167 (167)*	3,533
Used for level 3 categories: Candies, sugar free (561), Caramel, hard (623), Caramel, soft (62), Fudge (374), Sugar cotton (1), Chewing gum with added sugar (2,915), Chewing gum without added sugar (4,975)					
Candies, with sugar	137	60	51 (45-57)	296 (296)	9,880
Marzipan	51	94	18 (4-32)	20 (11-40)	845
Toffee	17	41	44 (43-44)		1,361
Dragée, sugar coated	27	44	15 (14-15)	56 (56)	457
Foamed sugar products	9	78	57 (47-67)		731
Liquorice candies	6	33	217 (215-219)		5,846
Gum drops	32	63	15 (14-16)	74 (74)	1,306
Jelly candies	41	63	12 (11-14)	75 (75)	5,978
Nougat	6	17	14 (14)		254
Halva	9	89	11 (5-17)		61
Dessert sauces	*31*	*35*	*31 (30-31)*	*110 (110)*	425
Used for level 3 categories: Fruit sauce (946), Fudge sauce (76), Alcoholic sweet sauce (1)					
Chocolate sauce	10	30	47 (47)		256
Molasses and other syrups	*100*	*58*	*9 (9-10)*	*42 (42)*	2,978
Used for level 3 categories: Maple syrup (96), Treacle (46)					
Molasses	6	67	25 (22-27)		144
Sugar beet syrup	5	80	2 (1-3)		4,254
Honey	*1,924*	*54*	*36 (32-41)*	*120 (120)*	12,025
Used for level 3 category: Honey, blended (322)					
Honey, monofloral	72	61	16 (12-19)	70 (70)	711
Honey, polyfloral	182	69	22 (16-29)	64 (64-80)	233

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.11. Animal and vegetable fats and oils

There were 1,731 analytical results reported for the “animal and vegetable fats and oils” food categories with the most results at FoodEx level 3 belonging to “butter” and “sunflower oil” (Table 13). Mean (MB) lead concentrations varied between 6 µg/kg in “margarine, normal fat” to 66 µg/kg in “ghee”. The maximum retained lead concentration of 870 µg/kg was recorded in “sunflower oil”. There were 40 results (2 %) with lead concentrations above 100 µg/kg of which none was left-censored data. The highest number of consumers was reported for “butter” followed by “margarine, normal fat”, and “olive oil”.

Table 13: The number of occurrence samples (N^o), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for “animal and vegetable fats and oils” food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Animal and vegetable fats and oils	Occurrence				Consumers
	N^o	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	N^c
Animal and vegetable fats and oils	*1,731*	*64*	*20 (17-22)*	*78 (78-79)*	7363
Animal fat	*566*	*63*	*16 (14-18)*	*75 (75-75)*	779
Used for level 3 categories: Butter oil (268), Chicken fat (3), Goose fat (366), Duck fat (53), Tallow (2), Ghee (96)					
Butter	395	65	16 (13-18)	78 (78-78)	137,826
Pork lard (Schmaltz)	161	60	17 (16-18)	69 (69-69)	6787
Fish oil	*1*	*0*	*8 (8)*		2
Used for level 3 category: Herring oil (2), Cod liver oil (73					
Vegetable fat	*114*	*41*	*23 (23-24)*	*78 (78)*	3,795
Used for level 3 categories: Coconut fat (60), Palm fat (74), Peanut butter (1,109)					
Cocoa butter	23	4	61 (61)	89 (89)	29
Vegetable oil	*924*	*65*	*23 (20-26)*	*85 (85)*	25,824
Used for level 3 categories: Coconut oil (10), Corn oil (2,514), Cottonseed oil (1), Grape seed oil (4,917), Linseed oil (72), Oil, frying, blend (8,213), Palm oil (1,067), Peanut oil (1,286), Pumpkinseed oil (73), Safflower oil (716), Sesame oil (61), Thistle oil (518), Walnut oil (150), Wheat germ oil (25)					
Olive oil	182	69	21 (18-25)	110 (110)	63,371
Rapeseed oil	130	60	15 (13-16)	79 (79)	9,394
Soybean oil	10	50	13 (12-14)		580
Sunflower oil	273	60	26 (23-29)	80 (80)	24,073
Fats of mixed origin	*1*	*0*	*50 (50)*		13,845
Margarine and similar products	*110*	*80*	*10 (6-13)*	*43 (43)*	8,344
Used for level 3 categories: Fat emulsions (9,213), Margarine, low fat (39,515), Margarine with other ingredients (2,887)					
Margarine, normal fat	52	81	6 (4-8)	20 (20)	129,099

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.12. Fruit and vegetable juices

There were 2,231 analytical results reported for the “fruit and vegetable juices” food categories with the most results at FoodEx level 3 belonging to “juice, apple”, “juice, orange” and “juice, grape” (Table 14). Mean (MB) lead concentrations varied between 4 µg/kg in “grape fruit juice” and “pineapple juice” to 79 µg/kg in “cranberry juice concentrate”. The maximum retained lead concentration of 371 µg/kg was recorded in “unspecified fruit juice concentrate”. There were 13 results (1 %) with lead concentrations above 100 µg/kg of which none was left-censored data. The highest number of consumers was reported for “juice, orange” followed by “unspecified concentrated fruit juice”, and “juice, apple”.

Table 14: The number of occurrence samples (N°), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "fruit and vegetable juices" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Fruit and vegetable juices	Occurrence				Consumers
	N°	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	N^c
Fruit and vegetable juices	*2,231*	*45*	*10 (9-12)*	*36 (36-38)*	592
Fruit juice	*1,538*	*57*	*9 (7-11)*	*29 (28-30)*	6,991
Used for level 3 categories: Juice, cranberry (21), Juice, mango (39), Juice, peach (264), Juice, pomegranate (1), Juice, lemon (10,077), Juice, lime (84), Juice, apricot (17), Juice, blackberry (7), Juice, prune (50), Juice, redcurrant (156), Juice, elderberry (42), Juice, passion fruit (5)					
Juice, apple	537	59	7 (5-9)	27 (27-28)	20,404
Juice, orange	338	75	7 (4-9)	28 (27-30)	25,789
Juice, grapefruit	95	93	4 (1-8)	8 (3-15)	743
Juice, pineapple	125	65	4 (2-5)	6 (6-12)	850
Juice, grape	244	19	18 (17-19)	41 (41)	997
Juice, pear	14	14	9 (9-10)		117
Juice, blackcurrant	6	50	18 (18-18)		597
Juice, mixed fruit	16	69	5 (3-7)		1,845
Concentrated fruit juice	*81*	*17*	*44 (44-45)*	*158 (158)*	22,491
Used for level 3 categories: Juice concentrate, raspberries (64), Juice concentrate, currants (black) (572), Juice concentrate, cranberries (1), Juice concentrate, sweet cherry (3)					
Juice concentrate, oranges	14	50	10 (9-11)		4,415
Fruit nectar	*112*	*50*	*9 (7-11)*	*38 (38)*	3,418
Used for level 3 categories: Nectar, pear (42), Nectar, mango (8), Nectar, banana (73), Nectar, apple (27)					
Nectar, peach	11	73	5 (3-7)		423
Nectar, orange	8	88	3 (1-5)		220
Nectar, pineapple	9	11	3 (3-4)		1
Mixed fruit juice	*64*	*31*	*9 (8-9)*	*20 (20)*	1,370
Used for level 3 categories: Juice, apple-grape (3), Juice, apple-cherry (9), Juice, orange-grapefruit (14), Juice, strawberry-cherry (1), Juice, apricot-orange (592), Juice, orange-peach (3), Juice, berries-grapes (1)					
Juice, multi-fruit	27	59	6 (5-7)	19 (19-19)	4,145
Dehydrated/powdered fruit juice	*31*	*55*	*24 (21-26)*	*79 (79)*	21
Vegetable juice	*252*	*69*	*8 (6-10)*	*33 (33)*	62
Used for level 3 categories: Juice, celery (4), Juice, potato (2)					
Juice, tomato	123	69	8 (6-10)	33 (33)	587
Juice, carrot	21	90	5 (1-9)	7 (3-14)	490
Juice, beetroot	55	51	9 (7-10)	36 (36)	29
Mixed vegetable juice	*2*	*0*	*10 (10)*		6
Used for level 3 categories: Juice, tomato-vegetable (8), Multi-vegetable juice (3)					
Mixed fruit and vegetable juice	*11*	*0*	*12 (12)*		82
Used for level 3 categories: Apple/carrot juice (83), Multi-fruit-carrot juice (176)					

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.13. Non-alcoholic beverages

There were 1,520 analytical results reported for the "non-alcoholic beverages" food categories with the most results at FoodEx level 3 belonging to "fruit tea, infusion" and "black tea, infusion" (Table 15). Mean (MB) lead concentrations varied between 0.4 µg/kg in "cola beverages" to 26 µg/kg in "green tea, infusion". The maximum retained lead concentration of 144 µg/kg was recorded in "black tea, infusion". There were 5 results (0.3 %) with lead concentrations above 100 µg/kg of which none was left-censored data. The highest number of consumers was reported for "coffee drink, espresso" followed by "coffee drink, café Americano" and "soft drink, flavoured".

Table 15: The number of occurrence samples (N°), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "non-alcoholic beverages" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Non-alcoholic beverages	Occurrence N°	Occurrence LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	Consumers N^c
Non-alcoholic beverages	*1,520*	*69*	*13 (12-14)*	*30 (30)*	170
Soft drinks	*680*	*63*	*14 (13-16)*	*50 (50-60)*	7,274
Soft drink, fruit content	40	63	6 (4-8)	23 (23-28)	10,102
Soft drink, flavoured	53	74	4 (3-5)	16 (16)	25,582
Cola beverages, caffeinic	8	63	0.4 (0.4-1)		14,374
Also used for level 3 categories: Cola beverages, decaffeinated (274), Cola beverages, caffeinic, low calorie (4,259), Cola beverages, decaffeinated, low calorie (118), Cola Mix (1,459)					
Tea (infusion)	*764*	*1*	*12 (12)*	*40 (40)*	20,440
Used for level 3 category: Instant tea, liquid (11,514)					
Black tea, infusion	162	0	12 (12)	35 (35)	33,176
Green tea, infusion	79	0	26 (26)	70 (70)	2,556
Fruit tee, infusion	298	2	9 (9)	31 (31)	6,167
Herbal tea, infusion	51	0	18 (18)	72 (72)	8,771
Coffee (beverage)	*32*	*28*	*4 (4)*	*60 (60)*	58,724
Used for level 3 categories: Coffee drink, espresso (29,114), Coffee drink, café américano (27,098), Coffee drink, café macchiato (1), Iced coffee (2), Coffee with milk (café latte, café au lait) (9,779), Instant coffee, liquid (5,149)					
Coffee drink, cappuccino	19	16	6 (6)		2,923
Coffee imitates beverage	*32*	*28*	*4 (4)*	*60 (60)*	*2,574*
Cocoa beverage	*4*	*50*	*10 (8-12)*		25
Used for level 3 categories: Hot chocolate (2,204), Cocoa drink (1,756)					

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.14. Alcoholic beverages

There were 3,554 analytical results reported for the "alcoholic beverages" food categories with the most results at FoodEx level 3 belonging to "wine, red" and "wine, white" (Table 16). Mean (MB) lead concentrations varied between 1 µg/kg in "herb liqueur" to 34 µg/kg in "fruit liqueur". The maximum retained lead concentration of 1,730 µg/kg was recorded in "beer, strong". There were 61 results (2 %) with lead concentrations above 100 µg/kg of which none was left-censored data. The highest number of consumers was reported for "beer, regular" followed by "wine, red" and "wine, white".

Table 16: The number of occurrence samples (N°), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "alcoholic beverages" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Alcoholic beverages	Occurrence N°	Occurrence LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	Consumers N^c
Alcoholic beverages	*3,554*	*63*	*21 (19-23)*	*61 (61-66)*	782
Beer and beer-like beverage	*894*	*76*	*12 (9-14)*	*40 (30-45)*	3,114
Used for level 3 category: Beer, light (reduced alcohol content) (2,162), Beer, alcohol-free (612), Beer-like beverages (malt drink) (1,188)					
Beer, strong	81	77	33 (30-35)	8 (8-10)	1,952
Beer, regular	198	89	18 (11-24)	50 (3-100)	19,609
Wine	*2,302*	*22*	*25 (23-27)*	*69 (69-75)*	5,282
Wine, white	695	33	29 (26-32)	85 (85-92)	9,922

Alcoholic beverages	Occurrence N°	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	Consumers N^c
Wine, white, sparkling	24	29	17 (15-18)	43 (43)	873
Wine, red	1,015	19	22 (21-23)	62 (62-67)	19,525
Fortified and liqueur wines	*18*	*17*	*15 (15)*	*42 (42)*	867
Used for level 3 categories: Sherry (570), Vermouth (1,142)					
Wine-like drinks	*139*	*23*	*19 (19-20)*	*81 (81)*	252
Used for level 3 category: Perry (5)					
Cider	81	27	14 (13-14)	42 (42)	1,000
Liqueur	*22*	*64*	*28 (27-30)*	*218 (218)*	640
Used for level 3 categories: Coffee liqueur (14), Egg liqueur (58), Cocoa cream liqueur (4), Cream liqueur (103), Fruit liqueur (307), Herb liqueur (367)					
Spirits	*88*	*48*	*11 (9-12)*	*43 (43-50)*	4,621
Used for level 3 categories: Spirits made from fruits (196), Spirits made from vegetables (Tequila) (123), Rum (577), Vodka and vodka-like spirits (428), Whisky (631)					
Brandy	22	50	8 (7-8)	23 (23)	469
Gin	11	91	2 (1-2)		75
Alcoholic mixed drinks	*3*	*67*	*9 (8-10)*		41
Used for level 3 categories: Cocktail drink (964), Punch (139), Alcopop (159)					

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.15. Drinking water

There were 7,119 analytical results reported for the "drinking water" food categories with the most results at FoodEx level 3 belonging to "tap water" (Table 17). Mean (MB) lead concentrations varied between 0.5 µg/kg in "carbonated mineral water" to 6 µg/kg in "tap water". The maximum retained lead concentration of 1,950 µg/kg was also recorded in "tap water". There were 33 results (0.5 %) with lead concentrations above 100 µg/kg of which none was left-censored data. Most, but not all, of these latter results came from a special investigation of lead soldered water piping in old buildings in one country. The limited number of high, but real, results influenced the overall mean for "tap water". Sampling methodology might influence measured lead levels in tap water but this information was not included in the reporting of results. The highest number of consumers was also reported for "tap water".

Table 17: The number of occurrence samples (N°), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "drinking water" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Drinking water	Occurrence N°	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	Consumers N^c
Drinking water	*7,119*	*52*	*4 (3-4)*	*7 (7-10)*	31,730
Tap water	4,118	38	6 (5-6)	13 (13-13)	239,989
Bottled water	*2,594*	*72*	*1 (0.2-1)*	*3 (1-5)*	46,622
Still mineral water	472	94	1 (0.1-1)	1 (1-3)	39,303
Carbonated mineral water	1,790	64	0.5 (0.3-1)	1 (1-3)	8,214
Water ice (for consumption)	*7,119*	*52*	*4 (3-4)*	*7 (7-10)*	254

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.16. Herbs, spices and condiments

There were 2,337 analytical results reported for the "herbs, spices and condiments" food categories with the most results at FoodEx level 3 belonging to "paprika powder", "parsley" and "pepper, black and white" (Table 18). Mean (MB) lead concentrations varied between 11 µg/kg in "cream sauce" to 1,110 µg/kg in "thyme". The maximum retained lead concentration of 8,500 µg/kg was also recorded in a herb ("oregano"). There were 937 results (40 %) with lead concentrations above 100 µg/kg of which 14 were left-censored data. The highest number of consumers was reported for "salt, iodised" followed by "salt", "pepper, black and white", "parsley", "yeast" and "mayonnaise".

Table 18: The number of occurrence samples (N^o), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "herbs, spices and condiments" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Herbs, spices and condiments	Occurrence						Consumers
	N^o	LC %	Mean µg/kg		P95 µg/kg		N^c
			MB	(LB-UB)	MB	(LB-UB)	
Herbs, spices and condiments	*2,337*	*29*	*224*	*(220-229)*	*930*	*(930)*	24
Herbs	*518*	*25*	*278*	*(276-281)*	*1,300*	*(1,300)*	8,772
Used for level 3 categories: Celery leaves (75), Sage, herb (453), Rosemary, herb (293), Bay leaves (laurel) (1,504)							
Chervil, herb	4	0	73	(73)			59
Chives, herb	69	43	27	(25-28)	69	(69)	3,462
Dill, herb	45	62	53	(48-58)	172	(172)	1,734
Parsley, herb	215	19	93	(91-96)	330	(330)	22,206
Thyme, herb	21	0	1,110	(1,110)	3,600	(3,600)	2,340
Basil, herb	72	35	80	(79-81)	500	(500)	1,848
Tarragon, herb	9	22	391	(385-397)			34
Spices	*935*	*24*	*285*	*(280-291)*	*990*	*(990)*	4,480
Used for level 3 categories: Ajowan (31), Allspice (1,276), Capers (362), Cardamom (55), Dill seed (3), Fennel seed (2), Horseradish, powder (185), Juniper berries (67), Mace (7), Saffron (347)							
Paprika powder	271	90	318	(316-320)	923	(923)	5,255
Chilli powder	24	50	257	(235-279)	950	(950)	619
Anise seed	9	56	95	(92-97)			8
Caraway	6	0	79	(79)			3,338
Cayenne pepper	8	13	492	(491-492)			141
Cinnamon	30	33	438	(432-444)	2,200	(2,200)	1,456
Cloves	5	60	119	(112-126)			652
Coriander seed	13	62	115	(98-132)			83
Cumin seed	36	8	127	(123-132)	380	(380)	405
Ginger	29	14	950	(943-957)	3,220	(3,220)	759
Nutmeg	98	52	106	(95-117)	400	(400)	556
Pepper, black and white	168	34	195	(184-205)	731	(731)	28,436
Turmeric	15	0	407	(407-407)			60
Herb and spice mixtures	*132*	*20*	*297*	*(293-301)*	*885*	*(885)*	153
Mixed herbs	11	64	383	(383)			4,101
Curry powder	72	17	312	(307-316)	670	(670)	2,077
Mixed spices	49	16	255	(251-259)	760	(760)	213
Seasoning or extracts	*149*	*46*	*292*	*(282-302)*	*1,320*	*(1,320)*	2,059
Used for level 3 categories: Gravy thickener (195), Gravy browning (30), Gravy instant granules (215), Meat extract (2,146), Malt extract (4,133), Yeast extract (466)							
Stock cubes (bouillon cube)	8	13	425	(425)			12,693
Vegetable extracts	6	0	38	(38)			179
Salt, iodised	16	13	838	(838)	3390	(3390)	131,346
Sea salt	9	44	451	(433-469)			427
Salt	91	65	168	(154-183)	512	(512)	69,458
Also used for level 3 categories: Salt, low sodium (835), Salt, iodised and fluoridated (893), Salt, flavoured (233)							
Condiment	*280*	*28*	*54*	*(52-56)*	*210*	*(210)*	5,189
Used for level 3 categories: Mustard, sweet (873), Mustard, hot (1,325), Barbecue sauce (187), Tabasco sauce (26), Horseradish sauce (160), Curry sauce (738), Salsa (68)							
Mustard, mild	22	23	47	(39-55)	200	(200)	6,883

Herbs, spices and condiments	Nº	LC %	Occurrence Mean µg/kg MB (LB-UB)	Occurrence P95 µg/kg MB (LB-UB)	Consumers Nᶜ
Vinegar, wine	49	37	27 (24-29)	79 (79)	13,109
Vinegar, apple	74	20	89 (87-90)	332 (332)	58
Tomato ketchup	56	27	41 (39-42)	180 (180)	16,432
Mint sauce	2	0	125 (125)		76
Soy sauce	4	50	10 (10-11)		2,444
Tartar sauce	7	57	60 (47-72)		411
Mixed condiment	3	0	22 (22)		2,267
Dressing	*63*	*57*	*30 (24-37)*	*86 (86)*	12,789
Used for level 3 categories: Salad dressing, > 50% oil (1,544), Salad dressing, 25 - 50% oil (12,366), Salad dressing, < 25% oil (4,456), Mayonnaise, < 25% oil (413)					
Mayonnaise, > 50% oil	25	72	16 (11-22)	70 (70)	20,409
Mayonnaise, 25 - 50% oil	20	30	16 (15-16)	59 (59)	6,072
Chutney and pickles	*10*	*40*	*17 (16-19)*		1
Used for level 3 categories: Tomato chutney (2,486), Apple chutney (13), Mango chutney (84), Piccalilli (69), Chilli pickle (104), Lime pickle (15), Mango pickle (6)					
Savoury sauces	*45*	*42*	*53 (46-59)*	*160 (160)*	4,121
Used for level 3 categories: White sauce (béchamel sauce, cheese sauce) (2,970), Butter sauce (203), Emulsion sauce (Hollandaise sauce) (654), Oil-based sauce (pesto, aioli sauce) (349), Alcoholic sauce (433), Meat sauce (2,242), Fish sauce (60), Vegetable sauce (4,301)					
Brown sauce (Gravy, Lyonnais sauce)	11	55	68 (56-80)		6,474
Cream sauce	3	67	11 (9-14)		1,872
Flavourings or essences	*43*	*49*	*92 (85-99)*	*437 (437)*	3,565
Used for level 3 categories: Vanilla essence (425), Vanilla pods (58), Lemon essence (3), Rum essence (2)					
Baking ingredients	*161*	*37*	*47 (46-47)*	*201 (201)*	113
Used for level 3 categories: Sodium bicarbonate (108), Pectin (3), Gum (2), Glaze (6)					
Yeast	32	44	16 (15-17)	54 (54)	23,624
Baking powder	25	68	17 (16-18)	100 (100)	1,177
Gelatine	101	28	63 (63)	260 (260)	678

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.17. Food for infants and small children

There were 2,065 analytical results reported for the "food for infants and small children" food categories with the most results at FoodEx level 3 belonging to "fruit puree" and "ready-to-eat meal, vegetable-based" (Table 19). Mean (MB) lead concentrations varied between 0.3 µg/kg calculated for "liquid follow-on formulae" to 19 µg/kg in "biscuits, rusks and cookies". The maximum retained lead concentration of 520 µg/kg was recorded in a "fruit puree". There were 9 results (0.4 %) with lead concentrations above 100 µg/kg of which none was left-censored data. The highest number of consumers was reported for "infant formula, milk-based liquid" followed by "biscuits, rusks and cookies", "infant formula, milk-based powder" and "fruit puree".

Table 19: The number of occurrence samples (Nº), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (Nᶜ) for "food for infants and small children" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Food for infants and small children	Nº	LC %	Occurrence Mean µg/kg MB (LB-UB)	Occurrence P95 µg/kg MB (LB-UB)	Consumers Nᶜ
Food for infants and small children	*2,065*	*51*	*12 (8-16)*	*25 (22-50)*	21
Infant formulae, powder	*253*	*77*	*6 (4-8)*	*22 (22)*	15
Used for level 3 categories: Infant formula, hypoallergenic, powder (63), Infant formula, soya-based, powder (16)					

Food for infants and small children	Occurrence				Consumers
	N[o]	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	N[c]
Infant formula, milk-based, powder	108	87	4 (2-5)	12 (12)	1,388
Infant formulae, liquid	*253*	*77*	*1 (0.5-1)*	*3 (3)*	
Used for level 3 categories: Infant formula, hypoallergenic, liquid (17), Infant formula, soya-based, liquid (3), Infant formula, milk and soya-based, liquid (4), Infant formula, protein hydrolysates, liquid (156)					
Infant formula, milk-based, liquid	*108*	*87*	*1 (0.5-1)*	*2 (2)*	1,981
Follow-on formulae, powder					
Follow-on formula, milk-based, powder	37	78	3 (2-4)	20 (20)	276
Follow-on formulae, liquid	*37*	*78*	*0.3 (0.2-0.5)*	*3 (3)*	
Used for level 3 categories: Follow-on formula, milk-based, liquid (216), Follow-on formula, hypoallergenic, liquid (2), Follow-on formula, soya-based, liquid (9)					
Cereal-based food	*294*	*55*	*13 (9-17)*	*32 (30-50)*	567
Used for level 3 category: Simple cereals to be reconstituted (592)					
Cereals high protein to be reconstituted	116	83	13 (6-19)	58 (58)	64
Biscuits, rusks and cookies	41	34	19 (15-23)	43 (40-85)	1,610
Pasta	30	57	12 (8-17)	40 (40)	16
Ready-to-eat meal	969	62	14 (7-20)	25 (20-50)	198
Ready-to-eat meal, vegetable-based	196	57	10 (7-13)	21 (21-25)	308
Ready-to-eat meal, cereal-based	26	8	7 (7)	20 (20)	251
Ready-to-eat meal, meat/fish-based	7	14	5 (5-6)	9 (9)	77
Ready-to-eat meal, meat and vegetables	66	33	9 (6-12)	19 (17-25)	162
Fruit purée	468	57	11 (8-14)	29 (25-34)	1,282
Yoghurt, cheese and milk-based dessert	*26*	*27*	*4 (4)*	*8 (8)*	9
Used for level 3 category: Yoghurt (23)					
Cheese preparations	4	75	1 (1-2)	3 (3)	22
Dessert and puddings	21	19	5 (4-5)	8 (8)	7
Fruit juice and herbal tea	*33*	*33*	*7 (6-7)*	*18 (18)*	2
Used For level 3 categories: Fruit nectar (1), Tee and juice mixture (17)					
Fruit juice	29	28	7 (6-7)	18 (18)	90
Tee	3	67	2 (2)	6 (6)	26

[1] The 95[th] percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.18. Products for special nutritional use

There were 2,864 analytical results reported for the "products for special nutritional use" food categories with the most results at FoodEx level 3 belonging to "combination vitamin and mineral supplements", "mineral supplements" and "vitamin supplements" (Table 20). Mean (MB) lead concentrations varied between 5 µg/kg in "nutritionally complete medical formulae" to 1,243 µg/kg in "mineral supplements". The maximum retained lead concentration of 59,600 µg/kg was recorded in the dietary supplement "propolis". Many supplements are concentrated, which may explain some high values, and consumed in low amounts. Lead might even be added deliberately to some products. There were 1,226 results (43 %) with lead concentrations above 100 µg/kg of which 19 were left-censored data. The highest number of consumers was reported for "vitamin supplements" followed by "combination vitamin and mineral supplements" and "fatty acid supplements".

Table 20: The number of occurrence samples (N^o), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "products for special nutritional use" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Products for special nutritional use	Occurrence						Consumers
	N^o	LC %	Mean µg/kg		P95 µg/kg		N^c
			MB	(LB-UB)	MB	(LB-UB)	
Products for special nutritional use	*2,864*	*30*	*714*	*(708-719)*	*2,550*	*(2,550)*	38
Food for weight reduction	*16*	*75*	*632*	*(613-651)*			12
Used for level 3 categories: Meal replacement for the whole daily diet (4), Meal replacement for one or more daily meals (212)							
Dietary supplements	*2,489*	*30*	*701*	*(695-706)*	*2,550*	*(2,550)*	2,455
Used for level 3 category: Coenzyme Q10 supplement (30)							
Vitamin supplements	238	59	79	(70-88)	350	(350)	3,317
Mineral supplements	337	32	1,243	(1,239-47)	6,360	(6,360)	1,577
Vitamins and mineral combination supplements	564	24	415	(409-421)	1,600	(1,600)	3,083
Fatty acid supplements	144	76	64	(47-80)	300	(300)	2,892
Protein and amino acids supplements	19	53	26	(18-33)			79
Fibre supplements	19	37	485	(478-492)			36
Plant extract formula	197	22	434	(429-438)	2,580	(2,580)	697
Yeast based supplement	16	25	67	(62-72)			54
Algae formula	218	14	908	(905-911)	3,800	(3,800)	102
Pollen-based supplement	5	40	235	(226-244)			20
Food for sports people	*130*	*30*	*490*	*(482-499)*	*1,714*	*(1,714)*	7
Used for level 3 categories: Carbohydrate-rich energy food products (122), Carbohydrate-electrolyte solutions (137)							
Protein and protein components	3	67	37	(20-53)			120
Dietetic food for diabetics	*91*	*35*	*29*	*(28-29)*	*77*	*(77)*	
Used for level 3 categories: Fine bakery products for diabetics (67), Confectionary for diabetics (1), Alcohol-free beverages (1), Jam, marmalade and other fruit spreads (352), Milk products (1), Beer (1)							
Chocolate and chocolate products	35	3	51	(51)	134	(134)	42
Fruit-based beverages	24	63	7	(7-8)	27	(27)	5
Medical food	*87*	*7*	*11*	*(10-13)*	*59*	*(59)*	
Used for level 3 category: Oral rehydration products (1)							
Nutritionally complete formulae	28	0	5	(5-5)	9	(9)	19
Nutritionally incomplete formulae	7	43	26	(16-37)			12

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.19. Composite foods

There were 565 analytical results reported for the "composite foods" food categories with the most results at FoodEx level 3 belonging to "goulash" (Table 21). Mean (MB) lead concentrations varied between 8 µg/kg in "pasta, cooked" to 366 µg/kg in "seafood-based meal". The maximum retained lead concentration of 1,580 µg/kg was recorded in the meat-based meal "goulash". There were 32 results (6 %) with lead concentrations above 100 µg/kg of which one was left-censored data. The highest number of consumers was reported for "unspecified vegetable meals" followed by "unspecified ready-to-eat soup", "meat/poultry soup", "vegetable/herb soup" and "prepared mixed vegetable salad".

Table 21: The number of occurrence samples (N^o), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "composite foods" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Composite foods	Occurrence N^o	Occurrence LC %	Occurrence Mean µg/kg MB (LB-UB)	Occurrence P95 µg/kg MB (LB-UB)	Consumers N^c
Composite food	*565*	*55*	*36 (34-39)*	*110 (110)*	883
Cereal-based dishes	*47*	*49*	*10 (8-11)*	*20 (20)*	384
Used for level 3 category: Sandwich and sandwich-like meal (1,022)					
Pizza and pizza-like pies	21	57	11 (9-13)	18 (18)	4,183
Pasta, cooked	16	69	8 (6-10)		3,797
Rice-based meals	*1*	*0*	*12 (12)*		382
Used for level 3 categories: Rice and vegetables meal (836), Rice and meat meal (287), Rice, meat, and vegetables meal (166)					
Potato based dishes	*15*	*40*	*21 (20-21)*		462
Used for level 3 categories: Potatoes and vegetables meal (283), Potatoes and meat meal (185), Potatoes, meat, and vegetables meal (33), Potatoes and cheese meal (469)					
Beans-based meals	*14*	*29*	*72 (72-73)*		17
Beans and meat meal	9	44	25 (24-25)		27
Beans and vegetables meal	1	0	13 (13-13)		512
Meat-based meals	*166*	*54*	*44 (42-47)*	*155 (155)*	2,516
Used for level 3 category: Meat balls (3,404), Meat burger (2,855)					
Goulash	89	62	68 (65-70)	298 (298)	235
Meat stew	12	42	17 (17-18)		3,247
Fish and seafood based meals	*96*	*52*	*57 (53-62)*	*143 (143)*	147
Used for level 3 categories: Fish and potatoes meal (157), Fish and rice meal (8)					
Fish and vegetables meal	13	46	55 (49-61)		240
Seafood-based meals	9	56	366 (359-373)		63
Vegetable-based meals	*26*	*54*	*46 (43-49)*	*189 (189)*	6,092
Used for level 3 categories: Mixed vegetables, grilled (6), Mixed vegetables, fried (280), Mixed vegetables, braised (318), Vegetables, gratinated (36), Ratatouille (11)					
Mixed vegetables, boiled	13	69	24 (19-29)		2,648
Egg-based meal (e.g. omelette)	*1,259*	*75*	*12 (8-15)*	*49 (49-50)*	506
Used for level 3 categories: Omelette, plain (417), Omelette with bacon (8), Omelette with cheese (20), Omelette with vegetables (28), Fried eggs (3,899), Poached eggs (317)					
Mushroom-based meals	*1,722*	*50*	*57 (53-60)*	*194 (194)*	487
Ready to eat soups	*47*	*32*	*31 (29-32)*	*110 (110)*	5,632
Used for level 3 categories: Grain soup (778), Potato soup (222), Meat/poultry soup (4,632), Fish soup (138), Legume (beans) soup (424), Milk product/egg soup (307), Mushroom soup (234), Fruit soup (1,331)					
Vegetable/herb soup	11	55	19 (16-22)		4,556
Prepared salads	*73*	*29*	*29 (27-30)*	*98 (98)*	182
Used for level3 categories: Prepared green salad (2,582), Prepared mixed vegetable salad (4,325), Prepared potato salad (257), Prepared pasta salad (37), Prepared meat salad (588), Prepared egg/meat/fish/vegetable salad (190)					
Prepared legume (beans) salad	2	50	15 (13-18)		10
Prepared fish salad	53	30	35 (33-37)	99 (99)	503

1 The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

3.1.20. Snacks, deserts and other foods

There were 879 analytical results reported for the "snacks, deserts and other foods" food categories with the most results at FoodEx level 3 belonging to "starchy pudding" (Table 22). Mean (MB) lead concentrations varied between 4 µg/kg in "pretzels" to 32 µg/kg in "popcorn". The maximum retained lead concentration of 1,420 µg/kg was recorded in the snack food "fruit snack with apple". There were 29 results (3 %) with lead concentrations above 100 µg/kg of which none was left-censored data. The highest number of consumers was reported for "ice cream, milk-based" followed by "potato crisps".

Table 22: The number of occurrence samples (N^o), left-censored proportion (LC %), mean and 95th percentile (P95) middle bound (MB) lead concentrations with lower and upper bound range (LB-UB) and the number of consumption occasions (N^c) for "snacks, deserts and other foods" food categories at FoodEx level 1 (green), 2 (brown) or 3 (white). Aggregated values are shown in red italics.

Snacks, deserts and other foods	Occurrence				Consumers
	N^o	LC %	Mean µg/kg MB (LB-UB)	P95 µg/kg MB (LB-UB)	N^c
Snacks, desserts, and other foods	*879*	*42*	*26 (25-28)*	*90 (90)*	5
Snack food	*520*	*36*	*34 (33-35)*	*96 (96)*	2,698
Used for level 3 categories: Corn chips (618), Tortilla chips (346), Corn curls (507), Fish-based snacks (153), Seafood chips (49), Cheese puffs (86)					
Potato crisps	66	68	19 (16-22)	52 (52)	10,049
Popcorn	15	27	32 (31-33)		1,983
Pretzels	4	75	4 (3-6)		259
Ices and desserts	*359*	*50*	*15 (14-17)*	*52 (52)*	4,374
Used for level 3 categories: Custard (5,323), Sorbet (1,104), Gelatine dessert 1,181), Granita (2)					
Ice cream, milk-based	30	43	8 (6-11)	17 (17)	16,367
Ice cream, not milk-based	6	50	5 (5-6)		744
Starchy pudding	142	40	19 (19-20)	55 (55)	2,245
Other foods	*879*	*42*	*26 (25-28)*	*90 (90)*	

[1] The 95th percentile is only shown for food categories with 20 or more samples but should be interpreted with caution if the sample number is less than 60 (EFSA, 2011).

In summary, actual lead occurrence results were used for 734 of the 1118 food categories at level 3 of the FoodEx system with consumption recorded, while they were estimated for 384 food categories by aggregating all existing results for the level 2 to which they belonged and entered at level 3 to match consumption. Of the 20 broad food categories at FoodEx level 1, 18 had some food consumption recorded only at this level. This was particularly true for the "drinking water" and the "meat and offal" categories. Equally, a number of FoodEx level 2 food categories had food consumption recorded only at this level. All FoodEx level 3 occurrence results were thus aggregated to its respective level 2 and level 1 category to match consumption at these levels.

3.2. Trend analysis

The annual average results of the analysis of lead in food across Europe can be very much influenced by the type of food tested and the inclusion of special investigations in a particular year. Nevertheless, an attempt was made to evaluate a potential trend in the occurrence of lead in food over the period covered by the data submitted to EFSA. Using the MS Excel® equation SLOPE and excluding the sampling year 2011 with few results, an overall decrease in lead levels of 23 % was estimated for the 8-year period across all sample results.

To test if the trend was uniform across broad food categories and to partly overcome annual sampling bias, samples at FoodEx level 1 were split into three-year intervals (last interval covering only two years) as presented in Figure 5. All food categories except "non-alcoholic beverages" and "food for infants and small children" showed an overall decreasing trend in lead occurrence over the time period. Four food categories ("products for special nutritional use", "fruit and fruit products", "legumes, nuts and oilseeds" and "fish and other seafood") initially showed an increase, but decreased overall over the period.

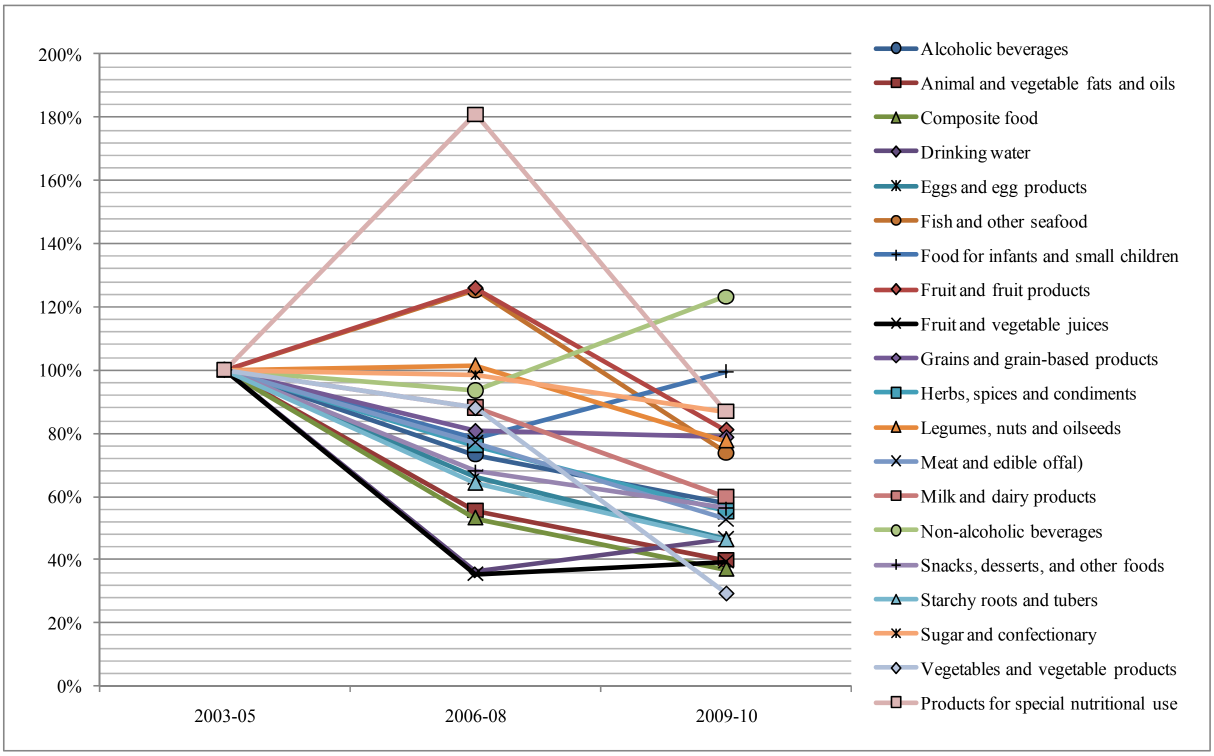

Figure 5: Analysis of the three-year interval trend (last interval only two years) in lead occurrence across the twenty broad food categories presented as percentage change, using 2003-05 as the base period.

3.3. Exposure assessment by country, survey and age group

European mean and 95th percentile lower, middle and upper bound dietary exposure were assessed. The detailed results of the exposure calculations are presented in Tables 23-29 for the respective survey and age group. Each table provides an indication of the range of results for the surveys included with the minimum, median and maximum of mean and 95th percentile exposure across dietary surveys.

3.3.1. Infants

There were two surveys available reporting food consumption information for infants, one of which included very few survey participants (Table 23). Therefore, the middle bound mean variation in lead dietary exposure of between 0.83 and 0.91 µg/kg b.w. per day should be taken only as a rough indication for European infants.

Table 23: Lower (LB), middle (MB) and upper (UB) bound mean and 95th percentile (P95) lead dietary exposure in infants in µg/kg b.w. per day.

Country	Survey	N	Mean			P95		
			LB	MB	UB	LB	MB	UB
Bulgaria	NUTRICHILD	860	0.73	0.91	1.09	1.39	1.80	2.22
Italy	INRAN SCAI 2005/06	16	0.63	0.83	1.02			
Minimum			**0.63**	**0.83**	**1.02**			
Median								
Maximum			**0.73**	**0.91**	**1.09**			

3.3.2. Toddlers

There were nine surveys available reporting food consumption for toddlers covering an overall 1,597 survey participants (Table 24). The middle bound lead dietary exposure varied for the mean between 1.00 and 1.54 µg/kg b.w. per day with a median of 1.31 µg/kg b.w. per day and for the 95th percentile between 1.40 and 2.84 µg/kg b.w. per day with a median of 1.73 µg/kg b.w. per day. The maximum upper bound 95th percentile lead dietary exposure in toddlers was estimated at 3.27 µg/kg b.w. per day.

Table 24: Lower (LB), middle (MB) and upper (UB) bound mean and 95th percentile (P95) lead dietary exposure in toddlers in µg/kg b.w. per day.

Country	Survey	N	Mean			P95		
			LB	MB	UB	LB	MB	UB
Belgium	Regional Flanders	36	1.30	1.54	1.77			
Bulgaria	NUTRICHILD	428	1.09	1.34	1.59	1.69	2.01	2.40
Finland	DIPP	497	1.14	1.35	1.57	2.40	2.84	3.27
Germany	DONALD 2006	92	0.82	1.03	1.23	1.20	1.44	1.76
Germany	DONALD 2007	85	0.81	1.00	1.19	1.18	1.45	1.69
Germany	DONALD 2008	84	0.82	1.01	1.21	1.20	1.40	1.67
Italy	INRAN SCAI 2005/06	36	0.98	1.21	1.45			
Netherlands	VCP kids	322	1.26	1.46	1.67	2.31	2.61	2.87
Spain	enKid	17	1.08	1.31	1.54			
Minimum			**0.81**	**1.00**	**1.19**	**1.18**	**1.40**	**1.67**
Median			**1.08**	**1.31**	**1.54**	**1.44**	**1.73**	**2.08**
Maximum			**1.30**	**1.54**	**1.77**	**2.40**	**2.84**	**3.27**

3.3.3. Other children

There were seventeen surveys available reporting food consumption for other children covering an overall 8,468 survey participants (Table 25). The middle bound lead dietary exposure varied for the mean between 0.73 and 1.27 µg/kg b.w. per day with a median of 0.96 µg/kg b.w. per day and the 95th percentile between 1.12 and 2.01 µg/kg b.w. per day with a median of 1.55 µg/kg b.w. per day. The maximum upper bound 95th percentile lead dietary exposure in other children was estimated at 2.27 µg/kg b.w. per day.

Table 25: Lower (LB), middle (MB) and upper (UB) bound mean and 95th percentile (P95) lead dietary exposure in other children in µg/kg b.w. per day.

Country	Survey	N	Mean			P95		
			LB	MB	UB	LB	MB	UB
Belgium	Regional Flanders	625	1.08	1.27	1.46	1.73	2.01	2.27
Bulgaria	NUTRICHILD	433	1.01	1.22	1.43	1.66	1.95	2.24
Czech Republic	SISP04	389	1.05	1.18	1.31	1.73	1.96	2.18
Denmark	Danish Dietary Survey	490	0.92	1.07	1.22	1.43	1.64	1.83
Finland	DIPP	933	1.00	1.17	1.34	1.55	1.76	2.02
Finland	STRIP	250	0.88	1.02	1.17	1.27	1.48	1.68
France	INCA2	482	0.76	0.91	1.06	1.37	1.55	1.77
Germany	DONALD 2006	211	0.67	0.80	0.94	0.99	1.18	1.37
Germany	DONALD 2007	226	0.66	0.80	0.93	0.98	1.12	1.32
Germany	DONALD 2008	223	0.65	0.78	0.91	0.99	1.18	1.34
Greece	Regional Crete	839	0.61	0.73	0.85	0.97	1.16	1.35
Italy	INRAN SCAI 2005/06	193	0.81	0.97	1.13	1.31	1.55	1.73
Latvia	EFSA_TEST	189	0.65	0.75	0.85	1.25	1.41	1.54
Netherlands	VCP kids	957	1.07	1.24	1.40	1.77	1.96	2.19
Spain	enKid	156	0.77	0.93	1.10	1.31	1.59	1.86
Spain	NUT_INK05	399	0.78	0.95	1.12	1.20	1.45	1.68
Sweden	NFA	1,473	0.82	0.96	1.11	1.32	1.55	1.77
Minimum			**0.61**	**0.73**	**0.85**	**0.97**	**1.12**	**1.32**
Median			**0.81**	**0.96**	**1.12**	**1.31**	**1.55**	**1.77**
Maximum			**1.08**	**1.27**	**1.46**	**1.77**	**2.01**	**2.27**

3.3.4. Adolescents

There were twelve surveys available reporting food consumption for adolescents covering an overall 6,329 survey participants (Table 26). The middle bound lead dietary exposure varied for the mean between 0.34 and 0.79 µg/kg b.w. per day with a median of 0.55 µg/kg b.w. per day and the 95th percentile between 0.58 and 1.36 µg/kg b.w. per day with a median of 0.97 µg/kg b.w. per day. The maximum upper bound 95th percentile lead dietary exposure in adolescents was estimated at 1.51 µg/kg b.w. per day.

Table 26: Lower (LB), middle (MB) and upper (UB) bound mean and 95th percentile (P95) lead dietary exposure in adolescents in µg/kg b.w. per day.

Country	Survey	N	Mean			P95		
			LB	MB	UB	LB	MB	UB
Belgium	Diet_National_2004	584	0.47	0.54	0.61	0.97	1.12	1.33
Cyprus	Child health	303	0.28	0.34	0.40	0.49	0.58	0.67
Czech Republic	SISP04	298	0.70	0.79	0.89	1.21	1.36	1.51
Denmark	Danish Dietary Survey	479	0.57	0.66	0.75	0.95	1.08	1.20
Germany	National Nutrition Survey II	1,011	0.41	0.49	0.57	0.75	0.89	1.02
France	INCA2	973	0.38	0.44	0.51	0.69	0.79	0.90
Italy	INRAN SCAI 2005/06	247	0.49	0.59	0.68	0.96	1.09	1.26
Latvia	EFSA TEST	470	0.48	0.55	0.62	0.89	0.99	1.12
Spain	AESAN FIAB	86	0.35	0.44	0.52	0.61	0.71	0.84
Spain	enKid	209	0.46	0.55	0.65	0.80	0.95	1.12
Spain	NUT INK05	651	0.47	0.57	0.67	0.73	0.88	1.02
Sweden	NFA	1,018	0.53	0.62	0.71	0.87	1.01	1.13
Minimum			**0.28**	**0.34**	**0.40**	**0.49**	**0.58**	**0.67**
Median			**0.47**	**0.55**	**0.64**	**0.84**	**0.97**	**1.12**
Maximum			**0.70**	**0.79**	**0.89**	**1.21**	**1.36**	**1.51**

3.3.5. Adults

There were fifteen surveys available reporting food consumption for adults covering an overall 30,788 survey participants (Table 27). The middle bound lead dietary exposure varied for the mean between 0.40 and 0.59 µg/kg b.w. per day with a median of 0.50 µg/kg b.w. per day and the middle bound 95th percentile range between 0.65 and 0.99 µg/kg b.w. per day with a median of 0.83 µg/kg b.w. per day. The maximum upper bound 95th percentile lead dietary exposure in adults was estimated at 1.16 µg/kg b.w. per day.

Table 27: Lower (LB), middle (MB) and upper (UB) bound mean and 95th percentile (P95) lead dietary exposure in adults in µg/kg b.w. per day.

Country	Survey	N	Mean			P95		
			LB	MB	UB	LB	MB	UB
Belgium	Diet National 2004	1,304	0.44	0.51	0.58	0.79	0.92	1.04
Czech Republic	SISP04	1,666	0.51	0.58	0.65	0.84	0.96	1.09
Denmark	Danish Dietary Survey	2,822	0.50	0.58	0.65	0.79	0.90	1.02
Finland	FINDIET 2007	1,575	0.47	0.54	0.60	0.81	0.92	1.01
France	INCA2	2,276	0.39	0.46	0.53	0.70	0.79	0.89
Germany	National Nutrition Survey II	10,419	0.42	0.49	0.56	0.74	0.85	0.97
Hungary	National Repr Surv	1,074	0.34	0.40	0.46	0.56	0.65	0.74
Ireland	NSIFCS	958	0.43	0.52	0.61	0.71	0.90	1.05
Italy	INRAN SCAI 2005/06	2,313	0.38	0.45	0.53	0.71	0.81	0.91
Latvia	EFSA TEST	1,306	0.35	0.41	0.46	0.63	0.71	0.82
Netherlands	DNFCS 2003	750	0.49	0.57	0.65	0.83	0.99	1.16
Spain	AESAN	410	0.51	0.59	0.67	0.61	0.76	0.89
Spain	AESAN FIAB	981	0.35	0.44	0.53	0.57	0.70	0.84
Sweden	Riksmaten 1997/98	1,210	0.42	0.49	0.55	0.65	0.75	0.85
United Kingdom	NDNS	1,724	0.43	0.50	0.57	0.72	0.83	0.96
Minimum			**0.34**	**0.40**	**0.46**	**0.56**	**0.65**	**0.74**
Median			**0.43**	**0.50**	**0.57**	**0.71**	**0.83**	**0.96**
Maximum			**0.51**	**0.59**	**0.67**	**0.84**	**0.99**	**1.16**

3.3.6. Elderly

There were seven surveys available reporting food consumption for the elderly covering an overall 4,056 survey participants (Table 28). The middle bound lead dietary exposure varied for the mean between 0.38 and 0.56 µg/kg b.w. per day with a median of 0.49 µg/kg b.w. per day and the middle bound 95th percentile range between 0.56 and 0.90 µg/kg b.w. per day with a median of 0.81 µg/kg b.w. per day. The maximum upper bound 95th percentile lead dietary exposure in the elderly was estimated at 0.99 µg/kg b.w. per day.

Table 28: Lower (LB), middle (MB) and upper (UB) bound mean and 95th percentile (P95) lead dietary exposure in elderly in µg/kg b.w. per day.

Country	Survey	N	Mean			P95		
			LB	MB	UB	LB	MB	UB
Belgium	Diet National 2004	518	0.41	0.48	0.54	0.81	0.90	0.98
Germany	National Nutrition Survey II	2,006	0.48	0.56	0.63	0.74	0.86	0.99
Denmark	Danish Dietary Survey	309	0.44	0.49	0.54	0.78	0.83	0.95
Finland	FINDIET_2007	463	0.42	0.49	0.56	0.68	0.78	0.88
France	INCA2	264	0.42	0.49	0.55	0.72	0.81	0.91
Hungary	National Repr Surv	206	0.33	0.38	0.44	0.49	0.56	0.65
Italy	INRAN SCAI 2005/06	290	0.37	0.44	0.51	0.66	0.78	0.90
Minimum			**0.33**	**0.38**	**0.44**	**0.49**	**0.56**	**0.65**
Median			**0.42**	**0.49**	**0.54**	**0.72**	**0.81**	**0.91**
Maximum			**0.48**	**0.56**	**0.63**	**0.81**	**0.90**	**0.99**

3.3.7. Very elderly

There were six surveys available reporting food consumption for the very elderly covering an overall 1,614 survey participants (Table 29). The middle bound lead dietary exposure varied for the mean between 0.40 and 0.54 µg/kg b.w. per day with a median of 0.48 µg/kg b.w. per day and the middle bound 95th percentile range between 0.59 and 0.83 µg/kg b.w. per day with a median of 0.80 µg/kg b.w. per day. The maximum upper bound 95th percentile lead dietary exposure in the very elderly was estimated at 0.94 µg/kg b.w. per day.

Table 29: Lower (LB), middle (MB) and upper (UB) bound mean and 95th percentile (P95) cadmium exposure in the very elderly in µg/kg b.w. per day.

Country	Survey	N	Mean			P95		
			LB	MB	UB	LB	MB	UB
Belgium	Diet National 2004	712	0.39	0.46	0.52	0.66	0.76	0.85
Germany	National Nutrition Survey II	490	0.47	0.54	0.62			
Denmark	Danish Dietary Survey	20	0.41	0.48	0.55	0.64	0.80	0.91
France	INCA2	84	0.42	0.48	0.54	0.74	0.82	0.92
Hungary	National Repr Surv	80	0.34	0.40	0.45	0.51	0.59	0.69
Italy	INRAN SCAI 2005/06	228	0.40	0.47	0.54	0.72	0.83	0.94
Minimum			**0.34**	**0.40**	**0.45**	**0.51**	**0.59**	**0.69**
Median			**0.41**	**0.48**	**0.54**	**0.66**	**0.80**	**0.91**
Maximum			**0.47**	**0.54**	**0.62**	**0.74**	**0.83**	**0.94**

3.3.8. Summary of individual survey results

When considering health impact, attention should be given to dietary exposure reflecting consumption patterns in all European Union countries across all age groups. In summary, calculations of lead dietary exposure across countries and age groups varied between a lower bound minimum of 0.28 to an upper bound maximum of 1.77 µg/kg b.w. per day for individual survey mean estimates and a lower bound minimum of 0.49 to an upper bound maximum of 3.27 µg/kg b.w. per day for individual survey 95th percentile estimates.

3.4. Overall European population dietary exposure estimate

Despite the methodological differences between the food consumption surveys and, as an indication only, as a second step the results from the calculation of lead dietary exposure from the individual surveys were summarised by merging the respective survey results per age group, as shown in Table 30. By weighting results from the different age groups in the survey population according to the number of years included out of an average life span of 77 years[8], the average middle bound (lower bound and upper bound range in brackets) lead dietary exposure can be roughly estimated at about 0.68 (0.58-0.78) µg/kg b.w. per day over a lifetime, varying from a low of 0.47 (0.40-0.53) µg/kg b.w. per day for the very elderly to a high of 1.32 (1.10-1.54) µg/kg b.w. per day for toddlers.

Although speculative and potentially unrealistic, 95th percentile lifetime exposure was nevertheless calculated with the assumption that the same individuals retained high exposure through life. Using this assumption, 95th percentile middle bound lifetime exposure (lower bound and upper bound range in brackets) was estimated at 1.17 (1.02-1.33) µg/kg b.w. per day, varying between 0.79 (0.71-0.89) µg/kg b.w. per day for the very elderly to 2.28 (1.95-2.56) µg/kg b.w. per day for toddlers.

Table 30: Lower (LB), middle (MB) and upper (UB) bound mean and 95th percentile (P95) lead dietary exposure in µg/kg b.w. per day for each age groups and as a mean and 95th percentile average lifetime exposure calculated by weighting the contribution of each age group according to the number of years covered (different range of countries covered in the respective age group).

Age group	N	Mean			P95		
		LB	MB	UB	LB	MB	UB
Infants	876	0.73	0.91	1.09	1.39	1.80	2.22
Toddlers	1,597	1.10	1.32	1.54	1.95	2.28	2.56
Other children	8,468	0.87	1.03	1.18	1.46	1.68	1.92
Adolescents	6,329	0.46	0.55	0.63	0.84	0.97	1.11
Adults	30,788	0.43	0.50	0.57	0.74	0.85	0.97
Elderly	4,056	0.42	0.48	0.55	0.72	0.82	0.92
Very elderly	1,614	0.40	0.47	0.53	0.71	0.79	0.89
Adjusted average	**53,728**	**0.58**	**0.68**	**0.78**	**1.02**	**1.17**	**1.33**

3.5. Contribution of broad food categories to dietary exposure

The middle bound mean contribution of each of the FoodEx Level 1 food categories to lead exposure was calculated for the overall European population as shown in Figure 6. The mean occurrence for each food group at FoodEx level 3 was used to estimate exposure and aggregated to FoodEx level 1 without applying any weighting of sample numbers.

[8] The age groups represent 1 year for infants (1.3%), 2 years for toddlers (2.6%), 7 years for other children (9.1%), 8 years for adolescents (10.4%), 47 years for adults (61.0%), 10 years for the elderly (13.0%) and 2 years for the very elderly (2.6%).

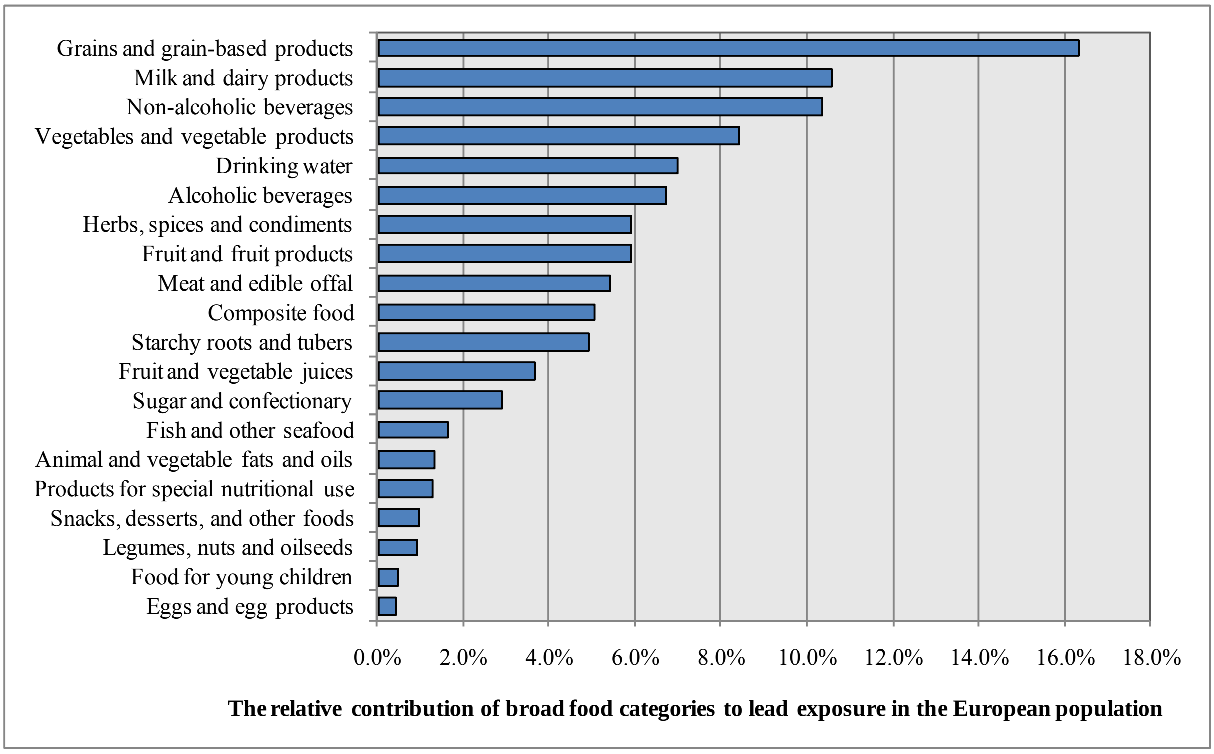

Figure 6: Contributions of twenty broad food categories to overall middle bound mean lead dietary exposure as averaged over the total population.

The highest contributors as averaged across all age groups for the middle bound results were “grains and grain-based products” at 16.3 % followed by “milk and dairy products” at 10.6 %, “non-alcoholic beverages” at 10.3 %, “vegetables and vegetable products” at 8.4 %, “drinking water” at 7.0 % and “alcoholic beverages” at 6.7 %. However, the exposure profile will vary with age group and location reflecting differences in eating patterns across Europe. Table 31 illustrates the range for the contribution to exposure of FoodEx level 1 food categories when estimating each age and survey group separately.

Table 31: Mean (survey range in brackets) of relative contributions in percent of twenty broad food categories to overall middle bound mean lead exposure across the food consumption surveys included for each age group (O-children= Other children).

Food categories	Mean food category contribution to exposure (survey range) (%)						
	Infants	Toddlers	O-children	Adolescents	Adults	Elderly	Very elderly
Grains and grain-based products	**9.0 %** (5.8-9.1)	**14.3 %** (9.1-19.4)	**17.3 %** (11.1-23.3)	**20.1 %** (15.8-23.1)	**15.9 %** (10.0-20.4)	**16.0 %** (11.6-20.7)	**15.9 %** (13.2-21.4)
Vegetables and vegetable products	**5.7 %** (5.7-5.8)	**7.9 %** (3.5-12.5)	**6.6 %** (3.1-19.6)	**7.2 %** (2.8-18.4)	**9.2 %** (2.6-36.6)	**8.4 %** (5.8-23.7)	**10.4 %** (5.2-20.0)
Starchy roots and tubers	**3.8%** (1.4-3.9)	**6.7 %** (2.9-10.4)	**5.3 %** (2.9-7.5)	**5.5 %** (1.4-8.3)	**4.3 %** (0.7-11.1)	**5.1 %** (3.5-8.0)	**6.3 %** (3.4-8.5)
Legumes, nuts and oilseeds	**0.6 %** (0.6-0.7)	**0.7 %** (0.2-2.7)	**0.8 %** (0.2-3.9)	**1.4 %** (0.3-4.3)	**1.0 %** (0.4-2.4)	**0.8 %** (0.4-2.5)	**0.7 %** (0.4-2.3)
Fruit and fruit products	**4.3 %** (4.3-7.0)	**7.1 %** (4.7-11.5)	**6.0 %** (3.8-10.5)	**4.9 %** (3.6-7.4)	**5.5 %** (2.9-8.2)	**8.0 %** (5.9-10.3)	**8.2 %** (5.8-9.9)
Meat and edible offal	**1.9 %** (0.8-2.0)	**4.5 %** (2.6-6.6)	**4.8 %** (2.9-7.9)	**6.1 %** (4.2-11.3)	**5.6 %** (3.4-9.4)	**5.4 %** (4.0-8.6)	**5.8 %** (3.9-7.3)
Fish and other seafood	**0.1 %** (0.1-0.6)	**0.8 %** (0.3-6.1)	**1.3 %** (0.5-5.0)	**2.0 %** (0.4-6.8)	**1.8 %** (0.6-8.7)	**1.7 %** (0.4-4.6)	**2.1 %** (0.4-3.3)
Milk and dairy products	**21.8 %** (21.5-38.4)	**20.0 %** (13.7-29.1)	**18.2 %** (6.5-26.9)	**10.7 %** (6.1-16.2)	**7.5 %** (4.4-13.9)	**7.8 %** (6.0-17.5)	**6.5 %** (6.1-10.5)
Eggs and egg products	**0.5 %** (0.1-0.5)	**0.4 %** (0.2-0.9)	**0.4 %** (0.0-1.0)	**0.3 %** (0.0-1.1)	**0.4 %** (0.1-1.1)	**0.4 %** (0.2-0.9)	**0.4 %** (0.2-0.9)
Sugar and confectionary	**1.3 %** (0.8-1.3)	**3.2 %** (0.8-8.5)	**4.9 %** (1.5-10.5)	**4.5 %** (2.1-8.6)	**2.3 %** (0.8-4.2)	**1.4 %** (1.1-2.1)	**1.5 %** (0.9-3.5)
Animal and vegetable fats and oils	**1.2 %** (1.2-1.5)	**1.6 %** (0.5-2.5)	**1.3 %** (0.4-2.8)	**1.2 %** (0.3-2.7)	**1.3 %** (0.4-3.1)	**1.3 %** (0.9-2.8)	**1.7 %** (1.1-3.1)
Fruit and vegetable juices	**3.5 %** (2.3-3.6)	**6.1 %** (2.0-15.6)	**6.4 %** (2.0-15.6)	**4.1 %** (1.9-8.4)	**2.9 %** (0.7-4.6)	**2.2 %** (0.5-3.1)	**1.4 %** (0.4-3.4)
Non-alcoholic beverages	**5.2 %** (2.9-5.2)	**2.7 %** (0.2-5.3)	**4.1 %** (1.0-15.5)	**6.6 %** (0.6-16.0)	**13.2 %** (0.5-21.6)	**15.1 %** (3.3-21.1)	**12.3 %** (3.4-22.2)
Alcoholic beverages	**0.0 %** (0.0)	**0.0 %** (0.0-0.1)	**0.1 %** (0.0-0.4)	**1.2 %** (0.0-3.8)	**10.2 %** (3.8-16.8)	**10.0 %** (2.2-15.7)	**8.3 %** (3.9-16.6)
Drinking water	**26.0 %** (6.2-26.4)	**12.5 %** (1.3-20.9)	**5.9 %** (0.0-12.3)	**6.6 %** (0.0-13.6)	**6.5 %** (0.3-13.1)	**5.6 %** (0.3-13.7)	**3.6 %** (0.2-8.2)
Herbs, spices and condiments	**1.4 %** (1.4-1.9)	**4.9 %** (1.4-9.8)	**6.4 %** (0.2-19.8)	**6.5 %** (0.3-21.2)	**6.3 %** (3.0-19.3)	**4.9 %** (2.9-12.6)	**3.5 %** (2.9-7.9)
Food for infants and small children	**12.2 %** (12.1-15.7)	**3.1 %** (0.7-14.2)	**0.3 %** (0.1-0.8)	**0.0 %** (0.0)	**0.0 %** (0.0)	**0.0 %** (0.0)	**0.0 %** (0.0)
Products for special nutritional use	**0.0 %** (0.0-0.8)	**0.0 %** (0.0-0.4)	**0.2 %** (0.0-0.9)	**2.0%** (0.0-15.9)	**1.6 %** (0.0-7.4)	**1.1 %** (0.1-3.6)	**2.2 %** (0.0-10.8)
Composite food	**0.4 %** (0.2-7.5)	**2.0 %** (0.3-13.8)	**8.1 %** (0.0-24.8)	**7.7 %** (0.1-19.7)	**3.9 %** (0.1-21.1)	**4.2 %** (0.1-12.5)	**8.8 %** (0.0-15.3)
Snacks, desserts, and other foods	**1.1 %** (0-1.1)	**1.5 %** (0.2-2.9)	**1.8 %** (0.7-3.5)	**1.4 %** (0.7-2.0)	**0.7 %** (0.1-1.2)	**0.4 %** (0.1-0.6)	**0.6 %** (0.1-0.7)

A considerable variation can be seen between age groups for the consumption of milk and dairy products, sugars and confectionary, fruit and vegetable juices, and snacks, desserts and composites foods which all contribute more in children (toddlers, other children and adolescents) than in adults, whereas non-alcoholic and alcoholic beverages contribute more in adults (adults, elderly and very elderly) than in the children age groups. Infants deviate from other age groups because of their different requirements. The range between surveys for the same age group reflects different consumption patterns, but could also be due to differences in survey methodology and the different range of countries covered for each age group.

3.6. The detailed influence of food groups to lead exposure

The contribution to dietary lead exposure was separately explored for each age group for foods at a more detailed level. The groupings of foods were arbitrary chosen in relation to the FoodEx levels keeping related foods together to provide an indication of potential risk management action, should this be desired.

3.6.1. Infants

Using food consumption information from the two only surveys of infants, the broad food categories estimated to contribute the most to exposure included "drinking water" followed by "milk and dairy products", "foods for infants and small children" and "grains and grain-based products". Twenty-seven detailed foods together contributed to 90 % of exposure with tap water (presumably used for infant formula preparation) and yoghurt at the top (Figure 7).

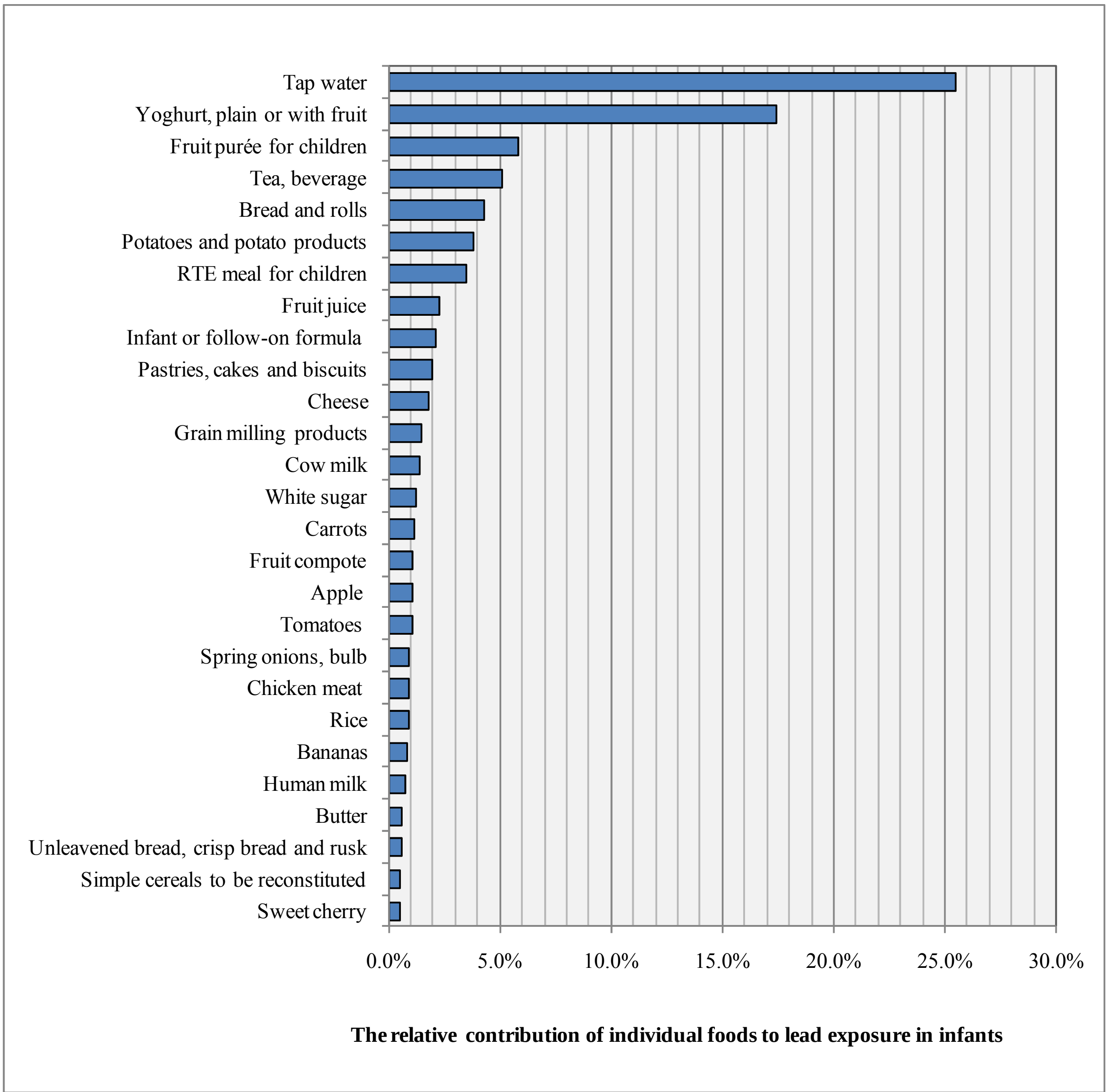

Figure 7: Major contributors to overall middle bound mean lead dietary exposure in infants at detailed food category level.

3.6.2. Toddlers

Using food consumption information from the nine surveys of toddlers, the broad food categories estimated to contribute the most to exposure included “milk and dairy products”, “grains and grain-based products” and “drinking water”. Twenty-nine detailed foods together contributed to 77 % of exposure with tap water, potatoes, yoghurt, bread and fruit juice at the top (Figure 8). Other foods than the 29 foods listed each contributed to less than 1 % of total exposure.

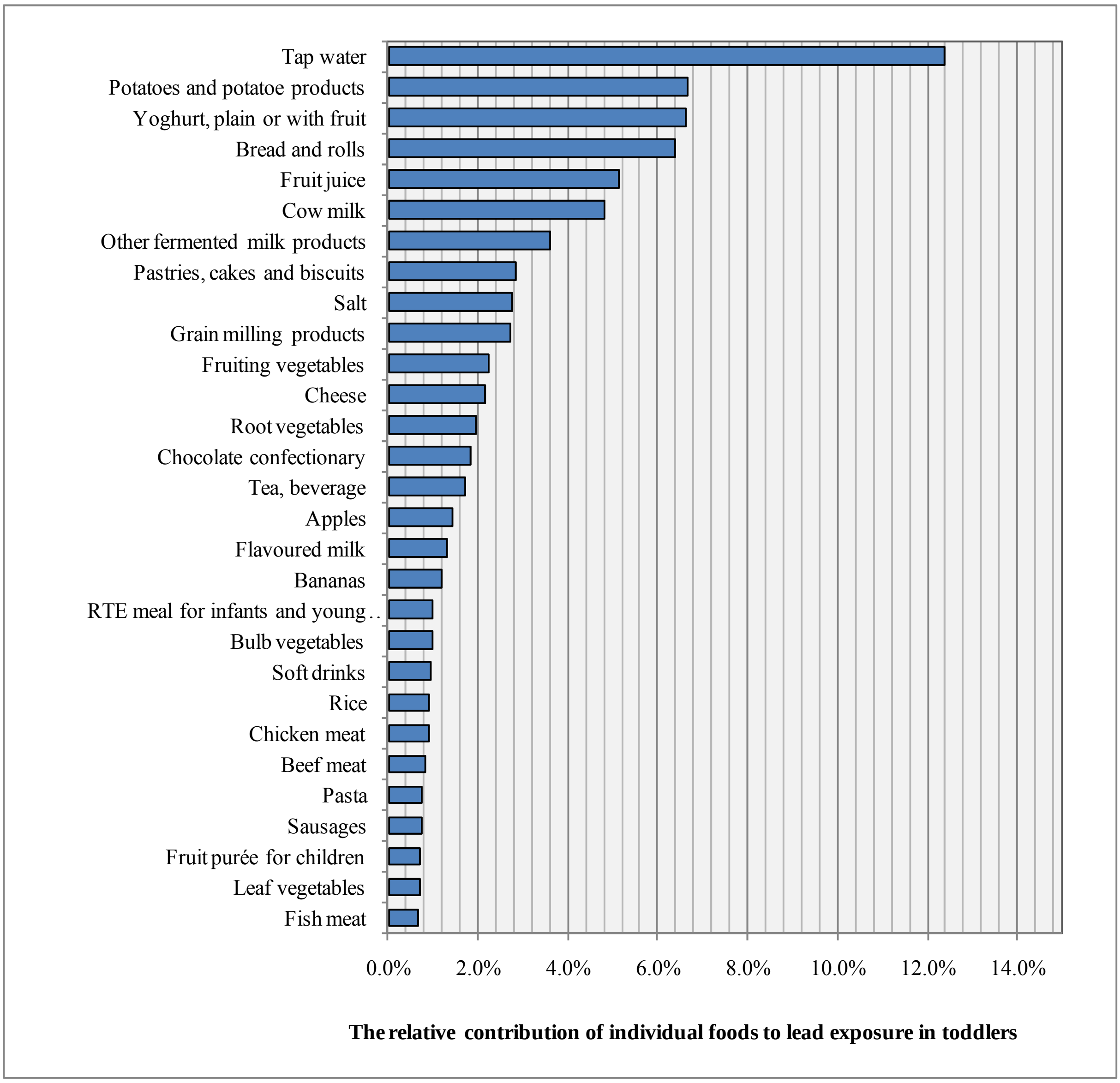

Figure 8: Major contributors to overall middle bound mean lead dietary exposure in toddlers at detailed food category level.

3.6.3. Other children

Using food consumption information from the seventeen surveys of other children, the broad food categories estimated to contribute the most to exposure included "milk and dairy products", "grains and grain-based products" and "composite foods". Thirty detailed foods together contributed to 75 % of exposure with bread, tap water, fruit juice, potatoes, pastries, cakes and biscuits, and milk at the top (Figure 9). Other foods than the 30 foods listed each contributed to less than 1 % of total exposure.

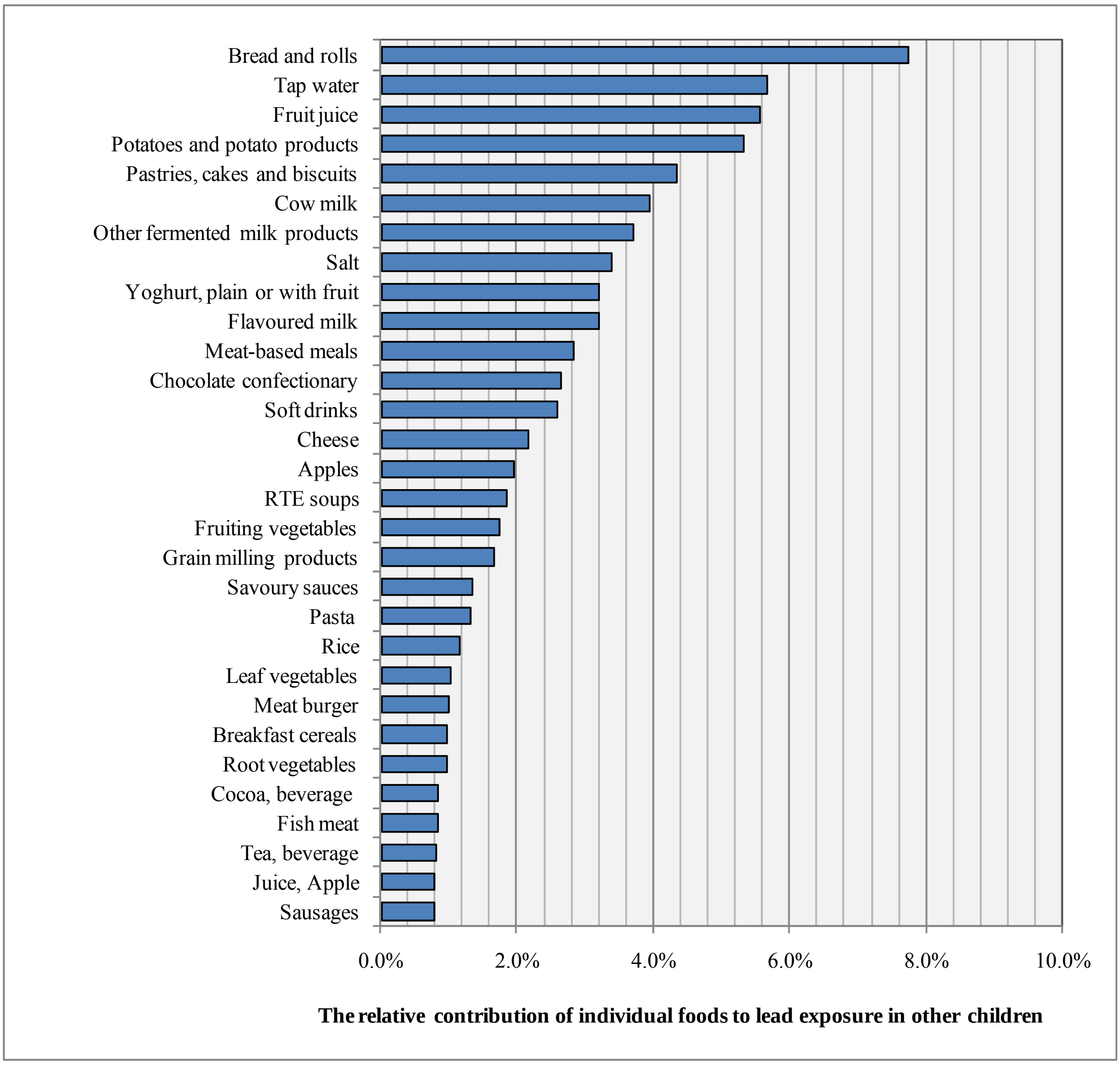

Figure 9: Major contributors to overall middle bound mean lead dietary exposure in other children at detailed food category level.

3.6.4. Adolescents

Using food consumption information from the twelve surveys of adolescents, the broad food categories estimated to contribute the most to exposure included "grains and grain-based products" "milk and dairy products", and "herbs, spices and condiments". Thirty detailed foods together contributed to 76 % of exposure with bread, tap water, potatoes, pastries, cakes and biscuits, fruit juice, and milk at the top (Figure 9). Other foods than the 30 foods listed each contributed to less than 1 % to total exposure.

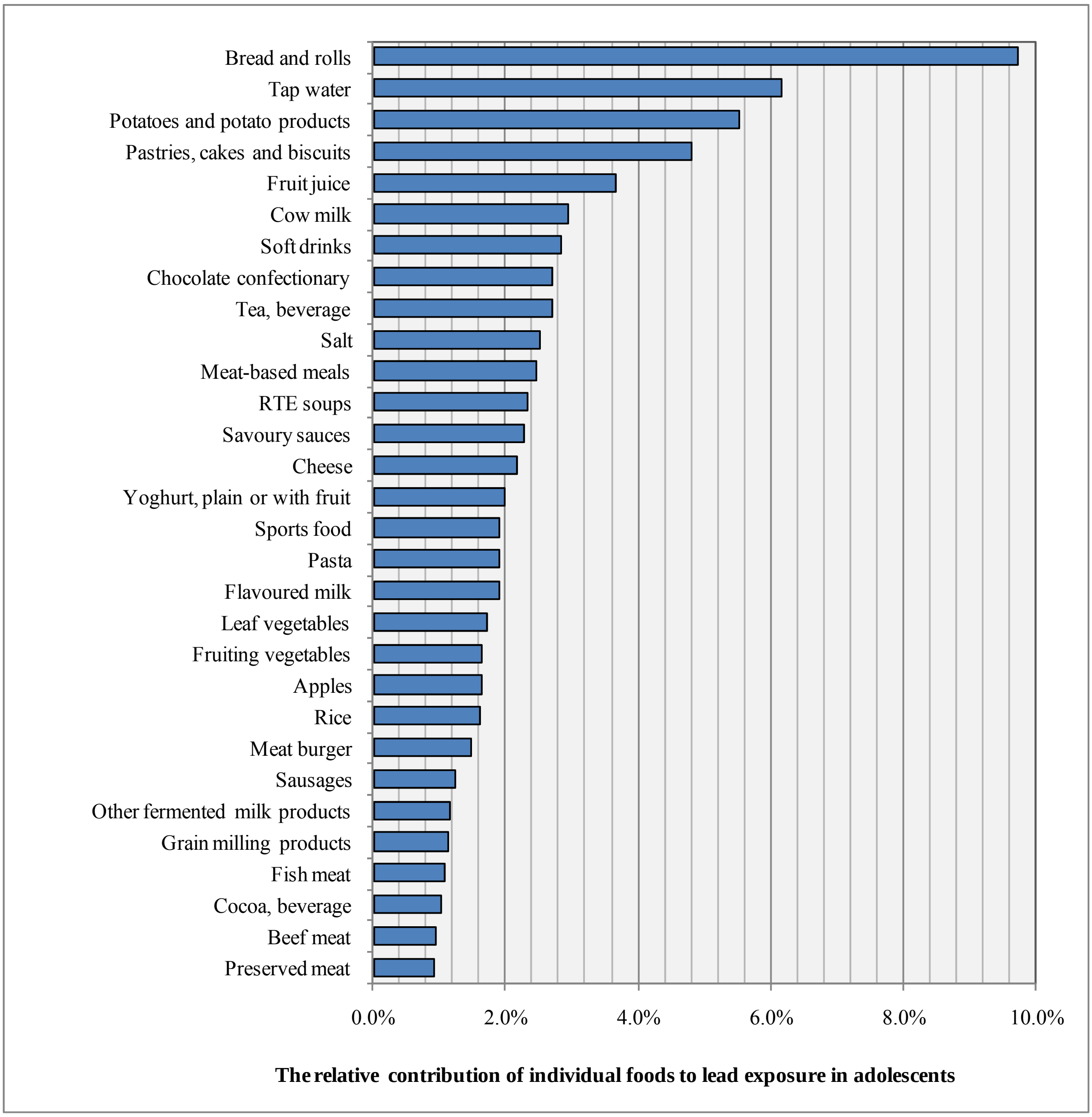

Figure 10: Major contributors to overall middle bound mean lead dietary exposure in adolescents at detailed food category level.

3.6.5. Adults

Using food consumption information from the fifteen surveys of adults, the broad food categories estimated to contribute the most to exposure included "grains and grain-based products" "non-alcoholic beverages", and "alcoholic beverages". Thirty detailed foods together contributed to 76 % of exposure with bread, beer, tea, tap water, potatoes, coffee, and wine at the top (Figure 11). Other foods than the 30 foods listed each contributed to less than 1 % of total exposure.

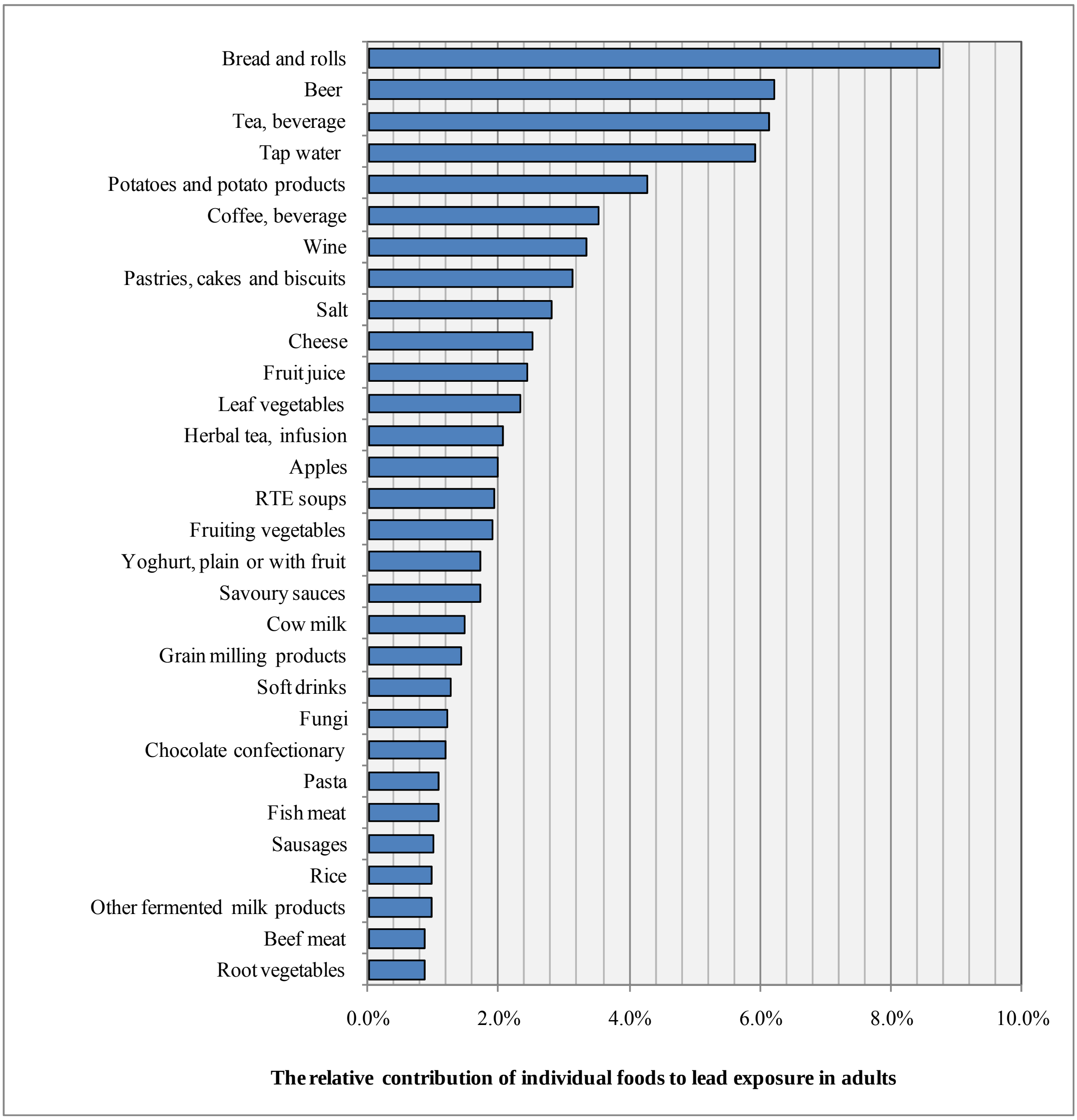

Figure 11: Major contributors to overall middle bound mean lead dietary exposure in adults at detailed food category level.

3.6.6. Elderly

Using food consumption information from the seven surveys of the elderly, the broad food categories estimated to contribute the most to exposure included “grains and grain-based products”, “non-alcoholic beverages”, and “alcoholic beverages” similar to the adult population groups. Thirty detailed foods together contributed to 80 % of exposure with bread, tea, beer, potatoes, tap water, coffee, and wine at the top (Figure 11). Other foods than the 30 foods listed each contributed to less than 1 % of total exposure.

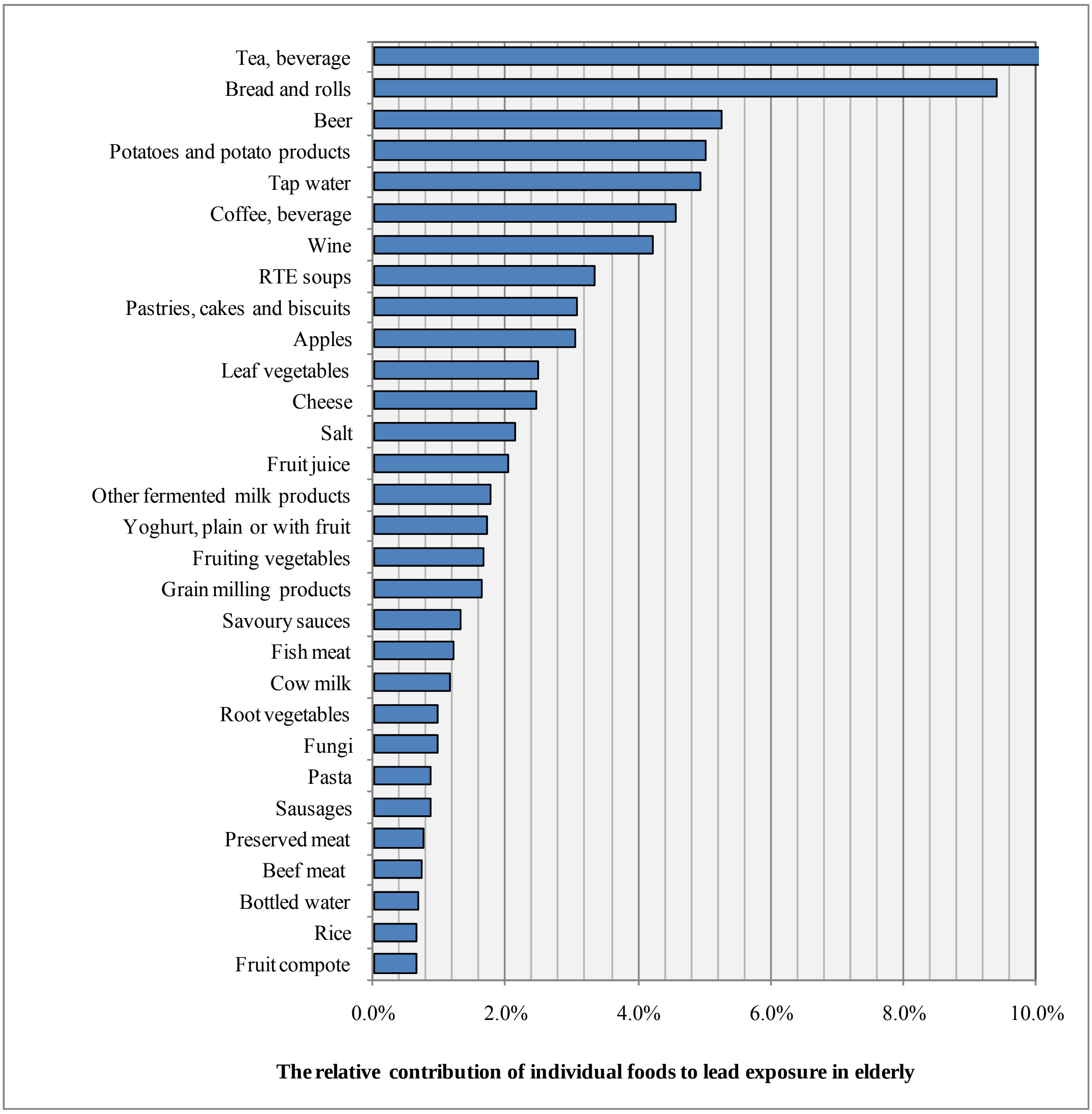

Figure 12: Major contributors to overall middle bound mean lead dietary exposure in the elderly at detailed food category level.

3.6.7. Very elderly

Using food consumption information from the six surveys of the very elderly, the broad food categories estimated to contribute the most to exposure included "grains and grain-based products" "non- alcoholic beverages", and "vegetables and vegetable products". Thirty detailed foods together contributed to 77 % of exposure with bread, ready-to-eat soup, potatoes, tea, wine, and coffee at the top (Figure 11). Other foods than the 30 foods listed each contributed to around 1 % or less to total exposure.

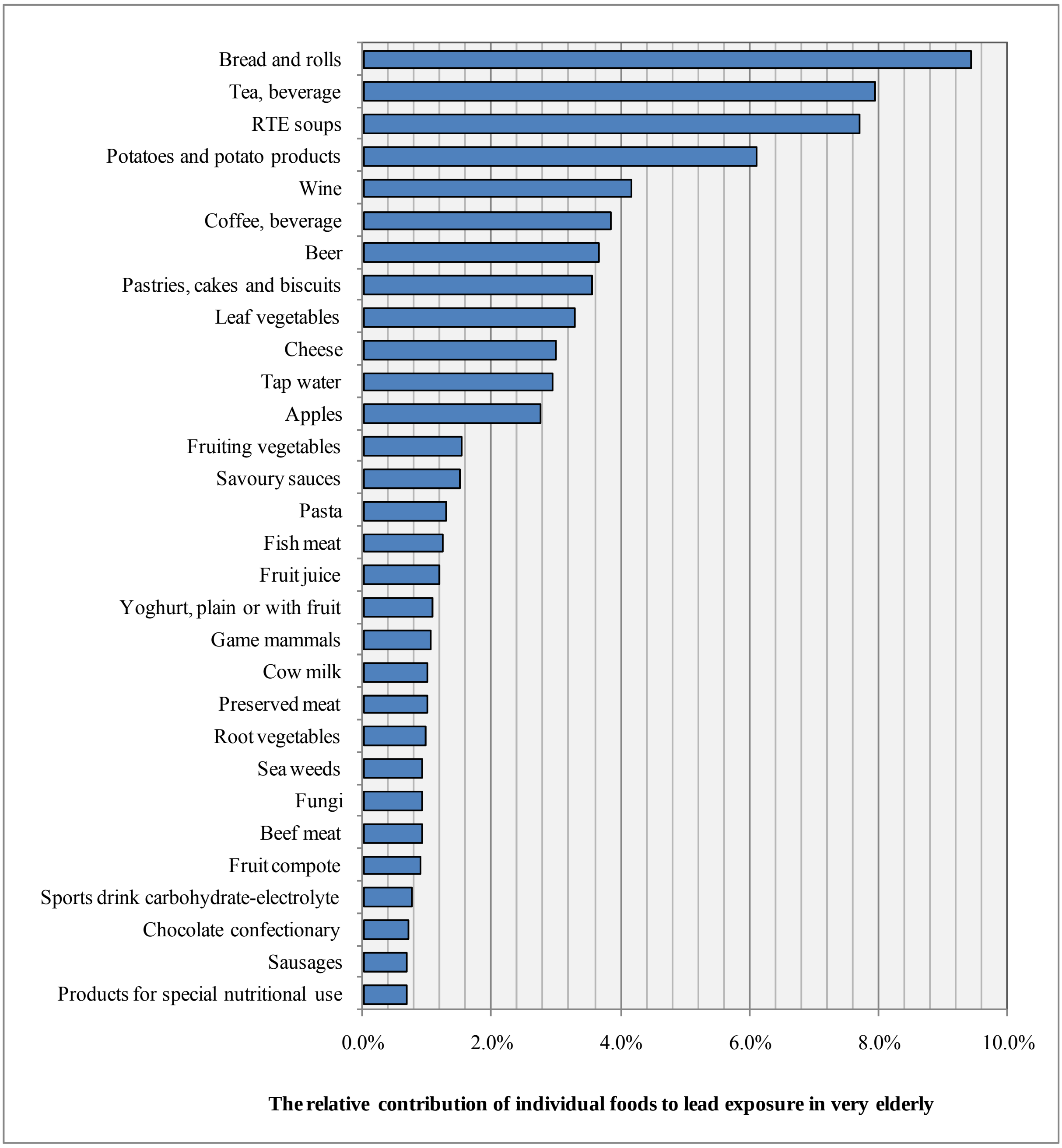

Figure 13: Major contributors to overall middle bound mean lead dietary exposure in the very elderly at detailed food category level.

3.6.8. Summary of food group contribution to exposure

There was some commonality in the foods contributing the most to lead dietary exposure across age groups. Bread and rolls ranked as the highest or second highest contributor in five of the seven age groups while tap water ranked as the highest or second highest in the four youngest age groups. Other liquids ranked among the five highest contributors included fruit juice, tea, beer and wine. Among the solid foods potatoes and pastries, cakes and biscuits ranked highly. In the vegetables category, root and fruiting vegetables dominated in the very young while leaf vegetables increased in importance with age.

4. Discussion

The 144,206 analytical results for lead in food retained in the current study were submitted by 20 countries, expanding the coverage of Europe compared to the 94,126 results from 15 countries retained for the calculations in the EFSA opinion published in 2010 (EFSA, 2010). This constituted an increase of 53 % in the number of reliable results available to EFSA for the period 2003 to 2011, of which 23,876 covered the period after 2008. However, a handful of countries still dominate the coverage of lead results providing a potential bias.

More than half of the foods tested showed lead levels at less than the limits of reporting (left-censored results). For a considerable number of those results rather high left-censoring limits were reported for some of the analytical method and matrix combinations used. To reduce their impact left-censored results linked to the LOQ rather than the LOD were halved resulting in a 4 % decrease in mean MB occurrence results. This is considered to be less conservative and closer to the true distribution since laboratories for ease of reporting often nominate only the LOQ as the left-censoring limit. This action was further justified by the definition of LOD and LOQ for food metal analysis in the European legislation, being about half of the calculated difference between the two in this study. There is still a considerable impact of left-censored results with the overall mean LB and UB exposure being 15 % lower and higher than mean MB exposure, respectively. The overall results, although lower than what was reported in the previous EFSA opinion, might thus still be overly conservative. The selected way of handling the left-censored data in this study was specific to the unique circumstances and would not be recommended as a future standard method.

Occurrence values varied widely between the 734 food categories covered individually in the detailed lead reporting. The mean MB lead level for the food categories at FoodEx level 3 calculated from their reported values varied between 0.3 µg/kg for follow-on formulae for infants to 4,300 µg/kg for dietetic products. Eighty-two food categories had mean lead levels exceeding 100 µg/kg. The highest individual sample maximum of 232,000 µg/kg was found in game meat, followed by 155,000 µg/kg in seaweed, 117,000 µg/kg in edible offal from game animals and 59,900 µg/kg in a dietary supplement. The overall median of the different category means across all 1,118 food categories with matching food consumption information, including also estimates through aggregation of food group mean results, was 21.4 µg/kg.

Including the new results lowered the overall sample mean by 10 %. The distribution of the lead levels reported differed between the two sampling occasions, as can be seen in Figure 14. The latest data collection included fewer very high values compared to the initial data collection, which can explain part of the decrease in the overall mean when including the new results.

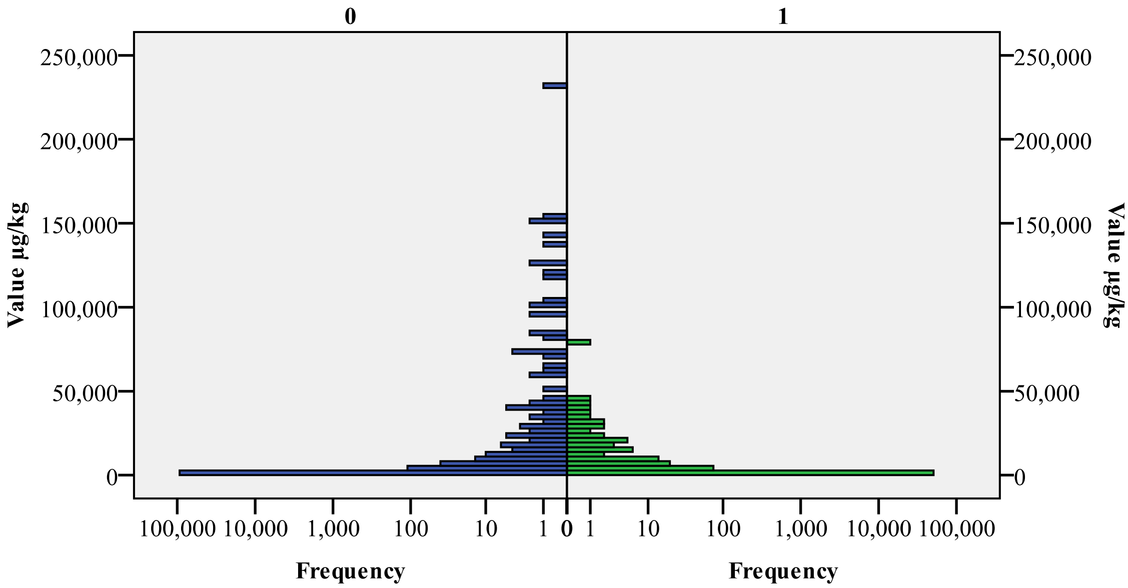

Figure 14: Distribution of lead occurrence values in all foods in the initial data submission in 2008 (0) and in the new data submission in 2011 (1).

An attempt was made to evaluate a potential trend in food lead levels over the nine years of data submitted to EFSA. Clearly, annual average lead occurrence results reported for food across Europe are influenced by the type of food tested and the inclusion of special investigations in a particular year. Nevertheless, excluding the sampling year 2011 with few results, an overall decrease in lead levels of 23 % was estimated for the 8-year period across all sample results. This is consistent with findings of decreasing dietary lead exposure in other surveys across the world (WHO, 2011). It is also consistent with decreases in European blood lead levels. For instance, the mean level of lead in children's blood in Germany has fallen by more than 50% over a longer 14-year period (ENHIS, 2009).

Using the more detailed and refined information now available through the FoodEx classification system and the Comprehensive Database for food consumption information, a more precise lead dietary exposure for all age groups could be estimated compared to the calculations published in the previous 2010 EFSA opinion. Mean lifetime exposure to lead was estimated to be 0.68 µg/kg b.w. per day at the middle bound in the overall European population given the assumptions used. Splitting this into the different age categories, toddlers were estimated to have the highest exposure at 1.32 µg/kg b.w. per day, followed by other children at 1.03 µg/kg b.w. per day and the two infant surveys ranging between 0.83 and 0.91 µg/kg b.w. per day. The adolescent to the very elderly age categories showed similar exposure varying between 0.47 to 0.55 µg/kg b.w. per day.

A comparison between the new exposure assessment and the results from the 2010 EFSA opinion for the adult population indicated a 31 % reduction. In the previous calculations, the adult survey median for MB mean lead dietary exposure was 0.75 µg/kg b.w. per day (not shown in the opinion), while it was estimated at 0.50 µg/kg b.w. per day in the current study. About half of the reduction in dietary exposure to lead might be attributable to the combined effect of the new sample data received covering a further three-year period of decreasing lead levels and the modified handling of reported left-censored results. The use of detailed individual consumption patterns and exclusion of surveys covering less than two days as well as a more accurate matching of occurrence and consumption data is believed to account for most of the remaining reduction. A similar reduction would be expected for the other age groups, although a direct comparison with the previous opinion is not possible because of a lack of detail in the latter.

Often it is not the food with the highest lead levels, but foods that are consumed in larger quantities that have the greatest impact on lead dietary exposure. This is typical for substances with a ubiquitous presence. The current study highlighted at the broad FoodEx level 1 grains and grain-based products (16.1 %), milk and dairy products (10.4 %), non-alcoholic beverages (10.2 %) and vegetables and vegetable products (8.4 %) as the major contributors to lead dietary exposure. In the grains and grain-based product category, wheat bread and rolls (6.0 %), pastries and cakes (2.8 %), mixed wheat and rye bread and rolls (1.7 %), wheat milling products (1.1 %) and rice (1.0 %) were the major contributors. In the milk and dairy products category, cow milk (2.1 %), fruit yoghurt (1.4 %), plain yoghurt (1.2 %) and flavoured milk (1.0 %) were the major contributors. In the non-alcoholic beverage category, black tea (2.6 %), herbal tea (1.8 %), coffee (1.6 %), soft drinks (0.7 %) and green tea (0.7 %) were the major contributors. In the vegetables and vegetable product category, leaf vegetables (2.0 %) in particular lettuce, fruiting vegetables (1.8 %) in particular tomatoes, and root vegetables (0.9 %) in particular carrots were the major contributors. The highest individual contributor at FoodEx level 3 was tap water (6.1 %) followed by wheat bread and rolls (3.7 %), regular beer (3.0 %), pastries and cakes (2.8 %), iodised salt (2.4 %) and boiled potatoes as the most common way of consuming potatoes (2.2 %).

Dietary lead exposure for all age groups is considerably lower than the previously established, but now invalidated, health-based guidance values. With an alternative approach, the 2010 EFSA opinion identified a 95th percentile lower confidence limit of the benchmark dose of 1 % extra risk ($BMDL_{01}$) of 0.50 µg/kg b.w. per day for developmental neurotoxicity in young children, which is lower than the estimated mean exposure. The 2010 EFSA opinion also lists cardiovascular effects and nephrotoxicity in adults as potential critical adverse health effects of lead with respective $BMDL_{01}$ and $BMDL_{10}$ of 1.50 and 0.63 µg/kg b.w. per day, which both are higher than the estimated mean exposure for adults.

In conclusion, it seems that lead dietary exposure in Europe is less than previously anticipated and that lead levels in food are decreasing. On the other hand, there is no threshold for the potential critical health effects of lead. It is considered important to confirm the seemingly decreasing lead levels in food by future testing. The standardised data collection system now in place for reporting of European analytical test results of chemicals in food to EFSA will facilitate a more accurate future trend analysis. It is suggested that the on-going work to collect harmonised occurrence and consumption data from across the European Union should continue with results pointing to the importance of using refined tools for calculating exposure.

5. Uncertainties

In Table 32, a summary of the uncertainty evaluation is presented, highlighting the main sources of uncertainty and indicating an estimate of whether the respective source of uncertainty might have led to an over- or underestimation of the exposure or of the calculated dietary exposure.

Table 32: Summary of qualitative evaluation of the impact of uncertainties on the dietary exposure to lead.

Sources of uncertainty	Direction [(a)]
Uncertainty of the analytical measurements	+/-
High left-censoring limits reported for some analytical method and matrix combinations	+
Sampling strategy: random/targeted	+
The majority of occurrence data on food provided by a limited number of countries	+/-
Use of UB occurrence data in the exposure estimations	+
Use of MB occurrence data in the exposure estimations	+/-
Use of LB occurrence data in the exposure estimations	-
Limited food consumption data on infants	+/-

(a): + = uncertainty with potential to cause over-estimation of exposure; - = uncertainty with potential to cause under-estimation of exposure

The vast majority of occurrence data were from a limited number of countries thus the occurrence data may not be fully representative for Europe. Data obtained on targeted samples collected in lead contaminated areas may lead to an overestimation of the exposure estimates. The use of the UB approach for the high percentage of left-censored occurrence data is conservative, i.e. it represents a clear overestimation of exposure. MB may over- or under-estimate the exposure. There was a lack of dietary surveys reporting consumption data for children younger than 1 year, which led to an uncertainty in this area.

When calculating lifetime exposure it was not possible to consider accumulation or excretion of lead in the organism over time, to take account of intra-individual variation of consumption habits during life, to adjust for global changes in consumption habits at the population level, or to allow for the expected reduction in global food contamination levels of lead due to legislative activities in many regions. In particular the 95th percentile lifetime exposure results are considered gross overestimations and should be taken as an indication only of an upper limit.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

- More than half of the individual food samples tested had levels of lead at less than detection or quantification limits, while individual quantified values ranged from a low of 0.001 µg/kg for a regular beer sample to a high of 232,000 µg/kg for a wild boar meat sample.

- The mean lead level in 82 out of 734 specific food categories exceeded 100 µg/kg including dietetic products, seaweed, mineral supplements, wild boar meat, thyme, boletus, ginger and iodised salt.

- Using detailed individual food consumption data, middle bound mean and 95th percentile lifetime dietary lead exposure for the European population was estimated at 0.68 and 1.17 µg/kg b.w. per day, respectively. It was highest in toddlers and lowest in the very elderly population group. Individual dietary survey results varied between a daily minimum lower bound mean of 0.28 µg/kg b.w. for adolescents to a maximum upper bound mean of 1.77 µg/kg b.w. for toddlers and a minimum lower bound 95th percentile of 0.49 µg/kg b.w. for adolescents and the elderly and a maximum upper bound 95th percentile of 3.27 µg/kg b.w. for toddlers reflecting different dietary habits and survey methodologies.

- Food consumed in larger quantities had the greatest impact on lead dietary exposure and this was true for the broad food categories of grains and grain products (16.1 %), milk and dairy products (10.4 %), non-alcoholic beverages (10.2) and vegetables and vegetable products (8.4 %). At a more detailed level tap water (6.0 %), wheat bread and rolls (3.7 %), regular beer (3.0 %), pastries and cakes (2.8 %), iodised salt (2.4 %) and potatoes most commonly consumed boiled (2.2 %) were important contributors to exposure.

- Dietary lead exposure was found to be about a third lower than previously estimated with mean levels for the four older age groups not exceeding the $BMDL_{01}$ and $BMDL_{10}$ of 1.50 and 0.63 µg/kg b.w. per day established for cardiovascular and nephrotoxicity effects in adults. However, mean exposure for the three children age groups exceeded the $BMDL_{01}$ of 0.50 µg/kg b.w. per day for developmental neurotoxicity in young children.

RECOMMENDATIONS

- It is considered important to confirm the seemingly decreasing lead levels in food by future testing. A standardised data collection system now in place for reporting of European analytical test results of chemicals in food to EFSA will facilitate a more accurate future trend analysis. As part of this system it is required to always report the LOD and LOQ of the analytical methods used and to clearly indicate whether sample results were below the detection or below the quantification limit.

- It is suggested that the on-going work to collect harmonised occurrence and consumption data from across the European Union should continue with results pointing to the importance of using refined tools for calculating exposure.

- For a few food categories rather high limits of detection and quantification were reported. To increase precision and accuracy in calculating exposure, it would be important to lower such limits as much as possible. WHO recommends that the LOQ for lead analysis of food should not exceed 10 µg/kg.

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GLOSSARY AND ABBREVIATIONS

b.w.	Body weight
Comprehensive Database	EFSA Comprehensive European Food Consumption Database
EFSA	European Food Safety Authority
EXPOCHI	Individual food consumption data and exposure assessment studies for children
FoodEx	Food classification system developed by EFSA for undertaking exposure assessments
JECFA	Joint FAO/WHO Expert Committee on Food Additives
LB	Lower bound - left-censored result entered as zero
LC	Left-censored result – results below the respective analytical limit
MB	Middle bound - left-censored result entered at half of the respective analytical limit
UB	Upper bound – left-censored result entered at the respective analytical limit
PTWI	Provisional Tolerable Weekly Intake