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and the Environment
Ministry of Health, Welfare and Sport

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RIVM Letter report 2017-0124
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Colophon

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Synopsis

The intake of contaminants via a diet according to the Dutch Wheel of Five Guidelines

Food can become contaminated with substances not intentionally added (contaminants). They can occur in plants through, for example, absorption from the (contaminated) soil or deposition from the air. Contaminants can also find their way in food during the production process and preparation of food. Contamination due to contaminants cannot always be prevented, but, in most cases, is of no public health concern. That is because the concentrations, on average, are low over time.

RIVM has calculated that the intake of the majority of 28 contaminants investigated is within an acceptable range when people eat and drink according to the Wheel of Five. This is not the case for three contaminants: acrylamide, arsenic and lead. That does not mean that it is certain that negative health effects will occur. It is just that they cannot be ruled out. Due to uncertainties in the calculation, no conclusion could be drawn for cadmium, aflatoxin B_1 and the sum of aflatoxins B_1, B_2, G_1 and G_2.

There are no recommendations possible within the Wheel of Five by which the intake of contaminants is sufficiently reduced and people can continue to eat a healthy diet. Therefore, it remains important to keep the concentrations of contaminants in food as low as possible. The current policy on contaminants in food focuses on this. The general advice to eat a varied diet also remains important for the lowest possible intake of contaminants.

The focus of the Wheel of Five is a healthy diet. This RIVM study examined whether the Wheel of Five also provides a safe diet regarding the intake of 28 contaminants. It also investigated whether recommendations for food choices are necessary and possible to improve food safety.

Keywords: Wheel of Five Guidelines, contaminants, food safety, intake calculations, risk assessment, adults, children

Publiekssamenvatting

De inname van contaminanten bij een voedingspatroon volgens de Richtlijnen Schijf van Vijf

Voedsel kan verontreinigd raken met chemische stoffen die er niet aan zijn toegevoegd (contaminanten). Dat kan bijvoorbeeld doordat gewassen deze stoffen opnemen via de (verontreinigde) grond of doordat ze via de lucht erin terechtkomen. Contaminanten kunnen ook tijdens het productproces en de bereiding van voedsel ontstaan. Verontreinigingen door contaminanten zijn niet altijd te voorkomen, maar vormen in de meeste gevallen geen probleem voor de volksgezondheid. Dat komt omdat de concentraties gemiddeld genomen in de tijd laag zijn.

Het RIVM heeft berekend dat de inname van het merendeel van 28 onderzochte contaminanten binnen de veilige marge ligt als mensen eten en drinken volgens de Schijf van Vijf. Voor drie contaminanten is dit niet het geval; dat betreft acrylamide, arseen en lood. Overigens betekent dit niet dat het zeker is dat hierdoor negatieve gezondheidseffecten zullen optreden. Ze kunnen alleen niet worden uitgesloten. Voor cadmium, aflatoxines B_1 en de som van aflatoxine B_1, B_2, G_1 en G_2 kon geen conclusie worden getrokken door onzekerheden in de berekening.

Binnen de Schijf van Vijf zijn er geen aanbevelingen mogelijk waarbij de inname van contaminanten voldoende wordt verlaagd en mensen toch gezond blijven eten. Het blijft daarom belangrijk om de concentraties van contaminanten in voedsel zo laag mogelijk te houden. Het huidige beleid op contaminanten in voedsel is daarop gericht. Ook het algemene advies om gevarieerd te eten blijft van belang voor een zo laag mogelijke inname van contaminanten.

Het belangrijkste uitgangspunt van de Schijf van Vijf is een gezond voedingspatroon. In deze RIVM-studie is onderzocht of de Schijf van Vijf ook een veilig voedingspatroon biedt wat de inname van 28 contaminanten betreft. Ook is onderzocht of aanbevelingen voor voedselkeuzes nodig en mogelijk zijn om de voedselveiligheid te vergroten.

Kernwoorden: richtlijnen Schijf van Vijf, contaminanten, voedselveiligheid, innameberekeningen, risicobeoordeling, volwassenen en kinderen

Contents

1 Introduction

The Health Council of the Netherlands (*Gezondheidsraad*) issued new Dutch dietary guidelines (*Richtlijnen goede voeding*) in 2015 (Health Council of the Netherlands, 2015). These guidelines are intended to prevent diet-related chronic diseases in the general population. In 2016, the Netherlands Nutrition Centre (*Voedingscentrum*) translated these guidelines into specific recommendations for various target groups based on age and gender in the Dutch population: the Wheel of Five Guidelines (*de Richtlijnen Schijf van Vijf*; Brink et al., 2016).

Food safety was not explicitly taken into account when drawing up the Dutch dietary guidelines 2015 (Health Council of the Netherlands, 2015). Although food safety is mentioned in the Wheel of Five Guidelines, the emphasis is on microbiological food safety: the prevention of foodborne infections from home cooking (Brink et al., 2016). With regard to chemical food safety – the presence of hazardous substances in food – the consumer often has fewer possibilities for action, because contamination is usually outside its sphere of influence. To address safety risks as a result of the presence of chemicals in food, the Wheel of Five Guidelines advise consumers to “minimise possible health detriments due to hazardous substances” by “varying within the different food groups in the Wheel of Five” (Brink et al., 2016). While the Wheel of Five Guidelines do not contain any information on the intake of hazardous substances via a diet according to these guidelines, they do contain information on the intake of energy and most nutrients.

The Ministry of Health, Welfare and Sport has therefore asked the National Institute for Public Health and the Environment (RIVM) to assess the Wheel of Five Guidelines for chemical food safety. As necessary, the results of this assessment can be used to incorporate recommendations in the guidelines to increase chemical food safety. Chemical food safety concerns, however, a wide variety of groups of chemicals that may be present in food, such as contaminants, food additives, residues of plant protection products and veterinary drugs. This report focuses on the intake of contaminants via a diet according to the Wheel of Five Guidelines. Contaminants are chemical substances that are not added to food by humans, but find their way into food through the environment (through absorption from the soil or deposition from the air) or during the production process. Based on current dietary patterns, possible risks to public health are more frequently calculated for contaminants than for substances added by humans during food production or processing, such as food additives, plant protection products and veterinary drugs (Mengelers et al., 2017). The use of the latter category of substances in food is legally regulated: these substances are only permitted for use in food if this does not constitute any risk to public health.

To assess the Wheel of Five Guidelines for chemical food safety with regard to the presence of contaminants, the intake of these substances was calculated for a diet according to these guidelines. The intake was calculated for the contaminants listed in Commission Regulation (EC)

Table 1. Contaminants for which the intake has been calculated for a diet according to the Wheel of Five Guidelines

Mycotoxins
Aflatoxin B_1
Sum of aflatoxins B_1, B_2, G_1 and G_2
Aflatoxin M_1
Citrinin
Deoxynivalenol (DON)
Sum of fumonisins B_1 and B_2
Ochratoxin A (OTA)
Patulin
Zearalenone
Ergot sclerotia and ergot alkaloids
Ergot sclerotia
Ergot alkaloids[a]
Natural plant toxins
Erucic acid
Tropane alkaloids[b]
Metals and other elements
Arsenic (inorganic)[c]
Cadmium
Mercury
Lead
Tin (inorganic)
Persistent organic pollutants
Sum of dioxins
Sum of dioxins and dioxin-like PCBs
Sum of non-dioxin-like PCBs
Process contaminants
3-MCPD
Acrylamide
Benzo(a)pyrene
Melamine
Sum of PAHs[d]
Other
Nitrate
Perchlorate

3-MCPD: 3-monochloropropane-1,2-diol; PAHs: polycyclic aromatic hydrocarbons; PCBs: polychlorinated biphenyls
[a] Sum of ergocristine/ergocristinine, ergotamine/ergotaminine, ergocryptine/ergocryptinine, ergometrine/ergometrinine, ergosine/ergosinine ergocornine/ergocorninine
[b] Atropine and scopolamine
[c] Sum of As(III) and As(V)
[d] Sum of benzo(a)pyrene, benz(a)antracene, benzo(b)fluoranthene and chrysene

No. 1881/2006. In addition, the website of the Netherlands Nutrition Centre refers to three contaminants that are not included in this regulation: acrylamide, perchlorate and pyrrolizidine alkaloids (PAs). For the first two contaminants, indicative values or action limits (section 2.2) and Dutch monitoring or survey data are available for calculation of intake. This did not apply sufficiently for the PAs. Therefore, the intake of these contaminants was not calculated in this study. See Table 1 for a summary of the contaminants for which the intake was calculated. The contaminants arsenic (inorganic) and tin (inorganic) are referred to as arsenic and tin, respectively, in the report.

2 Intake calculations

2.1 Diet according to the Wheel of Five Guidelines

The Wheel of Five Guidelines comprise 15 broad food groups with recommended consumption quantities broken down by eight age categories and gender, the so-called target groups (Brink et al., 2016) (Table 2). The age categories concerned are 1-3 years, 4-8 years, 9-13 years, 14-18 years, 19-30 years, 31-50 years, 51-69 years and 70+ years. The recommended consumption quantities for boys and girls in the age categories 1-3 years and 4-8 years are identical.

In order to calculate the intake of contaminants, consumption data at the level of the individual foods are required: concentrations of contaminants are available at food level. The broad recommendations per food group of the Wheel of Five Guidelines were therefore translated into consumption quantities per food. In order to make this translation, weighting factors were calculated on the basis of food consumption data from the Dutch National Food Consumption Surveys conducted among young children (2-6 years) in 2005-2006 (Ocké et al., 2008), persons aged 7-69 years in 2007-2011 (van Rossum et al., 2011) and independently living persons aged 70 and over in 2010-2012 (Ocké et al., 2013). For each food group of the Wheel of Five Guidelines, it was first determined which foods and quantities thereof are consumed in the current diet. Based on the quantities consumed, weighting factors were calculated in each food group for the foods that satisfy the criteria of the guidelines. The higher the consumption quantity of a food within a food group, the higher its weighting factor. The weighting factors within a food group add up to one. Based on these weighting factors and the recommended consumption quantities for each food group (Table 2), a consumption quantity for each food was calculated.

In view of the available food consumption data, the weighting factors for each relevant food were determined for four age groups: 2-6 years, 7-18 years, 19-69 years and 70+ years. The weighting factors for 2-6 years were used for the target groups 1-3 and 4-8 years, those for 7-18 years for the target groups 9-13 and 14-18 years, those for 19-69 years for the target groups 19-50 and 51-69 years and those for 70+ years were used for the corresponding target group. Table 3 illustrates the calculation of the consumption quantities for each relevant food for the food group ‘nuts and seeds’ for the target groups 1-3, 4-8 and 9-13 years.

The recommended consumption quantities in the Wheel of Five Guidelines represent approximately 85% of the energy requirements for each target group (Brink et al., 2016). The remaining 15% of the energy requirements can be obtained from foods covered or not covered by the guidelines. This ‘free space’ was not included in this analysis, because it is very difficult to quantify how this space is used.

Table 2. Recommended daily consumption quantities (grams per day) per food group and target group according to the Wheel of Five Guidelines (Brink et al., 2016)

Food group	Consumption quantities (grams per day) and target group (age (in years) and gender)													
	1-3 years	4-8 years	9-13 years		14-18 years		19-30 years		31-50 years		51-69 years		70+ years	
	B+G	B+G	B	G	B	G	M	W	M	W	M	W	M	W
Potatoes and tubers	53	88	158	140	210	158	158	158	158	158	140	123	140	105
Bread (excluding bread substitutes)	88	105	193	158	245	158	245	158	245	158	228	123	175	123
Eggs	11	18	18	18	18	18	18	18	18	18	18	18	18	18
Fruit	150	150	200	200	200	200	200	200	200	200	200	200	200	200
Grain/cereal products (not bread)	38	63	113	100	150	113	113	113	113	113	100	88	100	75
Vegetables	75	125	175	175	250	250	250	250	250	250	250	250	250	250
Cheese and cheese substitutes	0	20	40	20	40	40	40	40	40	40	40	40	40	40
Milk and dairy products	300	300	450	450	600	450	375	375	375	375	450	525	600	600
Non-alcoholic drinks	636	850	1100	900	1300	1000	1500	1100	1500	1100	1400	950	1300	900
Nuts and seeds	15	15	25	25	25	25	25	25	25	25	25	15	15	15
Legumes	4	12	17	17	19	19	19	19	19	19	19	19	19	19
Red meat	21	21	43	43	43	43	43	43	43	43	43	43	43	43
Spreading and cooking fats	30	30	45	40	55	40	65	40	65	40	65	40	55	35
Seafood	7	8	14	14	14	14	14	14	14	14	14	14	14	14
White meat and meat substitutes	14	14	29	29	29	29	29	29	29	29	29	29	29	29

B: boys; G: girls; M: men; W: women

Table 3. Weighting factors and consumption quantities for the foods of the Wheel of Five Guidelines food group 'nuts and seeds' for the target groups 1-3, 4-8 years and 9-13 years

Food	1-3 and 4-8 years		9-13 years	
	Weighting factor[a,b]	Consumption quantity (g per day)[c,d]	Weighting factor[a]	Consumption quantity (g per day)[c,e]
Almonds, peeled – unsalted	0.0282	0.42	0.0275	0.69
Brazil nuts – unsalted	0	0	0.0247	0.62
Cashew nuts – unsalted	0.1790	2.69	0.2540	6.35
Chestnuts	0.0873	1.31	0.0093	0.23
Hazelnuts – unsalted	0	0	0.0139	0.35
Macadamia nuts	0	0	0.0275	0.69
Mixed nuts – unsalted	0.3827	5.74	0.02821	0.71
Peanuts - dry roasted	0	0	0.0999	2.57
Peanuts – unsalted	0	0	0	0
Pecans – unsalted	0	0	0	0
Pine nuts	0.1095	1.64	0.0097	0.24
Trail mix (*studentenhaver*)	0.0630	0.95	0.0752	1.88
Walnuts – unsalted	0.0214	0.32	0.2171	5.43
Linseeds	0.0119	0.18	0.0415	1.04
Sesame seeds	0.0033	0.05	0.0167	0.42
Sunflower seeds	0.1136	1.70	0.1003	2.51
Pumpkin seeds	0	0	0.0821	2.05
Total	**1**	**15**	**1**	**25**

[a] Calculated based on consumption data according to the current diet (section 2.1)
[b] The target groups 1-3 and 4-8 years had the same weighting factors (section 2.1)
[c] Calculated by multiplying the weighting factor for each food by the recommended daily consumption quantity for the food group 'nuts and seeds'
[d] The target groups 1-3 and 4-8 years have the same recommended daily consumption quantity for the food group 'nuts and seeds' (Table 2)
[e] For the target group 9-13 years, the recommended daily consumption quantity for the food group 'nuts and seeds' is the same for boys and girls (Table 2)

In this report, the calculated consumption quantities for each food are referred to as a ‘diet according to the Wheel of Five Guidelines’. The procedure to derive consumption quantities per food based on recommended quantities of broad food groups was the same as used to optimise the Wheel of Five Guidelines regarding the intake of essential nutrients and energy (Geurts et al., 2016).

2.2 Tiered intake calculation

The intake of contaminants via a diet according to the Wheel of Five Guidelines was calculated based on a tiered approach (Figure 1). The intake was first calculated conservatively to determine if there is a potential health risk. If that could not be excluded, the intake was subsequently calculated in a more refined manner. This approach was chosen in order to make the most efficient use of the available time and resources.

In the first tier, the intake was calculated with maximum levels (MLs) as stated in Commission Regulation (EC) No. 1881/2006. This regulation does not contain any MLs for acrylamide and perchlorate. Therefore, the indicative values for acrylamide stated in Commission Recommendation 2013/647/EU were used. For perchlorate, the action limits as stated in a statement on 10 March 2015, updated on 23 June 2015, regarding the presence of perchlorate in food from the Standing Committee for Plants, Animals, Food and Feed (SCoPAFF), were used[1]. The indicative values for acrylamide and action limits for perchlorate are hereinafter referred to as ‘limit values’. The first tier is called the ‘ML scenario’ and was assumed to result in a conservative estimate of intake. This meant that a refined intake calculation (tier two) did not have to be performed when the intake calculated with this scenario resulted in a negligible health risk.

For contaminants for which a potential health risk could not be excluded (section 2.4) according to the ML scenario, the intake calculation was refined by replacing the MLs with Dutch monitoring or survey data (Figure 1). These data are hereinafter referred to as ‘measured concentrations’. If no measured concentrations were available for certain foods of a diet according to the Wheel of Five Guidelines, these were supplemented with measured concentrations as reported by the Scientific Panel on Contaminants in the Food Chain (CONTAM) of the European Food Safety Authority (EFSA). For contaminants for which no measured concentrations from the Netherlands were available at all, no refined calculation was performed.

For contaminants for which a health risk was negligible according to the ML scenario, it was verified, based on measured concentrations, whether the foods with an ML or limit value were those in which the contaminant can occur in daily life. If the contaminants were also found to occur in foods with no ML or limit value, it was determined whether these foods were part of a diet based on the Wheel of Five Guidelines. For contaminants that could be present in relevant foods without an ML or

[1] ec.europa.eu/food/safety/docs/cs_contaminants_catalogue_perchlorate_statement_food_update_en.pdf

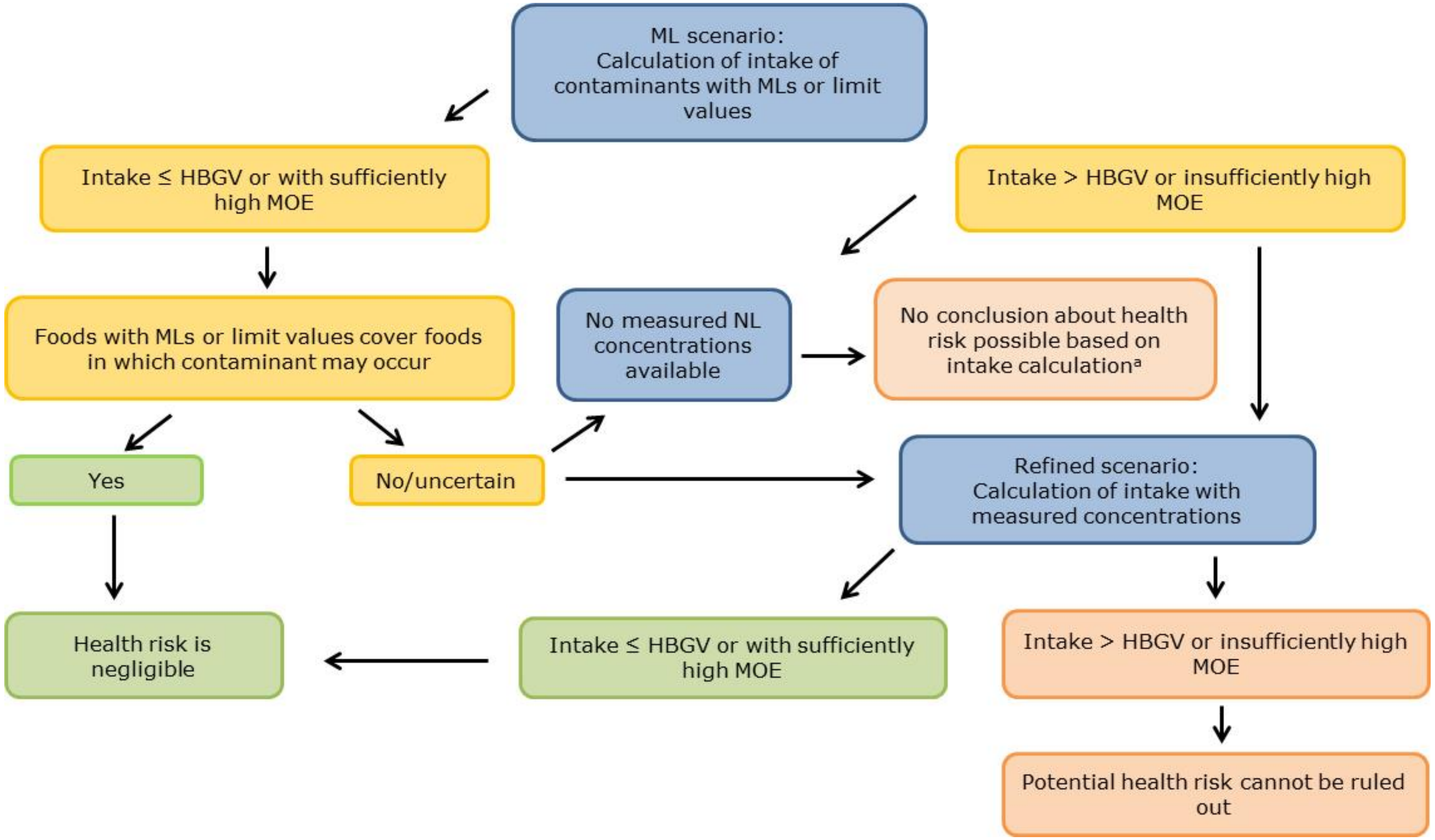

Figure 1. Tiered intake calculation of contaminants via a diet according to the Wheel of Five Guidelines. HBGV: health-based guidance value; ML: maximum level; MOE: margin of exposure (section 2.5). [a] *If no measured concentrations from the Netherlands were available for a refined intake calculation, a statement on potential health risks on the basis of an assessment by the European Food Safety Authority may be possible*

limit value, the ML scenario could not be considered conservative. Therefore, a refined intake calculation was also performed for those contaminants, provided that measured concentrations from the Netherlands, supplemented with data from the EFSA CONTAM Panel if necessary, were available (Figure 1). Measured concentrations from the Netherlands were also supplemented with these in the recent intake studies of lead and cadmium in the Netherlands for those foods for which Dutch measured concentrations were insufficiently available or lacking (Boon et al., 2017; Sprong & Boon et al., 2015).

2.3 Linking of MLs, limit values and measured concentrations

Food groups or the underlying foods of a diet according to the Wheel of Five Guidelines were linked to the most relevant MLs, limit values and measured concentrations for the calculation of the intake via the two intake scenarios (section 2.2). For example, the ML of lead in 'fats and oils, including milk fat' of 0.1 mg/kg was assigned to the whole food group 'spreading and cooking fats' of the Wheel of Five Guidelines, whereas the cadmium content measured in mussels was linked to the foods 'mussels – cooked' and 'mussels, glass – pickled'.

See Appendices 1 and 2 for a detailed description of the link for each contaminant for the ML and refined intake scenario, respectively.

2.4 Intake calculation

After linking, the intake of the contaminants was calculated for each target group by multiplying the consumed quantity of each food or food group (section 2.1) by the relevant concentration. The intake was then added up to calculate a total estimated intake per target group and divided by the average body weight (bw) for calculation of intake per kilogram (kg) bw. The body weights used for this are shown in Table 4 and are those used to optimise the Wheel of Five Guidelines regarding the intake of essential nutrients and energy (Geurts et al., 2016).

For the calculation of the refined intakes, average concentrations were calculated for each food or food group: in view of the concentrations in which contaminants occur in food, long-term intake is most relevant. In that case, the concentrations to which people are exposed via food are assumed to even out over time.

Table 4. Body weights (kg) used for each target group of the Wheel of Five Guidelines for the calculation of the intake of contaminants via a diet according to the Wheel of Five Guidelines, expressed per kg body weight

Age category (years)	Body weight (kg) and gender	
	Girls/women	Boys/men
1-3	12	13
4-8	22	22
9-13	39	36
14-18	57	64
19-30	64	77
31-50	64	77
51-69	64	77
70+	64	77

Measured concentrations are either reported as numerical concentrations or as concentrations below an analytical limit value, such as the limit of detection (LOD) or limit of quantification (LOQ), referred to as '< concentrations'. When calculating the average concentrations, these '< concentrations' were set at half the relevant limit value. Uncertainties in the estimated intakes because of this assumption have been quantified for a number of contaminants by also calculating the intake under the assumption that samples with a '< concentration' did not contain the contaminant (chapter 6).

2.5 Risk assessment

A risk assessment was performed in order to determine whether the calculated intakes of the contaminants via a diet according to the Wheel of Five Guidelines could result in a potential health risk. For this, the calculated intakes per target group were compared with a health-based guidance value (HBGV) or a margin of exposure (MOE) was calculated. For a number of contaminants, an intake covering all target groups, the so-called 'lifelong' intake, was calculated for comparison with the HBGV or calculation of the MOE. This was done by multiplying the intake per target group by the years of life in the target group, added together and then divided by the total number of life years. The 70+ target group was included in this calculation as 10 years of life. This brought the total years of life to 79. The 'lifelong' intake was calculated for aflatoxins (B_1 and the sum of B_1, B_2, G_1 and G_2) (chapter 6), sum of non-dioxin-like PCBs (section 3.2.2) and cadmium (section 4.1).

HBGVs are maximum intakes per unit of time, usually per day or week (such as the tolerable daily or weekly intake (TDI or TWI)). The calculated intake must be lower than the HBGV for a negligible health risk. MOEs are calculated by dividing lower limits of benchmark doses (BMDLs) by the calculated intake. BMDLs are doses in toxicity studies in which a percentage (e.g. 1%, 5% and 10%) increase in an adverse effect is observed. These BMDLs cannot be viewed as maximum acceptable intakes and are therefore evaluated via the calculation of an MOE. For a negligible health risk, the MOE must have a minimum value, which can vary between 1 and 10,000, depending on the nature of the critical endpoint on which the BMDL is based. For example, the MOE must be at least 10,000 compared to a $BMDL_{10}$ from an animal study for substances with a genotoxic and carcinogenic effect (EFSA, 2005a).

The HBGVs or BMDLs used in this report were derived by the EFSA CONTAM Panel or the predecessor of EFSA, the Scientific Committee on Food (SCF). If no HBGV has been derived by the EFSA CONTAM Panel or SCF, those of the Joint FAO/WHO Expert Committee on Food Additives (JECFA) were used. If JECFA has not derived a threshold value or BMDL either, other sources were sought.

For mercury, the MLs in Commission Regulation (EC) No. 1881/2006 concern seafood. Therefore, the HBGV for methylmercury was used for the risk assessment of the intake of mercury, because mercury mainly occurs as methylmercury in seafood (EFSA, 2012d). The rest of this report thus refers to the intake of methylmercury.

The HBGVs or BMDLs used all relate to health effects that can occur after long-term exposure. However, for a number of contaminants, HBGVs have also been derived for health effects that can occur within 24 hours after intake of the contaminant. These short-term effects are related to a high level of exposure on an arbitrary day. An example of such a short-term HBGV is the acute reference dose of 8 µg/kg bw per day for deoxynivalenol (DON) (JECFA, 2011b). The diet in accordance with the Wheel of Five Guidelines is however an average diet, offering the best food choices for a healthy dietary pattern over time. The consumption of large portions of foods on an arbitrary day, important when addressing short-term exposure, is not part of these guidelines. Short-term health effects have therefore not been included in this study.

3 Results

3.1 Health-based guidance values and BMDLs

Table 5 provides a summary of the HBGVs and BMDLs used in the risk assessment. Most come from the EFSA CONTAM Panel, followed by JECFA and SCF. Only for erucic acid, the HBGV from another authority, Food Standards Australia New Zealand (FSANZ), was used (FSANZ, 2003). For the sum of non-dioxin-like PCBs, a margin of body burden (MoBB) was derived by the RIVM based on information from the EFSA CONTAM Panel (2005b) and JECFA (2016), which was used as a HBGV in this study (Appendix 3). Table 5 lists also the minimum sizes of the MOEs for a negligible health risk. These minimum MOEs, 10 and 10,000, were derived by the EFSA CONTAM Panel (EFSA, 2010a) and the EFSA Scientific Committee (EFSA, 2005a), respectively.

The EFSA CONTAM Panel has derived various BMDLs for lead: for renal effects ($BMDL_{10}$ = 0.63 µg/kg bw per day), systolic blood pressure ($BMDL_{01}$ = 1.50 µg/kg bw per day) and neurological development ($BMDL_{01}$ = 0.5 and 0.54 µg/kg bw per day) (Table 5). Effects on neurological development are relevant for children up to and including 7 years of age and for the foetus. For effects on neurological development of the foetus, a $BMDL_{01}$ of 0.54 µg/kg bw per day was derived for women of childbearing age. The EFSA CONTAM Panel has calculated that a lead intake of 0.54 µg/kg bw per day by the mother results in foetal blood lead levels comparable to those in 7-year-olds at which a 1-point decrease in IQ has been calculated (EFSA, 2010a). This $BMDL_{01}$ was used to review the lead intake for the target groups women aged 19-30 and 31-50 years[2]. The lead intake of the target groups 1-3 and 4-8 years (including 8-year-olds) was compared to the $BMDL_{01}$ of 0.5 µg/kg bw per day. Effects of lead on the kidneys and systolic blood pressure are relevant for adults from 18 years of age (EFSA, 2010a). These BMDLs were therefore used to review the lead intake for the target groups women aged 51-69 and 70+ years and men over 18 years. The lead intake of the target groups women aged 19-30 and 31-50 years was not assessed for these two effects, because effects on neurological development are the most sensitive effects for these target groups. The lead intake for the target groups 9-13 and 14-18 years was not reviewed due to lack of a relevant BMDL.

Table 5 does not contain HBGVs or BMDLs for contaminants with a zero intake in the ML scenario and where the MLs also sufficiently covered the foods in which the contaminants may occur (section 2.2; Figure 1).

[2] The Wheel of Five Guidelines also contain recommended consumption quantities per food group for pregnant women. However, for lead, the long-term intake is more important than the intake during the 9 months of pregnancy. Therefore, the intake of lead for this target group was calculated with the recommended consumption quantities for the target groups women aged 19-30 and 31-50 years.

Table 5. Health-based guidance values and BMDLs of various contaminants[a], including the minimum margin of exposure (MOE) for a negligible health risk, if relevant

Contaminant	Type	Value	Unit	Minimum MOE[b]	Source
3-MCPD	TDI	0.8	µg/kg bw per day	-	EFSA, 2016b
Acrylamide	$BMDL_{10}$	0.17	mg/kg bw per day	10,000	EFSA, 2015
Aflatoxin B_1	$BMDL_{10}$	170	ng/kg bw per day	10,000	EFSA, 2007
Sum of aflatoxins B_1, B_2, G_1 and G_2					
Aflatoxin M_1	$BMDL_{10}$	1700[c]			
Arsenic[d]	$BMDL_{0.5}$	3[e]	µg/kg bw per day	Not specified[f]	JECFA, 2011b
Benzo(a)pyrene	$BMDL_{10}$	0.07	mg/kg bw per day	10,000	EFSA, 2008b
Cadmium	PTWI	2.5	µg/kg bw per week	-	EFSA, 2009b
Citrinin	Level of no concern	0.2	µg/kg bw per day	-	EFSA, 2012e
Deoxynivalenol (DON)	TDI[g]	1	µg/kg bw per day	-	JECFA, 2011b
Sum of dioxins	TWI	14	pg WHO TEQ[h]/kg bw per week	-	SCF, 2001
Sum of dioxins and dioxin-like PCBs				-	
Ergot alkaloids	TDI	0.6	µg/kg bw per day	-	EFSA, 2012c
Erucic acid	PTDI	500	mg/kg bw per day	-	FSANZ, 2003
Sum of fumonisins B_1 and B_2	PMTDI	2	µg/kg bw per day	-	JECFA, 2011a, 2017; SCF, 2003
Lead	$BMDL_{01}$[c]	0.5[i], 0.54[j] and 1.5[k]	µg/kg bw per day	10	EFSA, 2010a
	$BMDL_{10}$	0.63[k]	µg/kg bw per day		
Melamine	TDI	0.2	mg/kg bw per day	-	EFSA, 2010b
Methylmercury	TWI	1.3[l]	µg/kg bw per week	-	EFSA, 2012d
Sum of non-dioxin-like PCBs	MoBB	25	Dimensionless	-	Appendix 3
Nitrate	ADI	3.7	mg/kg bw per day	-	EFSA, 2008a
Ochratoxin A (OTA)	TWI	120	ng/kg bw per week	-	EFSA, 2006
Sum of PAHs	$BMDL_{10}$	0.34	mg/kg bw per day	10,000	EFSA, 2008b
Perchlorate	TDI	0.3	µg/kg bw per day	-	EFSA, 2014b
Tin[d]	PTWI	14	mg/kg bw per week	-	JECFA, 2001
Zearalenone	TDI	0.25	µg/kg bw per day	-	EFSA, 2011

3-MCPD: 3-monochloropropane-1,2-diol; ADI: acceptable daily intake; BMDL: lower limit of the benchmark dose; $BMDL_{01}$: lower limit of the 95% confidence interval of the estimated dose with a 1% additional risk; $BMDL_{10}$: lower limit of the 95% confidence interval of the estimated dose with a

10% additional risk; MoBB: Margin of Body Burden; PAHs: polycyclic aromatic hydrocarbons; PCBs: polychlorinated biphenyls; PMTDI: provisional maximum tolerable daily intake; PTDI: provisional tolerable daily intake; PTWI: provisional tolerable weekly intake; TDI: tolerable daily intake; TEQ: toxic equivalent; TWI: tolerable weekly intake; WHO: World Health Organization

[a] For the contaminants with an intake of zero in the ML scenario and where the foods with MLs sufficiently cover the foods in which the contaminant may occur (Figure 1), the intakes were not reviewed relative to a health-based guidance value or BMDL (patulin, ergot sclerotia and tropane alkaloids).

[b] Contaminants for which an MOE was calculated and the minimum value of the MOE for a negligible health risk

[c] Based on the $BMDL_{10}$ for aflatoxin B_1 and a 10% potency of aflatoxin M_1 compared to aflatoxin B_1 (JECFA, 2002)

[d] Concerns the inorganic form

[e] For arsenic, the EFSA CONTAM Panel (EFSA, 2009a) and JECFA (2011b) both derived BMDLs for the induction of lung tumours and urinary tract tumours. Because JEFCA's $BMDL_{0.5}$ of 3 µg/kg bw per day is based on studies with a relatively long follow-up and large study population, this $BMDL_{0.5}$ was used for the risk assessment.

[f] The EFSA CONTAM Panel (EFSA, 2009a) and JECFA (2011b) do not indicate how large the MOE has to be for a negligible health risk for the intake of arsenic. Assuming intakes close to the BMDL, the EFSA CONTAM Panel concluded "Therefore, there is little or no MOE and the possibility of a risk to some consumers cannot be excluded."

[g] Concerns a group TDI, which applies to the sum of deoxynivalenol (DON) and its acetylated derivatives (3-Ac-DON and 15-Ac-DON)

[h] This is the unit used to express the sum of dioxins and the sum of dioxins and dioxin-like PCBs (van den Berg et al., 2006)

[i] The $BMDL_{01}$ of 0.50 µg/kg bw per day is relevant for children up to and including 7 years of age (EFSA, 2010a)

[j] The $BMDL_{01}$ of 0.54 µg/kg bw per day is relevant for the foetus via the lead intake by the mother (EFSA, 2010a)

[k] The $BMDL_{10}$ of 0.63 µg/kg bw per day and the $BMDL_{01}$ of 1.5 µg/kg bw per day are relevant for men and women from 18 years of age (EFSA, 2010a)

[l] See section 2.5

3.2 Intake of contaminants according to the ML scenario

3.2.1 Calculated intake

The calculated intakes of contaminants according to the ML scenario are listed in Appendices 4 and 5. For seven contaminants, the intake was zero in all target groups: patulin, citrinin, ergot sclerotia, ergot alkaloids, tropane alkaloids, 3-MCPD and melamine. The reason for this was the absence of MLs for foods within a diet based on the Wheel of Five Guidelines.

3.2.2 Comparison with HBGV or calculation of MOE

Contaminants with an intake lower than the HBGV or sufficiently high MOE

For the following contaminants, the estimated intake in the ML scenario was lower than the HBGV (Appendix 4) or resulted in a sufficiently high MOE (Appendix 5):

- Benzo(a)pyrene
- Sum of dioxins
- Sum of dioxins and dioxin-like PCBs
- Erucic acid
- Sum of fumonisins B_1 and B_2
- Nitrate
- Ochratoxin A (OTA)
- Sum of PAHs
- Tin
- Zearalenone

For these contaminants, as well as the contaminants for which the intake was zero due to the absence of relevant MLs (section 3.2.1), it was investigated whether the ML scenario indeed resulted in a conservative intake estimate (section 2.2; Figure 1). This analysis showed that, for eight contaminants, the foods in which these contaminants can occur were sufficiently covered by the foods with an ML. Thus, for these contaminants, the intake according to the ML scenario was sufficiently conservative: sum of dioxins, sum of dioxins and dioxin-like PCBs, ergot sclerotia, erucic acid, patulin, tin, tropane alkaloids and zearalenone (Table 6).

For the other nine contaminants, the foods in which they can occur were unlikely to be sufficiently covered by the foods with an ML. An example of this was 3-MCPD. In the ML scenario the intake of 3-MCPD was zero. For this substance, MLs are only available for hydrolysed vegetable proteins and soy sauce; foods that do not occur in a diet based on the Wheel of Five Guidelines. However, 3-MCPD can occur in high concentrations in ester form in vegetable oils, particularly palm oil, and in products containing these oils, such as margarine and low-fat margarine. In the gastrointestinal tract, 3-MCPD is completely released from its ester and then has the same toxic effect as in its free form (EFSA, 2016b). In a recent RIVM report (Boon & te Biesebeek, 2016) and an opinion of the EFSA CONTAM Panel (EFSA, 2016b), the intake of 3-MCPD and 3-MCPD esters in the Netherlands and Europe, respectively, was close to the HBGV. In view of this finding, and because the consumption of margarine and low-fat margarine is part of a diet based

Table 6. Comparison of foods with a maximum level (ML) in Commission Regulation 1881/2006 and foods with monitoring and survey data for contaminants with a calculated intake below the health-based guidance value or sufficiently high margin of exposure in the ML scenario

Contaminant	Dutch		Monitoring data from EFSA[b]	Sufficient coverage for foods with ML[c]	Refined intake calculation
	Monitoring data[a,b]	Survey data[b]			
3-MCPD	-	+[d]	+[e]	No	Yes
Benzo(a)pyrene	-	-	+[f]	No	No
Citrinin	+	+[g]	-	No	Yes
Sum of dioxins	+	-	+[h]	Yes	No
Sum of dioxins and dioxin-like PCBs	+	-	+[h]	Yes	No
Ergot alkaloids	-	+[g]	-/+[i]	No	Yes
Ergot sclerotia	-	-	-[i]	Yes	No
Erucic acid	-	-	-	Yes[m]	No
Sum of fumonisins B_1 and B_2	+	+[g]	-	No	Yes
Melamine	-	-	+[j]	No	No
Nitrate	+	-	+[k]	No	Yes
Ochratoxin A (OTA)	-	+[g]	-	No	Yes
Sum of PAHs	-	-	+[f]	No	No
Patulin	+	+[g]	-	Yes	No
Tin[n]	-/+	-	-	Yes	No
Tropane alkaloids	-	+[g]	-	Yes	No
Zearalenone	+	+[g]	+[l]	Yes	No

3-MCPD: 3-monochloropropane-1,2-diol; EFSA: European Food Safety Authority; KAP: Quality Programme for Agricultural Products; PAHs: polycyclic aromatic hydrocarbons; PCBs: polychlorinated biphenyls

[a] Present in KAP database (section 3.3.1)
[b] -: not available; +: available; -/+: limited availability
[c] Concerns foods of a diet according to the Wheel of Five Guidelines
[d] Boon & te Biesebeek, 2016;
[e] EFSA, 2016b
[f] EFSA, 2008b
[g] López et al., 2016; Sprong et al., 2016a
[h] EFSA, 2012f
[i] EFSA, 2012c
[j] EFSA, 2010b
[k] EFSA, 2010c
[l] EFSA, 2011
[m] Based on a report of the Food Standards Australia New Zealand on the presence of erucic acid in food (FSANZ, 2003)
[n] Concerns the inorganic form

on the Wheel of Five Guidelines, 3-MCPD was also included in the refined scenario. Based on a similar analysis, the intakes were also calculated for citrinin, ergot alkaloids, sum of fumonisins B_1 and B_2, nitrate and ochratoxin A (OTA) according to the refined scenario (Table 6).

No refined intake was calculated for benzo(a)pyrene, melamine and sum of PAHs due to lack of measured concentrations from the Netherlands (section 2.2; Table 6).

Contaminants with an intake higher than the HBGV or an insufficiently high MOE
For the following contaminants, the estimated intake in the ML scenario was higher than the HBGV (Appendix 4) or resulted in an insufficiently high MOE (Appendix 5):

- Acrylamide
- Aflatoxin B_1
- Sum of aflatoxins B_1, B_2, G_1 and G_2
- Aflatoxin M_1
- Cadmium
- Deoxynivalenol (DON)
- Lead
- Methylmercury
- Sum of non-dioxin-like PCBs
- Perchlorate

A refined intake calculation (Figure 1) was performed for these contaminants, with the exception of the sum of non-dioxin-like PCBs. For this group of contaminants, only the youngest target group of 1-3 years had an intake with an MoBB lower than the minimum MoBB of 25, which is not associated with a health risk (Table 5; Appendix 3): 16-18 (Appendix 4). Non-dioxin-like PCBs cause liver and thyroid toxicity after a longer period of exposure. A temporary increase in intake up to and including age 3 does not necessarily have to be detrimental. A ‘lifelong’ intake of this group of substances was therefore calculated (section 2.5) resulting in an MoBB of 35, which exceeded the minimum value of 25. Therefore, the health risk for this group of substances was estimated to be negligible, and no refined intake assessment was performed.

The intake of arsenic resulted in MOEs varying from 9 to 22 in the ML scenario (Appendix 5). Because the possibility of the calculated MOEs resulting in a potential health risk could not be ruled out, a refined intake calculation was also performed for arsenic.

Summary
The result of the ML scenario is summarised in Table 7. For eight contaminants, the intake via a diet according to the Wheel of Five Guidelines resulted in a negligible health risk. For the remaining contaminants, this could not be determined with the ML scenario. For these contaminants, the intake calculation was refined with measured concentrations, with the exception of three contaminants for which no measured concentrations from the Netherlands were available.

Table 7. Result of the ML scenario

Contaminants
Negligible health risk
Ergot sclerotia
Erucic acid
Patulin
Sum of dioxins
Sum of dioxins and dioxin-like PCBs
Sum of non-dioxin-like PCBs
Tin[a]
Tropane alkaloids
Zearalenone
Calculation intake according to refined scenario
3-MCPD
Acrylamide
Aflatoxin B_1
Sum of aflatoxins B_1, B_2, G_1 and G_2
Aflatoxin M_1
Arsenic[a]
Cadmium
Citrinin
Deoxynivalenol (DON)
Ergot alkaloids
Sum of fumonisins B_1 and B_2
Lead
Methylmercury
Nitrate
Ochratoxin A (OTA)
Perchlorate
No conclusion about potential health risk possible based on intake calculation[b]
Benzo(a)pyrene
Melamine
Sum of PAHs

3-MCPD: 3-monochloropropane-1,2-diol; ML: maximum level; PAHs polycyclic aromatic hydrocarbons; PCBs: polychlorinated biphenyls

[a] Concerns the inorganic form

[b] The maximum levels stated in Commission Regulation (EC) No. 1881/2006 did not sufficiently cover the foods of a diet according to the Wheel of Five Guidelines in which these contaminants may occur (Table 6). Due to lack of measured concentrations from the Netherlands, it was not possible to refine the intake calculation

3.3 Intake of contaminants according to the refined scenario

3.3.1 Measured concentrations

Table 8 provides a summary of the measured concentrations used in the refined scenario. For most contaminants, the measured concentrations used were from monitoring programmes conducted in the Netherlands by the Netherlands Food and Consumer Product Safety Authority (NVWA). All of these concentrations are stored in the Quality Programme for Agricultural Products (KAP) database. This database contains samples coded as received via random, selective and suspect sampling. Samples coded as ‘suspect’ were not included in the refined scenario. If insufficient measured concentrations from the Netherlands

Table 8. Summary of the measured concentrations used in the refined scenario

Contaminant	Years	Source
3-MCPD	2013-2014	Survey data (Boon & te Biesebeek, 2016)
Acrylamide	2009-2014[a]	Monitoring data (KAP database); EFSA, 2015
Aflatoxin B_1	2013	Survey data (López et al., 2016; Sprong et al., 2016a)
Sum of aflatoxins B_1, B_2, G_1 and G_2		
Aflatoxin M_1		
Arsenic[b]	2009-2014[a]	Monitoring data (KAP database); EFSA, 2014a
Cadmium	2009-2014[a]	Monitoring data (KAP database); EFSA, 2012a; survey data for drinking water (Sprong & Boon, 2015)[c]
Citrinin	2013	Survey data (López et al., 2016; Sprong et al., 2016a)
Deoxynivalenol (DON)	2013	Survey data (López et al., 2016; Sprong et al., 2016a)
Ergot alkaloids	2013	Survey data (López et al., 2016; Sprong et al., 2016a)
Sum of fumonisins B_1 and B_2	2013	Survey data (López et al., 2016; Sprong et al., 2016a)
Lead	2009-2014[a]	Monitoring data (KAP database); EFSA, 2012b; survey data for drinking water[d] and for food groups bread and grain/cereal products (Boon et al., 2017)
Methylmercury	2009-2014	Monitoring data (KAP database)[e]
Nitrate	2011-2014	Monitoring data (KAP database); survey data for drinking water[f] (Boon et al., 2009)
Ochratoxin A (OTA)	2013	Survey data (López et al., 2016; Sprong et al., 2016a)
Perchlorate	2011-2014[a]	Monitoring data (KAP database)

3-MCPD: 3-monochloropropane-1,2-diol; mTDS: mycotoxin-dedicated Total Diet Study;
KAP: Quality Programme for Agricultural Products (KAP) database
[a] Concerns the years included in the selection of the monitoring data from KAP
[b] Concerns the inorganic form
[c] Measured concentrations in Dutch drinking water from 2006-2010 (n=781)
[d] Measured concentrations in Dutch drinking water from 2012-2015 (n=6822)
[e] Front Office Food and Product Safety, 2016
[f] Measured concentrations in Dutch drinking water from 2006 (n=1118)

were available for relevant foods, they were supplemented with measured concentrations from intake studies of the EFSA CONTAM Panel. This was the case for acrylamide, arsenic, cadmium and lead (Table 8). Three contaminants (cadmium, lead and nitrate) occur in drinking water, an important component of the Wheel of Five Guidelines. In order to include this source of intake in the refined scenario, concentrations in drinking water were obtained from three Dutch intake studies of these contaminants (Boon et al., 2009; Boon et al., 2017; Sprong & Boon, 2015). Nitrate levels in foods are reduced through cooking (Boon et al., 2009). In the refined scenario, this effect was included for the relevant foods with information from Boon et al. (2009).

Measured concentrations of the relevant mycotoxins were derived from a Dutch mycotoxin-dedicated Total Diet Study (mTDS) (Table 8). In this study, various mycotoxins were analysed in foods available on the Dutch market in the autumn/winter of 2013 (López et al., 2016; Sprong et al., 2016a). In 2015, the mTDS samples for bread and grain/cereal products (such as rice, pasta, biscuits and breakfast cereals) were also analysed for lead (Boon et al., 2017). These measured concentrations were used for the calculation of the intake of lead via the food groups 'bread (excluding bread substitutes)' and 'grain/cereal products (not bread)'. For 3-MCPD, measured concentrations were used from a survey on the presence of 3-MCPD in foods available on the Dutch market in 2013 and 2014 (Boon & te Biesebeek, 2016).

The average measured concentrations per food or food group used in the refined scenario are listed in Appendix 2.

3.3.2 *Calculated intake*

A summary of the calculated intakes per contaminant according to the refined scenario can be found in Appendices 6 and 7.

For the contaminants with a positive intake in the refined scenario, the intake of most was higher in children than in adults. The reason for this is that children consume more food per kg body weight. An exception to this was ochratoxin A (OTA). One of the foods in which ochratoxin A (OTA) was detected was coffee, part of the food group 'non-alcoholic drinks' of the Wheel of Five Guidelines. Coffee is consumed in greater quantities by adults than by children, resulting in a higher intake of ochratoxin A (OTA) by the adult target groups.

The intakes in the refined scenario were lower than those calculated with the ML scenario through often lower measured concentrations than MLs or limit values. An exception to this was the intake of arsenic, nitrate and the sum of fumonisins B_1 and B_2, because the foods with an ML insufficiently cover the foods in which these contaminants may occur (Table 6).

3.3.3 *Comparison with HBGV or calculation of MOE*

Contaminants with an intake lower than the HBGV or sufficiently high MOE

The calculated refined intakes of the mycotoxins citrinin, ergot alkaloids, deoxynivalenol (DON), sum of fumonisins B_1 and B_2, and ochratoxin A (OTA), and of nitrate and methylmercury were below the HBGV for all target groups (Appendix 6). For aflatoxin M_1, the refined intake estimate resulted in a sufficiently high MOE for all target groups (Appendix 7). For these contaminants, the intake via a diet according to the Wheel of Five Guidelines resulted in a negligible health risk (Figure 1).

Contaminants with an intake higher than the HBGV or insufficiently high MOE

For the remaining contaminants, the intake in one or more target groups was higher than the HBGV (Appendix 6) or resulted in an insufficiently high MOE (Appendix 7):

- 3-MCPD
- Acrylamide
- Aflatoxin B_1
- Cadmium
- Sum of aflatoxins B_1, B_2, G_1 and G_2
- Arsenic
- Lead
- Perchlorate

A risk assessment was performed for these contaminants (chapter 4).

4 Risk assessment

When following a diet according to the Wheel of Five Guidelines, the intake of eight contaminants resulted in an exceedance of the HBGV or an insufficiently high MOE throughout a certain period of life or a whole lifetime in the refined exposure scenario (Appendices 6 and 7). The significance of this in relation to potential health risks is addressed below.

In addition, due to the lack of measured concentrations from the Netherlands, it was not possible to determine whether a potential health risk exists for three contaminants: benzo(a)pyrene, melamine and sum of PAHs (Table 7). These three contaminants will also be addressed briefly below.

4.1 Refined scenario

3-MCPD

The critical effect of 3-MCPD is renal tubular hyperplasia with a TDI of 0.8 µg/kg bw per day as derived by the EFSA CONTAM Panel (EFSA, 2016b). The calculated intakes in the youngest target groups (1-3 and 4-8 years) were higher than the TDI (Appendix 6). In 2007, a scientific panel of experts developed a decision tree to assess potential health risks in young children whose intake exceeds the HBGV (VWA, 2008). This decision tree is suitable to evaluate long-term effects for which HBGVs (such as the TDI) have been derived. The expert panel stated that if

1) the HBGV is derived from a life-time study in which young animals had a higher intake than the full-grown animals due to their lower body weight and relative high food consumption, and
2) the intake exceeds the HBGV by no more than a factor of two for a limited period during childhood,

there is no reason for concern.

The underlying toxicity study for the derivation of the TDI for 3-MCPD was a 2-year study in rats given food to which 3-MCPD was added in a constant dosage (EFSA, 2016b). Due to the higher food intake per kg body weight by the young animals, exposure to 3-MCPD in these animals was 2-3 times higher than in full-grown animals. The higher exposure in young animals was therefore implicitly included in the derived TDI.

In the two youngest target groups, the intakes of 3-MCPD in the refined scenario were no more than a factor of two higher than the TDI. From 9 years of age, the intake was lower than this HBGV (Appendix 6). Therefore, based on the criteria of the expert panel, the intake of 3-MCPD via a diet according to the Wheel of Five Guidelines is of no concern. JEFCA also assessed 3-MCPD at the end of 2016 (JECFA, 2017). Based on the same toxicity data as used by the EFSA CONTAM Panel, JECFA derived a TDI of 4 µg/kg bw per day. The intakes of the two youngest target groups were below this TDI.

Acrylamide
For acrylamide, MOEs of 520-1500 were calculated in the refined scenario (Appendix 7). According to EFSA, there is little cause for concern with regard to adverse health effects for this substance with an MOE of at least 10,000 (EFSA, 2005a). The critical effect of acrylamide is tumour induction in rodents with a $BMDL_{10}$ of 0.17 mg/kg bw per day (EFSA, 2015). In its 2015 opinion on acrylamide in food, the EFSA CONTAM Panel indicated that people may be less sensitive to the carcinogenic properties of acrylamide than rodents are (EFSA, 2015). Although the minimum MOE of 10,000 may be conservative, the EFSA CONTAM Panel did not indicate how much lower the minimum MOE could be. The low MOEs indicate that the intake of acrylamide is a reason for concern when following a diet according to the Wheel of Five Guidelines.

Aflatoxin B_1 and sum of aflatoxins B_1, B_2, G_1 and G_2
The critical effect of all aflatoxins (B_1 and sum of B_1, B_2, G_1 and G_2) is tumour induction in the liver of rats with a $BMDL_{10}$ of 170 ng/kg bw per day (EFSA, 2007). The MOEs were 220-850 for aflatoxin B_1 and 57-210 for the sum of aflatoxins B_1, B_2, G_1 and G_2 (Appendix 7). As is the case for acrylamide, with an MOE of at least 10,000 there is little cause for concern with regard to adverse health effects according to EFSA (2005a). The calculated MOEs were well below this minimum value for all target groups. The low MOEs for aflatoxins indicate that potential health risks cannot be ruled out when following a diet according to the Wheel of Five Guidelines.

Arsenic
The critical effect of arsenic is induction of lung tumours in humans, with a $BMDL_{0.5}$ of 3 µg/kg bw per day (JECFA, 2011b). The MOEs for arsenic were 1.8-4.6 for all target groups (Appendix 7). Neither JECFA (2011b) nor the EFSA CONTAM Panel (2009a) indicated at which MOE there is no health concern. The intakes for all target groups were slightly below the intake levels at which a 0.5% increase in the incidence of lung tumours in humans was calculated. This means that potential health risks due to the intake of arsenic cannot be ruled out when following a diet according to the Wheel of Five Guidelines.

Cadmium
The calculated intakes of cadmium in the younger target groups (1-18 years) were higher than the HBGV of 2.5 µg/kg bw per week: 2.6-5.0 µg/kg bw per week (Appendix 6). Cadmium accumulates in the kidneys. The HBGV has been established so that if the average intake remains below this level over a lifetime, the accumulation of cadmium will remain below the level at which it can cause kidney damage. Thus, a temporary increase in intake up to and including age 18 does not necessarily have to be detrimental. Therefore, the ‘lifelong’ intake was calculated for cadmium (section 2.5). This intake amounted to 2.4 µg/kg bw per week, only slightly below the HBGV. In view of this small safety margin between the ‘lifelong’ intake and HBGV, it is uncertain whether a potential adverse effect on health can be ruled out for cadmium when following a diet according to the Wheel of Five Guidelines.

Lead

The EFSA CONTAM Panel considers an intake of lead with an MOE of at least 10 to constitute a negligible health risk (EFSA, 2010a). Lower MOEs, but greater than one, are considered to constitute a very low risk for effects on the kidneys and systolic blood pressure. For effects on neurological development, the risk is assumed to be low in that case, “but not such that it could be dismissed as of no potential concern” (EFSA, 2010a).

MOEs of 0.48-0.70 were calculated for the target groups up to 8 years of age for effects on neurological development (Appendix 7). For women of childbearing age (19-50 years), the MOE for these effects was 1.4. The critical effect for lead is a decrease in IQ scores (section 3.1). The calculated intakes of lead in young children resulted in MOEs of less than one (Appendix 7). This indicates that negative effects on IQ as a result of lead intake by young children cannot be ruled out when following a diet according to the Wheel of Five Guidelines. For the foetus, the risk of these effects is low.

For adult men and women (of non-fertile age), renal toxicity is the most critical effect. For all relevant target groups, the intake of lead resulted in MOEs greater than one for this effect (1.8-1.9; Appendix 7) when following a diet according to the Wheel of Five Guidelines. Therefore, the risk of renal toxicity was estimated to be very low. This was also true for the effects on systolic blood pressure: the calculated intake of lead resulted in MOEs of 4.2 to 4.5 in the relevant target groups.

Perchlorate

For perchlorate, children up to 3 years of age slightly exceeded the TDI of 0.3 μg/kg bw per day when following a diet according to the Wheel of Five Guidelines (Appendix 6). Perchlorate competitively inhibits iodine uptake by the thyroid, which can lead to disrupted thyroid hormone synthesis due to an iodine shortage. The EFSA CONTAM Panel’s TDI of 0.3 μg/kg bw per day is based on a $BMDL_{05}$ for 5% inhibition of iodine uptake by the thyroid in adults (EFSA, 2014b). The panel concluded that long-term exposure to perchlorate might be a reason for concern, particularly for individuals in younger age groups with mild to moderate iodine deficiency and a high intake of perchlorate. The panel also noted that the calculated $BMDL_{05}$ is a conservative estimate and that it is not clear at which degree of iodine uptake inhibition over a long period of time negative health effects occur. Based on the small exceedance of the TDI in young children and the observation that the TDI is conservative, the probability of negative health effects in young children as a result of exposure to perchlorate was estimated to be very low when following a diet according to the Wheel of Five Guidelines.

How adequate iodine intake is in young children in the Netherlands is not known. However, a 2014 study in the Netherlands showed that, despite a decrease in the salt content in bread since 2009 as part of efforts to make the food supply healthier, the intake of iodine among adults in the Netherlands is still sufficient (Geurts et al., 2014). This was confirmed by a nutritional status study conducted among adults from Doetinchem in 2015 (Hendriksen et al., 2016).

4.2 ML scenario

For three contaminants, for which the ML scenario may not have been conservative enough, it was not possible to refine the intake calculation due to lack of measured concentrations from the Netherlands (section 3.2.2). A discussion of these substances in relation to potential health risks when following a diet according to the Wheel of Five Guidelines is included below.

Benzo(a)pyrene and sum of PAHs
The critical effect of benzo(a)pyrene and the sum of PAHs is tumour induction in mice with a $BMDL_{10}$ of 0.07 and 0.34 mg/kg bw per day, respectively (EFSA, 2008b). In the ML scenario, MOEs higher than the minimum value of 10,000 for a negligible health risk were calculated for these contaminants (Appendix 5). The MOEs were a factor of 1.4 to 6.4 higher than this minimum value, with MOEs increasing with age.

However, benzo(a)pyrene and the other PAHs can occur in more foods than those included in the ML scenario, such as vegetables, dairy products, nuts and grains (EFSA, 2008b). These contaminants enter food via the environment and during preparation by the industry and by consumers at home. Therefore, it is likely that the inclusion of these foods in the calculation would have resulted in lower MOEs than those calculated in the ML scenario. However, the concentrations in these food groups are low (EFSA, 2008b). In view of the level of the calculated MOEs and the low concentrations, we estimate that the inclusion of these sources in the intake calculation would not have resulted in MOEs < 10,000, except perhaps in the youngest target group of 1-3 years. For this target group, the MOE was a factor of 1.4 higher than the minimum value. Because PAHs can be harmful after long-term exposure, a temporary high intake of these substances during the first years of life does not necessarily have to be detrimental if the MOEs in the subsequent years are greater than 10,000.

Important sources of PAHs are burnt foods, such as meat or bread. The intake can be limited by cutting off the black edges/crusts that occur as a result of toasting, roasting, frying or barbecuing. Furthermore, conservative estimates of PAHs intake via food calculated by the EFSA CONTAM Panel show that there is little cause for concern for the average consumer (EFSA, 2008b).

Melamine
In combination with other substances, such as endogenous uric acid, melamine can form crystals in the urine, which can damage the kidneys. A TDI at which this damage is considered negligible is 0.2 mg/kg bw per day (EFSA, 2010b). The intake of melamine was zero for all target groups in the ML scenario. Commission Regulation (EC) No. 1881/2006 only contains MLs for baby food (not part of the Wheel of Five Guidelines) and one ML of 2.5 mg/kg for all foods. This ML was not included in the ML scenario, because it would have led to an unrealistically high intake.

In 2010, the EFSA CONTAM Panel together with the EFSA Panel on Food Contact Materials, Enzymes, Flavourings and Processing Aids (CEF) performed a conservative intake calculation for melamine based on concentration data of melamine in foods (EFSA, 2010b). The majority of the available samples (80%) had concentrations lower than the limit of detection or quantification. The calculated intakes were well below the HBGV in all population groups. We therefore estimate that the intake of melamine when following a diet according to the Wheel of Five Guidelines will not pose a health risk.

4.3 Conclusion

Based on the risk assessment above, it can be concluded when following a diet according to the Wheel of Five Guidelines that:

- the health risk of the intake of benzo(a)pyrene, the sum of PAHs, melamine, perchlorate and 3-MCPD is expected to be negligible or very low;
- a potential health risk cannot be ruled out for aflatoxin B_1, sum of aflatoxins B_1, B_2, G_1 and G_2, acrylamide and arsenic;
- the health risk of the intake of lead is expected to be very low for adult men and women (of non-fertile age), whereas a potential health risk of the intake of lead cannot be ruled out for the two youngest target groups and is estimated to be low for the foetus via the lead intake of women of childbearing age (19-50 years);
- it is uncertain whether a potential health risk can be ruled out for cadmium due to a small safety margin between the calculated 'lifelong' intake and HBGV.

5 Contribution food groups to intake

For the contaminants for which a potential health risk could not be ruled out when following a diet according to the Wheel of Five Guidelines, it was investigated which food groups of the Wheel of Five Guidelines would contribute most to the intake. This was calculated for the refined scenario. Given the small safety margin between the 'lifelong' intake and HBGV, cadmium was also included in this analysis. Table 9 provides a summary of the contributions per contaminant.

Acrylamide
The food group 'grain/cereal products (not bread)' contributed most to the intake of acrylamide in the target groups up to 18 years of age, followed by the food groups 'nuts and seeds' and 'bread (excluding bread substitutes)'. The food group 'grain/cereal products (not bread)' contributed through the consumption of wholegrain 'Cracotte' crackers (49-73%), wholegrain crispbread (*knäckebröd*) (17-44%), 7-grains 'energy breakfast' (5%) and wholegrain Dutch rusk (*beschuit*) (5-12%). Wholegrain crispbread and 'Cracotte' crackers contributed due to a relatively high acrylamide concentration (165 µg/kg) (Appendix 2). Of the recommended consumption of food group 'grain/cereal products (not bread)' in the two youngest target groups, 23% was attributable to wholegrain 'Cracotte' crackers (9-14 grams per day) and 5% to wholegrain crispbread (2-3 grams per day).

For the adult target groups, the same three food groups contributed to the intake of acrylamide (Table 9), while there was also a substantial contribution from the food group 'non-alcoholic drinks'. This contribution was fully attributable to the consumption of coffee.

For the food group 'nuts and seeds' measured concentrations of acrylamide were only available for (dry-) roasted nuts (Appendix 2). There is no distinction between (dry-) roasted and raw nuts in the Wheel of Five Guidelines (Brink et al., 2016).

Aflatoxin B_1 and sum of aflatoxins B_1, B_2, G_1 and G_2
Important food groups that contributed to the intake of aflatoxins (B_1 and the sum of B_1, B_2, G_1 and G_2) in all target groups were 'fruit', 'bread (excluding bread substitutes)' and 'grain/cereal products (not bread)' (Table 9). Aflatoxin concentrations measured in these food groups were all '< concentrations' (Appendix 2): the contributions were determined by the assumption that these concentrations amounted to half the relevant limit value (section 2.3).

Arsenic
The intake of arsenic was attributable mainly to the food group 'seafood'. In the two youngest target groups, the intake was attributable to the consumption of fish fingers and fried fillet of fish. These two fish products did not have high arsenic concentrations (Appendix 2), but represented an important part of the consumption of seafood in these target groups (37% and 26%, respectively) based on the current diet.

Table 9. Contribution (%) of the food groups to the intake of contaminants via a diet according to the Wheel of Five Guidelines for the different target groups

Food group	Target group	Contribution (%)
Acrylamide		
Grain/cereal products (not bread)	1-8 years	39-58
Nuts and seeds		17-26
Bread (excluding bread substitutes)		17-26
Non-alcoholic drinks		0-4
Grain/cereal products (not bread)	19-70+	28-36
Nuts and seeds		10-16
Bread (excluding bread substitutes)		15-20
Non-alcoholic drinks		26-35
Aflatoxin B_1 and sum of aflatoxins B_1, B_2, G_1 and G_2		
Fruit	All target groups	27-41
Bread (excluding bread substitutes)		22-34
Grain/cereal products (not bread)		10-20
Arsenic		
Seafood	All target groups	31-42
Grain/cereal products (not bread)		11-22
Vegetables		9-12
Non-alcoholic drinks		7-11
Cadmium		
Vegetables	All target groups	26-43
Potatoes and tubers		14-20
Bread (excluding bread substitutes)		10-17
Grain/cereal products (not bread)		10-16
Nuts and seeds		6-21
Lead		
Fruit	1-8 years	25-31
Bread (excluding bread substitutes)		17-18
Vegetables		9-12
Grain/cereal products (not bread)		8-10
Fruit	19-70+	17-24
Bread (excluding bread substitutes)		14-23
Vegetables		11-17
Potatoes and tubers		10-14
Grain/cereal products (not bread)		9-13

In the link between consumption and concentration, it was assumed in accordance with the Wheel of Five Guidelines that 70% of these products consist of fish (Brink et al., 2016). In the older target groups, the main sources of intake of arsenic via the food group ‘seafood’ were herring, cod and prawns. This was caused by a combination of a relatively high arsenic concentration (Appendix 2) and a high contribution from these fish types to the recommended consumption quantity for this food group based on the current diet. The second major source for the intake of arsenic in all target groups was the food group ‘grain/cereal products (not bread)’ through the consumption of rice.

In addition to these two food groups, the food groups ‘vegetables’ and ‘non-alcoholic drinks’ contributed to the consumption of arsenic. As the consumption of foods in the ‘vegetables’ food group was linked to one average arsenic concentration (Appendix 2), the greatest contributions were from vegetables with the highest consumption quantities based on the current diet, such as cucumber, carrots, cauliflower and green beans. For the food group ‘non-alcoholic drinks’, the intake was attributable mainly to the consumption of drinking water and tea.

Cadmium
In all target groups, the intake of cadmium was mainly attributable to the consumption of the food groups ‘vegetables’, followed by the food groups ‘bread (excluding bread substitutes)’, ‘grain/cereal products (excluding bread)’ and ‘nuts and seeds’. As for arsenic, the consumption of foods in the food group ‘vegetables’ was linked to one average cadmium concentration (Appendix 2), as a result of which the vegetables with the highest consumption quantities based on the current diet contributed most. This was also the case for the foods in the food group ‘bread (excluding bread substitutes)’. In the food group ‘grain/cereal products (not bread)’, the contribution was attributable mainly to rice and pasta. In the food group ‘nuts and seeds’, the contribution was attributable to the consumption of sunflower seeds and pine nuts due to a higher cadmium concentration in seeds compared to nuts (0.036 versus 0.371 mg/kg; Appendix 2).

Lead
In the two youngest target groups, lead intake when following a diet according to the Wheel of Five Guidelines was attributable largely to fruit consumption (Table 9), particularly apple and banana, which together represented approximately 66% of the total recommended daily consumption quantities of the food group ‘fruit’. This contribution was not attributable to high lead concentrations in apple and banana (Appendix 2), but to a high contribution from these two fruits to the recommended consumption quantities for this food group based on the current diet. Another major source of intake in the two youngest target groups was the food group ‘bread (excluding bread substitutes)’. Lead concentrations measured in bread were all ‘< concentrations’ (Appendix 2). Thus, the contribution by this food group was determined by the assumption that all underlying bread products contained lead at half the relevant limit value (section 2.3).

For the older target groups (from 9-13 years), lead intake was also attributable to the food groups ‘fruit’ and ‘bread (excluding bread substitutes)’ (Table 9). Other food groups that contributed at least 10% to the lead intake in (some of) these target groups were ‘vegetables’, ‘potatoes and tubers’ and ‘grain/cereal products (not bread)’.

6 Uncertainty in intake calculations due to '< concentrations'

The calculated intakes of the contaminants when following a diet according to the Wheel of Five Guidelines in the refined scenario are subject to a number of uncertainties. The main uncertainty concerns the concentrations assigned to samples with a '< concentration' for aflatoxins (B_1 and sum of B_1, B_2, G_1 and G_2) and lead in view of the outcomes of the intake calculations (chapters 3 and 5) and the accompanying risk assessment (chapter 4). For these contaminants, a potential health risk could not be ruled out when following a diet according to the Wheel of Five Guidelines. However, the measured concentrations of the food groups that made a major contribution to the intake were only '< concentrations': 'bread (excluding bread substitutes)' for lead, and 'fruit', 'bread (excluding bread substitutes)' and 'grain/cereal products (not bread)' for aflatoxins.

To quantify this uncertainty, the intake of these contaminants was also calculated under the assumption that the food groups with only measured '< concentrations' contained no lead or aflatoxins (scenario 0). The measured concentrations of lead in the underlying foods of the Wheel of Five Guidelines food groups 'bread (excluding bread substitutes)' and 'grain/cereal products (not bread)' thus became zero (Appendix 2). For aflatoxins, the foods in the food groups 'fruit', 'bread (excluding bread substitutes)', 'grain/cereal products (not bread)', 'white meat and meat substitutes', 'red meat', 'milk and dairy products', 'cheese and cheese substitutes' and 'spreading and cooking fats' were assigned a concentration equal to zero (Appendix 2).

The intake of lead and aflatoxins decreased in scenario 0 while the MOEs increased (Table 10), compared to the refined scenario estimates (section 3.3). For lead, this resulted in MOEs > 1 for the adult target groups, for effects on the kidneys and systolic blood pressure as well as on neurological development for women of childbearing age. For the youngest target groups of 1-3 and 4-8 years, the MOEs remained < 1 for effects on neurological development (Table 10). For aflatoxin B_1, the MOEs were sufficiently high (> 10,000) for the target groups from 9 years of age and for boys aged 4-8 years. The intake of the sum of aflatoxins B_1, B_2, G_1 and G_2 in scenario 0 was the same as that of aflatoxin B_1, because measured concentrations higher than the relevant limit value were only reported for aflatoxin B_1. As in the refined scenario, the intake of lead was largely attributable to the food group 'fruit' in all target groups (34-43% in the two youngest target groups and 26-31% in the other target groups), followed by the food groups 'vegetables', and 'potatoes and tubers'. The intake of aflatoxins was fully attributable to the consumption of the food group 'nuts and seeds'.

This analysis shows that the conclusion that health risks cannot be ruled out for aflatoxins when following a diet according to the Wheel of Five Guidelines is uncertain: if all '< concentrations' were assumed not to contain any aflatoxins, the MOEs were only insufficiently high in the youngest target group and in the target group of girls aged 4-8 years

Table 10. Intake of aflatoxins and lead via a diet according to the Wheel of Five Guidelines and the accompanying margin of exposure (MOE)[a] calculated with measured concentrations (refined scenario) and according to refined scenario but based on the assumption that some of the foods[a] did not contain any aflatoxins or lead (scenario 0)

Target group (gender and age in years)	Contaminant, intake and margin of exposure											
	Aflatoxin B_1				Sum of aflatoxins B_1, B_2, G_1 and G_2				Lead			
	Refined scenario		Scenario 0		Refined scenario		Scenario 0[b]		Refined scenario		Scenario 0	
	Intake[c]	MOE	Intake[c]	MOE	Intake[c]	MOE	Intake[c]	MOE	Intake[d]	MOE[e]	Intake[d]	MOE[e]
Women												
1-3	0.76	220[f]	0.033	5200	2.99	57	0.033	5200	1.0	0.48	0.77	0.65
4-8	0.46	370	0.018	9400	1.82	94	0.018	9400	0.71	0.70	0.52	0.96
9-13	0.37	460	0.008	21000	1.53	110	0.008	21000	0.59	-	0.42	-
14-18	0.26	670	0.006	28000	1.06	160	0.006	28000	0.44	-	0.32	-
19-30	0.23	730	0.004	43000	0.95	180	0.004	43000	0.39	1.4	0.29	1.9
31-50	0.23	730	0.004	43000	0.95	180	0.004	43000	0.39	1.4	0.29	1.9
51-69	0.21	830	0.003	57000	0.84	200	0.003	57000	0.36	1.8	0.28	2.3
70+	0.21	830	0.006	28000	0.81	210	0.006	28000	0.35	1.8	0.27	2.3
Men												
1-3	0.70	240	0.031	5500	2.76	62	0.031	5500	0.95	0.52	0.71	0.70
4-8	0.46	370	0.010	17000	1.82	94	0.010	17000	0.71	0.70	0.52	0.96
9-13	0.45	380	0.005	34000	1.80	94	0.005	34000	0.69	-	0.47	-
14-18	0.29	600	0.004	43000	1.17	150	0.004	43000	0.48	-	0.32	-
19-30	0.22	760	0.004	43000	0.94	180	0.004	43000	0.36	1.7	0.25	2.6
31-50	0.22	760	0.004	43000	0.94	180	0.004	43000	0.36	1.7	0.25	2.6
51-69	0.22	790	0.004	34000	0.90	190	0.004	34000	0.35	1.8	0.24	2.6
70+	0.20	850	0.005	34000	0.80	210	0.005	34000	0.33	1.9	0.24	2.6

[a] For more details, see chapter 6
[b] In scenario 0, the intake of the sum of aflatoxins B_1, B_2, G_1 and G_2 was the same as that of aflatoxin B_1, because in the mTDS concentrations higher than the detection limit were only reported for aflatoxin B_1
[c] Expressed in ng/kg bw per day
[d] Expressed in µg/kg bw per day
[e] Calculated for effects on neurological development for the target groups 1-3 and 4-8 years (0.5 µg/kg bw per day) and women aged 19-30 and 31-50 years (0.54 µg/kg bw per day). For the other adult target groups, the MOE was calculated for effects on the kidneys (0.63 µg/kg bw per day). No relevant BMDL was available for the target groups 9-13 and 14-18 years (section 3.1). The MOEs for effects on systolic blood pressure (1.5 µg/kg bw per day) varied from 5.4 to 6.2 for the relevant adult target groups.
[f] MOEs lower than 10,000, the minimum value above which a potential health effect is negligible for aflatoxins (Table 5), are shown in red forthese contaminants. For lead, this was done for the MOEs lower than one, the minimum value above which a potential health risk is (very) low (chapter 4).

(Table 10). Because aflatoxins can be harmful after lifelong exposure and the MOEs for most target groups were sufficiently high, a ‘lifelong’ intake was also calculated for this scenario (section 2.5). This intake was 0.006 ng/kg bw per day and resulted in a sufficiently high MOE (28,000) for a negligible health risk. For lead, the same analysis resulted in the conclusion that the health risk was very low for the effects of lead on the kidneys and systolic blood pressure, while the MOEs for effects on neurological development in the two youngest target groups remained insufficiently high (Table 10) . For effects on neurological development in the foetus, the health risk was low. These conclusions for lead did not differ from the conclusions from the refined scenario (‘< concentrations’ amounting to half the relevant limit value; section 4.1).

Because it is unlikely that the food groups with only ‘< concentrations’ do not contain any aflatoxins or lead, the intake in scenario 0 was very likely underestimated. However, the extent of this underestimation cannot be assessed on the basis of the available data.

7 Discussion

In this report, the intake of contaminants in food was calculated for a diet according to the Wheel of Five Guidelines. This showed that, for a number of contaminants, the intake when following such a diet is likely to be higher than desirable throughout a certain period of life or a whole lifetime. In this discussion, we compare the calculated intakes of the contaminants when following a diet according to the Wheel of Five Guidelines with the current intakes and discuss the uncertainties of the analysis. In addition, some options are discussed to increase chemical food safety of a diet according to the Wheel of Five Guidelines.

7.1 Comparison between calculated intakes via a diet according to the Wheel of Five Guidelines and current intakes

The calculated intakes via the relevant scenario (ML or refined) were compared with national intake estimates for these contaminants reported from 2009 (Table 11). These intake estimates were calculated with measured concentrations and food consumption data from the two most recent Dutch National Food Consumption Surveys (DNFCSs) conducted among children aged 2-6 years (Ocké et al., 2008) and persons aged 7-69 years (van Rossum et al., 2011). This comparison was made for those contaminants for which an intake estimate was performed based on the current diet in the Netherlands. Intake estimates for the Netherlands reported by the EFSA CONTAM Panel were not included in this comparison because they often result in an overestimate of the intake due to the methodology used (Boon et al., 2011; Boon et al., 2017; Sprong & Boon 2015). For the comparison, the median intake from the different reports was used, because the average intake was not a standard part of the reporting. There are no intake estimates of contaminants available based on data from the DNFCS for independently living persons aged 70 and over (Ocké et al., 2013).

When following a diet according to the Wheel of Five Guidelines, the intake of three contaminants is expected to be reduced compared to the current diet: 3-MCPD, acrylamide and the sum of dioxins and dioxin-like PCBs. The intake of 3-MCPD and acrylamide will decrease, because the foods in which these process contaminants can occur in high concentrations, such as crisps, chips, cakes and biscuits, are not part of the guidelines. The intake of the sum of dioxins and dioxin-like PCBs will also decrease due to a higher consumption of (semi-) skimmed milk and dairy products instead of varieties with a higher fat content, and a lower consumption of meat compared to the currently consumed amounts (Ocké et al., 2008; van Rossum et al., 2011).

The intake of five contaminants is expected to increase (slightly): cadmium, deoxynivalenol (DON), ergot alkaloids, methylmercury and nitrate (Table 11). The intake of cadmium and nitrate will increase, because these contaminants occur in vegetables, for which the recommended consumption quantities are higher than the quantities currently consumed (Ocké et al., 2008; van Rossum et al., 2011). Similarly, the expected higher intake of methylmercury can be explained

Table 11. Intake of contaminants calculated for the current diet and for a diet according to the Wheel of Five Guidelines

Contaminant[a,b]	Intake[c,d]				Source of estimated intake via current diet
	Current diet (P50)		Diet according to Wheel of Five Guidelines (average)		
	2-6 years	7-69 years	1-8 years	9-70+ years	
3-MCPD (µg)	1490	674	1.1	0.45	Boon & te Biesebeek, 2016
Acrylamide (mg)	0.0007	0.0003	0.0003	0.0001	Boon et al., 2009, Geraets et al., 2011
Aflatoxin B_1 (ng)	0-0.93	0-0.42	0.56	0.24	Sprong et al., 2016a
Sum of aflatoxins B_1, B_2, G_1 and G_2 (ng)	0-3.60	0-1.62	2.22	0.97	Sprong et al., 2016a
Aflatoxin M_1 (ng)	0-0.023	0-0.005	0.008	0.003	Sprong et al., 2016a
Cadmium (µg)	0.47	0.22	0.60	0.32	Sprong & Boon, 2015
Citrinin (µg)	0-0.08	0-0.03	0.05	0.02	Sprong et al., 2016a
Deoxynivalenol (DON) (µg)	0.28-0.30	0.1-0.11	0.32	0.12	Sprong et al., 2016a
Sum of dioxins and dioxin-like PCBs (pg)	0.92	0.5	0.006	0.003	Boon et al., 2014
Ergot alkaloids (µg)	0.24-0.25	0.07-0.09	0.30	0.11	Sprong et al., 2016a
Sum of fumonisins B_1 and B_2 (µg)	0-0.06	0-0.09	0.05	0.03	Sprong et al., 2016a
Lead (µg)	0.88	0.41	0.81	0.39	Boon et al., 2017
Methylmercury (µg)	0.01	0.01	0.22	0.11	Front Office Food and Product Safety, 2016
Nitrate (mg)	1.55	0.94	2.1	1.5	Geraets et al., 2011
Ochratoxin A (OTA) (ng)	0.45-4.4	5.2-7.1	2.5	6.8	Sprong et al., 2016a
Patulin (ng)	0-121	0-47.5	0	0	Sprong et al., 2016a
Zearalenone (µg)	0.03-17.6	0.28-9.1	0.08	0.03	Sprong et al., 2016a

3-MCPD: 3-monochloropropane-1,2-diol; PAHs: polycyclic aromatic hydrocarbons; PCBs: polychlorinated biphenyls; TEQ: toxic equivalent

[a] There were no estimates of intake via the current diet available for the following contaminants: arsenic, benzo(a)pyrene, sum of dioxins, ergot sclerotia, erucic acid, melamine, sum of non-dioxin-like PCBs, sum of PAHs, perchlorate, tropane alkaloids and tin

[b] The unit of the calculated intake is mg, µg or ng per kg body weight per day. For the sum of dioxins and dioxin-like PCBs, the intake is expressed in pg WHO TEQ per kg bw per day.

[c] Intake was calculated using measured concentrations, with the exception of the intake estimates for the sum of dioxins and dioxin-like PCBs, patulin and zearalenone via a diet according to the Wheel of Five Guidelines. These intakes were estimated using the maximum levels in Commission Regulation (EC) No. 1881/2006

[d] For mycotoxins, the intake via the current diet was reported as a range, with the limits referring to the lower and upper bound estimates of the intake. The lower bound estimate was calculated under the assumption that samples with concentrations lower than the limit of detection did not contain any mycotoxin and that those with concentrations between the limit of detection and quantification contained mycotoxin at the level of the limit of quantification. The upper bound estimate was calculated under the assumption that these samples contained the mycotoxin at the level of the limit of detection and quantification, respectively

by the higher recommended consumption of seafood than consumed according to the current diet (Brink et al., 2016). The intake of deoxynivalenol (DON) and ergot alkaloids is also expected to increase slightly when following a diet according to the Wheel of Five Guidelines (Table 11). This is due to a higher consumption of foods of the food groups ‘bread (excluding bread substitutes)’ and ‘grain/cereal products (not bread)’ compared to the current consumed amounts (Ocké et al., 2008; van Rossum et al., 2011). For the other nine contaminants, the mycotoxins and lead, the intake is expected to remain more or less the same (Table 11).

Observed differences in intake between a diet according to the Wheel of Five Guidelines and the current diet may also have been partly due to differences in the concentrations used in the calculations. This is relevant for the three contaminants for which the intake was only calculated with the ML scenario: sum of dioxins and dioxin-like PCBs, patulin and zearalenone. For these contaminants, MLs were used to calculate the intake via a diet according to the Wheel of Five Guidelines (section 2.2), which are normally higher than measured concentrations as used to calculate the intake via the current diet. The intake of these three contaminants was, however, either comparable (patulin and zearalone) or lower (sum of dioxins and dioxin-like PCBs) when following a diet according to the Wheel of Five Guidelines (Table 11). For the other contaminants, the refined intake estimates were used. The concentrations used to obtain these estimates were the same as those used to calculate the intake via the current diet for all relevant contaminants, except for acrylamide and nitrate. For cadmium, only the concentrations in drinking water were the same (section 3.3.1). Comparing the concentrations used in both calculations showed that concentrations were either higher, lower or the same for individual foods. Thus, differences in concentrations may also have contributed to the observed differences in intake between the two diets for these three contaminants, together with differences in food consumption.

The comparison in intake between a diet according to the Wheel of Five Guidelines and the current diet is subject to two additional uncertainties. First, intakes of the contaminants when following a diet according to the Wheel of Five Guidelines have been corrected using the same body weights as those used to calculate the intake of essential nutrients and energy via a diet according to the Wheel of Five Guidelines (Geurts et al., 2016). These body weights were however lower than those of the respondents in the two food consumption surveys on which the intakes for the current diet are based. For example, adult men and women weighed an average of 87 and 75 kg, respectively (van Rossum et al., 2011); approximately 10 kg more than the body weights used in this report (Table 4). The calculated intakes when following a diet according to the Wheel of Five Guidelines would therefore have been lower if the same body weights had been used. Secondly, the recommended consumption quantities in the Wheel of Five Guidelines represent approximately 85% of the energy requirements for each target group (Brink et al., 2016). The remaining 15% of the energy requirements can be obtained from foods not covered by these guidelines. This ‘free space’ was not included in the calculation of the intake of contaminants. Therefore, it is possible that the intake of the contaminants was (slightly) higher than calculated here, depending on the food choice. The intake via the current diet does comprise the total energy intake.

7.2 Translation of Wheel of Five Guidelines into consumption of individual foods

Maximum levels (MLs) and measured concentrations of contaminants usually concern individual foods. The Wheel of Five Guidelines concern recommended consumption quantities at the food group level (Table 1). For the calculation of the intake of contaminants when following a diet according to these guidelines, the recommended consumption quantities were translated into consumption quantities for individual foods. This was done using consumption data from the most recent DNFCSs. The assumption in this respect is that consumers continue to eat the same foods, but only choose the foods that fit within the Wheel of Five Guidelines and adjust consumption quantities such that they satisfy the recommended consumption quantities for each food group. The same method was used to optimise the Wheel of Five Guidelines regarding the intake of essential nutrients and energy (Brink et al., 2016; Geurts et al., 2016).

The resulting diet in accordance with the Wheel of Five Guidelines is an average diet. If consumers favour certain foods that are part of the guidelines, and that contain a relatively high concentration of a contaminant (e.g. arsenic in rice products, methylmercury in tuna), the actual intake for such an individual may be higher than calculated here. The advice within the Wheel of Five Guidelines to consume a variety of foods plays an important role in addressing such situations (Brink et al., 2016).

In addition, the Wheel of Five Guidelines also contain recommendations for vegetarians, vegans and flexitarians. For these populations, the intake of substances may deviate from the calculated intakes via an average diet. These populations were not included when calculating the effects of a diet according to the Wheel of Five Guidelines on the intake of essential nutrients and energy, and were therefore not included in the present study.

7.3 Measured concentrations

In the refined scenario, the intake of contaminants when following a diet according to the Wheel of Five Guidelines was calculated using concentrations from monitoring programmes, surveys or – for the mycotoxins – from a Dutch mycotoxin Total Diet Study (mTDS). For some contaminants, these measured concentrations did not sufficiently cover the possible foods that may contain those contaminants. In those cases, and if available, the concentrations were supplemented with data published by the EFSA CONTAM Panel in order to prevent an underestimate of the intake.

Given the available information, the link between measured and consumed foods was optimised as much as possible. This meant, in some cases, that the Dutch monitoring data could be linked with consumption data at the individual food level (e.g. for cadmium in seafood and nitrate in endive (Appendix 2)). However, in other cases, the number of measured concentrations per food was limited. Depending on the variation in concentrations and the number of measured concentrations available, foods were grouped for the link to consumption. This could mean that in certain cases a single concentration was assigned to a whole food group of the Wheel of Five Guidelines (e.g. one concentration for the food group 'vegetables' for lead and cadmium) or to part of a food group (e.g. lead in pome fruit). This is a source of uncertainty that may have led to an under- or overestimate of the intake of contaminants via a diet according to the Wheel of Five Guidelines.

The measured concentrations of the mTDS come from representative foods that may contain mycotoxins (Sprong et al., 2016b). Prior to the analysis, these foods were prepared as consumed, if relevant, in order to include any effects of processing. This study contains a number of uncertainties, which have an effect on the reported concentrations. For a complete overview of these uncertainties, we refer to Sprong et al. (2016a). An important source of uncertainty is the fact that the mTDS was conducted in the autumn/winter of 2013. Concentrations of mycotoxins can vary by season and by year, depending on the weather conditions. Thus, the intake estimates for mycotoxins presented here apply to this period. Extrapolation of these intakes to other years is uncertain. Despite this uncertainty, it was estimated that these concentrations were more complete and more suitable for calculation of the intake of mycotoxins than the available monitoring data.

In the calculations, samples with concentrations lower than the limit of detection or quantification, the '< concentrations', were assigned concentrations of half the relevant limit value. This assumption was made because, based on the literature and data published by the EFSA CONTAM Panel, the possibility of a contaminant being present in the food could not be ruled out. However, for a number of contaminants this may have led to an overestimate of the contribution of certain food groups to the intake and of the overall intake, especially for lead and aflatoxins (chapter 6). An intake calculation with the assumption that several food groups with solely '<-concentrations' did not contain these contaminants (scenario 0), showed that the intakes of aflatoxins resulted in MOEs lower than the minimum value (10,000) in only the youngest target group (Table 10). For lead, the MOEs in the two youngest target groups remained lower than one; the MOE above which a health risk is low.

For pyrrolizidine alkaloids (PAs), no intake calculation could be performed due to lack of sufficient measured concentrations from the Netherlands, as well as MLs and limit values. EFSA (2016a) recently calculated the intake of PAs in Europe on the basis of measured concentrations of 28 PAs in green and black tea, herbal tea and honey. Data used in these calculations included PA concentration data from RIKILT (Mulder et al., 2015). In 2017, the EFSA CONTAM Panel (2017) performed a risk assessment on the basis of the calculated intakes, and concluded that that there is a possible concern for human health related to the exposure to PAs, in particular for frequent and high consumers of tea and herbal infusions. However, there were a number of uncertainties concerning the intake calculation as a result of which the intakes must be interpreted with caution: e.g. large number of ‘< concentrations’, lack of detail concerning consumed and measured varieties of tea, and the selected PAs were not all measured in all samples. Furthermore, EFSA noted that the supplied PA concentrations in tea in 2015 were lower than in the previous years, and attributed this to the use of more sensitive measurement methods rather than a decrease in PA concentrations in the measured products. Considering all uncertainties together, EFSA concluded that the calculated intake of PAs very likely overestimates the actual intake (EFSA, 2016a). For the Wheel of Five Guidelines, only the intake of PAs via green and black tea is relevant, because herbal tea and honey are not part of these guidelines. Currently, insufficiently reliable concentrations of PAs in tea are available to calculate the potential intake of PAs via a diet according to the Wheel of Five Guidelines. Based on the risk assessment of PAs, the EFSA CONTAM Panel identified a list of 17 PAs of relevance for monitoring in food (EFSA, 2017).

7.4 Risk assessment

The intake of 22 out of 28 contaminants when following a diet according to the Wheel of Five Guidelines resulted in a negligible or very low health risk when following a diet according to the Wheel of Five Guidelines. For two contaminants, a potential adverse effect on health could not be ruled out when following such a diet (chapter 4): acrylamide and arsenic. For lead, such an effect could not be ruled out for the two youngest target groups, and for the foetus via the lead intake of women of childbearing age. For aflatoxins (B_1 and sum of B_1, B_2, G_1 and G2), it was not clear whether this was the case due to uncertainties in the measured concentrations used (chapter 6).

For cadmium, the safety margin between the ‘lifelong’ intake and the HBGV was small: 2.4 vs. 2.5 µg/kg bw per week (section 4.1). Given this small margin, several uncertainties in the intake assessment are relevant to determine whether there is a reason for concern. The first one is the uncertainty in the measured concentrations that may have resulted in an over- or underestimation of the intake (section 7.3). Secondly, as described in section 7.1, the average body weights used per target group to correct the intake estimates were lower than those of the respondents of two DNFCSs, and therefore very likely lower than the average body weights of persons currently living in the Netherlands. The actual intake levels when following a diet according to the Wheel of Five Guidelines may therefore have been lower. We estimate, in view of the safety margins between the calculated intake and HBGV and the calculated MOEs, that these lower body weights will not have affected the conclusions for those contaminants for which a health risk could not be ruled out when following a diet according to the Wheel of Five Guidelines (chapter 4). An exception to this may however be cadmium, for which the difference between the HBGV and the ‘lifelong’ intake was only 0.1 µg/kg bw per week. We therefore recalculated the ‘lifelong’ intake of cadmium with the body weights of the respondents from the food consumption surveys conducted among persons aged 7-69 years in 2007-2011 (van Rossum et al., 2011) and independently living persons aged 70 and over (Ocké et al., 2013) for the target groups from 9 years of age. This resulted in a ‘lifelong’ intake of 2.2 µg/kg bw per week: a difference of 0.3 µg/kg bw per week compared to the HBGV for cadmium. In this calculation, for the two youngest target groups of the Wheel of Five Guidelines, the body weights were used as listed in Table 4: no suitable average body weights could be obtained from the relevant reports (Ocké et al., 2008; van Rossum et al., 2011). In view of the uncertainties in the measured concentrations (section 7.3), as well as the additional uncertainty that 15% of the energy intake was not covered by the diet according to the Wheel of Five Guidelines (section 7.1), a safety margin of 0.3 µg/kg bw per week is still small. It remains therefore uncertain whether a potential health concern for cadmium can be ruled out when following a diet according to the Wheel of Five Guidelines.

In a recent study performed by the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) on the intake of contaminants via a diet that satisfies the French guidelines for a healthy diet[3], the intake of acrylamide, arsenic and lead were found to be a cause for concern.

7.5 Reduction in intake of contaminants

A decrease in intake of contaminants via a diet according to the Wheel of Five Guidelines, if desired, can be achieved in two ways: through the food choice in the Wheel of Five Guidelines and by decreasing the concentrations of contaminants in foods. These two options are discussed below for the contaminants for which a potential health risk could not be ruled out or was uncertain.

Food choice within Wheel of Five Guidelines

For acrylamide, in view of the contribution by coffee to its intake in the adult target groups, replacing some or all coffee consumption with other drinks, such as tea, could result in a reduced intake. Another option could be to choose raw nuts when consuming nuts. Raw nuts have negligible acrylamide concentrations compared to (dry-) roasted ones (EFSA, 2015). If consumers no longer drink coffee and only consume raw nuts, the MOE for children up to 18 years of age will increase by a factor of 1.3 on average. For adults, the MOEs will increase by a factor of 1.8 on average. However, the MOEs will remain below the minimum value of 10,000: the maximum MOE will be 3,100 in women aged 70 and over.

Seafood made a substantial contribution to the intake of arsenic (Table 9). If no seafood is consumed, the MOE of arsenic will increase by a factor of 1.6 to a maximum of 7.4. This is still low. Furthermore, consumption of seafood has also beneficial health effects, the reason why the consumption of this food group is part of the Wheel of Five Guidelines (Health Council of the Netherlands, 2015; Brink et al., 2016). Rice also contributed to the intake of arsenic via a diet according to the Wheel of Five Guidelines. A recommendation to not consume rice every day could result in a decrease in intake. However, the average consumption of rice in the Dutch population based on the current diet is so low that this would have hardly any effect on the average intake of

[33] www.anses.fr/en/content/anses-updates-its-food-consumption-guidelines-french-population

arsenic. If the concentration of arsenic in rice is set at zero, the intake of arsenic will decrease by a factor of 1.2 on average in all target groups.

Lead is found in basic foods, such as bread, vegetables, meat, dairy products, fruit and grain/cereal products. It is not possible to find an alternative for these foods that does not contain lead. Furthermore, these foods are part of a healthy dietary pattern. Reduction of their consumption would thus negatively affect the health benefits of the guidelines. The same would apply to cadmium and aflatoxins, which are also found in the same basic foods.

Overall, possible adjustments concerning food choice within the Wheel of Five Guidelines will only have a negligible effect on the intake of acrylamide and arsenic. For lead, aflatoxins and cadmium, no alternative food choices are possible without negatively affecting the health benefits of the Wheel of Five Guidelines.

Reducing the concentration of contaminants in foods
The policy is aimed at keeping the intake of contaminants via the food as low as reasonably achievable (ALARA) by formulating and regularly re-evaluating legal MLs. Furthermore, due to various legal measures, fewer and fewer contaminants (such as lead, cadmium and arsenic) find their way into the environment and thus the concentrations in food will also decrease over time. Examples of such measures are the introduction of unleaded petrol and paint, the replacement of lead water pipes and the reduced use of heavy metals in paint products.

Concentrations of acrylamide have decreased through self-regulating agreements in the food industry[4], since its discovery in food in 2002: via adjustments to the production processes and the raw materials used. In addition, action limits have been set within the EU for acrylamide and an EU Regulation is being drawn up, which will oblige food producers to include mitigation measures in their food safety plans in order to limit the formation of acrylamide as much as possible. Furthermore, consumers can also decrease the concentration of acrylamide in home-cooked foods that contain acrylamide, such as fried and baked potatoes.

Given that possible adjustments concerning food choice witin the Wheel of Five Guidelins will not result in meaningful reductions in the intake of the relevant contaminants and by which people can also continue to eat a healthy diet, it is important to keep the concentrations of contaminants in food as low as possible. The current policy on contaminants in food focuses on this.

7.6 Conclusion

For 22 of the 28 contaminants examined the intake via a diet according to the Wheel of Five Guidelines was of no health concern. For acrylamide, arsenic and lead, there may be a concern via such a diet. That does not mean that it is certain that negative health effects will occur. It is just that they cannot be ruled out. For cadmium, it was unclear whether the safety margin will be achieved with a diet according

[4] www.fooddrinkeurope.eu/uploads/publications_documents/AcrylamideToolbox_2013.pdf

to the Wheel of Five Guidelines, due to the uncertainties in the measured concentrations used in combination with a narrow margin between the calculated intake and the HBGV. For aflatoxin B_1 and the sum of aflatoxins B_1, B_2, G_1 and G_2, this was also not clear due to uncertainties in the measured concentrations used.

Adjustments in food choices within the Wheel of Five Guidelines are no option for decreasing the intake of the relevant contaminants. The effects of such adjustments on the intake would either be too limited or would negatively affect the health benefits of the Wheel of Five Guidelines. It remains therefore important to keep the concentrations of these substances in food as low as possible. The current policy on contaminants in food focuses on this. Additionally, the general advice to eat a varied diet remains important for the lowest possible intake of contaminants.

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Appendix 1 Link of maximum levels (MLs), indicative levels and action limits to foods of a diet according to the Wheel of Five Guidelines

Link of maximum levels (MLs) as reported in Commission Regulation (EC) No. 1881/2006 (Table 2-A), indicative levels for acrylamide as reported in Commission Recommendation 2013/647/2013 (Table 2-B) and action limits for perchlorate as reported in a statement on 10 March 2015, updated on 23 June 2015, regarding the presence of perchlorate in food from the Standing Committee on Plants, Animals, Food and Feed (SCoPAFF)[5] (Table 2-C) to foods of a diet according to the Wheel of Five Guidelines.

Table 2-A. Link of the maximum levels (MLs)[a]

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
Aflatoxin B_1 and sum of aflatoxins B_1, B_2, G_1 and G_2		
1.1.5	Groundnuts (peanuts) and other oilseeds and processed products thereof, intended for direct human consumption or use as an ingredient in food	Linseeds Peanuts - dry roasted Peanuts - unsalted Sesame seeds Sunflower seeds Tempeh[c] Tofu[c]
1.1.7	Tree nuts and processed products thereof, intended for direct human consumption or use as an ingredient in food	Cashew nuts – unsalted Walnuts - unsalted
1.1.9	Almonds, pistachios and apricot kernels, intended for direct human consumption or use as an ingredient in food	Almonds, peeled - unsalted Mixed nuts – unsalted Trail mix (*studentenhaver*)[d]

[5] ec.europa.eu/food/safety/docs/cs_contaminants_catalogue_perchlorate_statement_food_update_en.pdf

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
1.1.11	Hazelnuts and Brazil nuts, intended for direct human consumption or use as an ingredient in food	Brazil nuts - unsalted Hazelnuts - unsalted Macadamia nuts Pecans - unsalted
1.1.12	Cereals and all products derived from cereals	Bread (excluding bread substitutes), except 'maize bread' and 'maize bread w sunflower seeds' Grain/cereal products (not bread), except 'unpolished rice – cooked' Groats porridge, buttermilk Oatmeal porridge, unsweetened - prepared w semi-skimmed milk
1.1.13	Maize and rice to be subjected to sorting or other physical treatment before human consumption or use as an ingredient in food	Corn oil Maize bread Maize bread w sunflower seeds Maize germ oil Unpolished rice - cooked
Aflatoxin M_1		
1.1.15	Raw milk, heat -treated milk and milk for the manufacture of milk -based products	Cheese and cheese substitutes Milk and dairy products
Ochratoxin A (OTA)		
1.2.3	All products derived from unprocessed cereals and cereals intended for direct human consumption	Bread (excluding bread substitutes) Grain/cereal products (not bread)
1.2.6	Soluble coffee (instant coffee)	Coffee - brewed
Deoxynivalenol (DON)		
1.4.4	Cereals intended for direct human consumption, cereal flour, semolina, bran and germ as end product marketed for direct human consumption	Oat bran Oatmeal Wheat bran Wheat flour Wheat germs 7-grains 'energy breakfast'

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
1.4.5	Pasta	Wholegrain pasta - cooked
1.4.6	Bread, pastries, biscuits, cereal snacks and breakfast cereals	Bread (excluding bread substitutes) Wholegrain 'Cracotte' crackers Wholegrain crispbread (*knäckebröd*) Wholegrain Dutch rusk (*beschuit*)
Zearalenone		
1.5.3	Cereals intended for direct human consumption, cereal flour, semolina, bran and germ as end product marketed for direct human consumption	Oat bran Oatmeal Wheat bran Wheat flour Wheat germs 7-grains ‘energy breakfast’
1.5.5	Bread, pastries, biscuits, cereal snacks and breakfast cereals	Bread (excluding bread substitutes) Wholegrain 'Cracotte' crackers Wholegrain crispbread (*knäckebröd*) Wholegrain Dutch rusk (*beschuit*)
1.5.9	Refined maize oil	Corn oil Maize germ oil-
Fumonisin B_1 and B_2		
1.6.2	Maize intended for direct human consumption, maize - based food for direct human consumption	Corn oil Maize bread Maize bread w sunflower seeds Maize germ oil
Erucic acid		
2.1.1	Vegetable oils and fats	‘Becel’ oil Corn oil Groundnut oil Linseed oil Maize germ oil

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
		Olive oil Safflower oil Soybean oil Sunflower oil 'Wok' oil avg.
2.1.2	Food containing added vegetable oils and fats	Spreading and cooking fats, except foods linked to erucic acid food category 2.1.1
Nitrate		
3.1	Fresh spinach (*Spinacia oleracea*)	Chard – cooked Chard - raw Spinach – cooked Spinach - raw
3.2	Preserved, deep -frozen or frozen spinach	Spinach, frozen - cooked
3.3	Fresh Lettuce *(Lactuca sativa* L.)	Head lettuce – raw[e] Green lettuce avg. – raw[e]
3.4	'Iceberg' type lettuce	Iceberg lettuce – raw[f]
3.5	Rucola (*Eruca sativa, Diplotaxis* sp., *Brassica tenuifolia, Sisymbrium tenuifolium*)	Rocket – raw[g]
Lead		
4.1.1	Vegetables	Potatoes and tubers[h] Artichoke - raw Asparagus - cooked Bami package - cooked Bean sprouts - cooked Bean sprouts - raw Broad beans - cooked Broad beans, frozen - uncooked Bunched carrots - raw Bunched carrots - cooked

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
		Carrots avg. - cooked Carrots avg. - raw Celeriac - cooked Celeriac - raw Celery - cooked Celery - raw Fennel - cooked Fennel - raw Green beans - cooked Green beans, frozen - cooked Garlic - raw Kohlrabi - cooked Kohlrabi - raw Leek - cooked Leek - raw Lettuce onion - cooked Lettuce onion - raw Mangetout - cooked Mangetout w carrots – cooked Onion - raw String beans - cooked String beans, frozen - uncooked Radish - raw Red beets - cooked Swedish turnip - cooked Vegetables avg. - raw Vegetable mix, Mexico, frozen - uncooked Vegetable mix, puszta, frozen - uncooked Vegetable soup, frozen - uncooked

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
		Vegetable soup - raw Vegetables avg. - cooked Vegetables avg. - raw Winter carrots - raw Winter carrots - cooked Yardlong beans - cooked
4.1.2	Leafy brassica, salsify, leaf vegetables and cultivated fungi: common mushroom (*Agaricus bisporus*), oyster mushroom (*Pleurotus ostreatus*) and shiitake mushroom (*Lentinula edodes*)	Broccoli - cooked Broccoli - raw Brussels sprouts - cooked Brussels sprouts, frozen – cooked Cauliflower - raw Cauliflower – cooked Chanterelles - cooked Chard - cooked Chard - raw Chicory - cooked Chicory - raw Chinese cabbage - cooked Chinese cabbage - raw Conical cabbage - cooked Conical cabbage - raw Endive - cooked Endive, frozen - uncooked Endive - raw Green cabbage - cooked Green lettuce avg. - raw Head lettuce - raw Head lettuce + frisee lettuce Iceberg lettuce - raw

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
		Kale - cooked Kale, frozen - cooked Kale, glass Lamb's lettuce – cooked Lamb's lettuce - raw Lettuce - cooked Mole lettuce - raw Mushrooms - cooked Mushrooms - raw Mustard cabbage - raw Onion - cooked Purslane - cooked Purslane - raw Red cabbage – cooked Red cabbage - raw Red lettuce - raw Rocket – raw Salsify - cooked Savoy cabbage - cooked Savoy cabbage - raw Spinach - cooked Spinach, frozen - cooked Spinach - raw Tayer leaves - raw Turnip greens - raw White cabbage - cooked White cabbage - raw
4.1.3.1	Fruiting vegetables: Sweet corn	Sweet corn - cooked
4.1.3.2	Fruiting vegetables: other than sweet corn	Aubergine - cooked

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
		Beefsteak tomato - cooked Beefsteak tomato - raw Cherry tomato - raw Courgette - cooked Courgette - raw Cucumber - cooked Cucumber w/o peel - raw Cucumber w peel - raw Pumpkin - cooked Sweet pepper avg. – cooked Sweet pepper avg. - raw Sweet pepper, green - raw Sweet pepper, green - cooked Sweet pepper, red - raw Sweet pepper, red - cooked Sweet pepper, yellow - raw Sweet pepper, yellow - cooked Tomato avg. - cooked Tomato avg. - raw Tomato - cooked Tomato - raw Vine tomato - raw
4.1.4.1	Fruit: Cranberries, currants, elderberries and strawberry tree fruit	Strawberries Cranberries
4.1.4.2	Fruit: Fruits other than cranberries, currants, elderberries and strawberry tree fruit	Fruit, except strawberries and cranberries
4.1.5	Cereals and pulses	Legumes Peas - cooked Peas, frozen – cooked

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
		Peas w carrots, frozen - uncooked Tempeh[i] Tofu[i]
4.1.6	Meat of bovine animals, sheep, pig and poultry	Red meat, except ‘beef liver – raw’, ‘horse meat – raw’, ‘hare – raw’, ‘wild roe – raw’ and ‘goat meat avg. – raw’ Chicken breast - cooked Chicken breast - raw Chicken drumstick w skin – raw Chicken w skin - raw Turkey breast – raw Turkey - raw
4.1.7	Offal of bovine animals, sheep, pig and poultry	Beef liver - raw
4.1.8	Muscle meat of fish	Seafood, except foods linked to lead food categories 4.1.10 and 4.1.11, and ‘vineyard snails’
4.1.10	Crustaceans	Crab in water, tin Dutch shrimps - cooked Lobster - cooked Shrimps in water, tin
4.1.11	Bivalve molluscs	Mussels - cooked Mussels, glass - pickled Oysters
4.1.12	Raw milk, heat -treated milk and milk for the manufacture of milk -based products	Cheese and cheese substitutes Milk and dairy products
4.1.14	Fats and oils, including milk fat	Spreading and cooking fats
Cadmium		
4.2.1	Vegetables and fruit	Fruit Vegetables, except foods linked to cadmium food categories 4.2.2.1, 4.2.2.2. and 4.2.3
4.2.2.1	Root, tuber and stem vegetables: celeriac,	Celeriac - cooked

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
	parsnips, salsify, horseradish and celery	Celeriac - raw Celery - cooked Celery - raw Salsify - cooked
4.2.2.2	Root, tuber and stem vegetables: other than celeriac, parsnips, salsify, horseradish and celery	Potatoes and tubers Asparagus - cooked Bunched carrots - cooked Bunched carrots - raw Carrots avg. - cooked Carrots avg. - raw Chicory - cooked Chicory - raw Fennel - cooked Fennel - raw Garlic - raw Leek - cooked Leek - raw Lettuce onion – cooked Lettuce onion - raw Onion - raw Radish - raw Red beets - cooked Winter carrots - cooked Winter carrots - raw
4.2.3	Leaf vegetables, fresh herbs, leafy brassica	Broccoli - cooked Broccoli -raw Cauliflower - cooked Cauliflower - raw Chard – cooked

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
		Chard - raw Chinese cabbage – cooked Chinese cabbage - raw Conical cabbage - cooked Conical cabbage - raw Endive - raw Endive - cooked Endive, frozen - uncooked Garden cress - raw Green cabbage - cooked Green lettuce avg. - raw Head lettuce + frisee lettuce Head lettuce - raw Iceberg lettuce - raw Kale - cooked Kale, frozen - cooked Kale, glass Kohlrabi - raw Lamb's lettuce - cooked Lamb's lettuce - raw Lettuce - cooked Mole lettuce - raw Mustard cabbage - raw Onion - cooked Purslane - cooked Purslane - raw Red cabbage - cooked Red cabbage - raw Red lettuce - raw

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
		Rocket – raw Savoy cabbage - cooked Savoy cabbage - raw Spinach - cooked Spinach, frozen - cooked Spinach - raw Tayer leaves - raw Turnip greens - raw White cabbage - cooked White cabbage - raw
4.2.4.1	Common mushroom (*Agaricus bisporus*), oyster mushroom (*Pleurotus ostreatus*) and shiitake mushroom (*Lentinula edodes*)	Chanterelles - cooked Mushrooms - cooked Mushrooms - raw
4.2.5	Cereal grains	Maize bread Maize bread w sunflower seeds Oatmeal
4.2.6	Wheat and rice grains, wheat bran and wheat germ for direct consumption, soy beans	Bread (excluding bread substitutes), except 'maize bread' and 'maize bread w sunflower seeds' Grain/cereal products (not bread), except oatmeal Tempeh Tofu
4.2.7	Meat of bovine animals, sheep, pig and poultry	White meat and meat substitutes, except tempeh, tofu and 'domestic rabbit – raw' Red meats, except 'horse meat – raw', beef liver – raw', 'hare – raw', 'wild roe – raw' and 'goat meat avg. – raw'
4.2.8	Horse meat	Horse meat - raw
4.2.9	Liver of bovine animals, sheep, pig, poultry and horse	Beef liver - raw
4.2.11	Muscle meat of fish	Seafood, excepts foods linked to cadmium food categories 4.2.12,

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
		4.2.14, 4.2.15 and 4.2.16, and 'vineyard snails'
4.2.12	Muscle meat of mackerel *(Scomber* species), tuna (*Thunnus* species, *Katsuwonus pelamis, Euthynnus* species) and bichique (*Sicyopterus lagocephalus*)	Mackerel fillet - smoked Mackerel in oil, tin Mackerel - prepared in microwave w/o additives Mackerel - steamed Squid - prepared in microwave w/o additives Tuna in oil, tin Tuna in water, tin Tuna - raw
4.2.14	Muscle meat of anchovy *(Engraulis species)*, swordfish *(Xiphias gladius)* and sardine *(Sardina pilchardus)*	Sardines in oil, tin Anchovies in oil, tin
4.2.15	Crustaceans	Crab in water, tin Dutch shrimps - cooked Lobster - cooked Shrimps in water, tin
4.2.16	Bivalve molluscs	Mussels - cooked Mussels, glass - pickled Oysters
Mercury[j]		
4.3.1	Fishery products and muscle meat of fish	Seafood, except foods linked to mercury food category 4.3.2
4.3.2	Muscle meat of anglerfish (Lophius species), Atlantic catfish (Anarhichas lupus), bonito (Sarda sarda), eel (Anguilla species), emperor, orange roughy or rosy soldierfish (Hoplostethus species), grenadier (Coryphaenoides rupestris), halibut (Hippoglossus hippoglossus), kingklip (Genypterus capensis), marlin (Makaira species), megrim (Lepidorhombus species),	Eel - prepared in microwave w/o additives Eel - smoked Squid - prepared in microwave w/o additives Tuna in oil, tin Tuna in water, tin Tuna - raw

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
	mullet (Mullus species), pink cusk eel (Genypterus blacodes), pike (Esox lucius), plain bonito (Orcynopsis unicolor), poor cod (Tricopterus minutes), Portuguese dogfish (Centroscymnus coelolepis), rays (Raja species), redfish (Sebastes marinus, S. mentella, S. viviparus), sail fish (Istiophorus platypterus), scabbard fish (Lepidopus caudatus, Aphanopus carbo), seabream or pandora (Pagellus species), shark (all species), snake mackerel or butterfish (Lepidocybium flavobrunneum, Ruvettus pretiosus, Gempylus serpens), sturgeon (Acipenser species), swordfish (Xiphias gladius), tuna (Thunnus species, Euthynnus species, Katsuwonus pelamis)	
Arsenic (inorganic)		
4.4.2	Parboiled rice and husked rice	Unpolished rice - cooked
Tin (inorganic)		
4.5.1	Canned food	Anchovies in oil, tin Brown beans, tin/glass Crab in water, tin Herring fillet in tomato sauce, tin Mackerel in oil, tin Salmon, tin Sardines in oil, tin Shrimps in water, tin Tuna in oil, tin Tuna in water, tin

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
Sum of dioxins, sum of dioxins and dioxin-like PCBs and sum of non-dioxin-like PCBs[k]		
5.1.1.1	Meat and meat products of bovine animals and sheep	Red meat, except foods linked to dioxins and PCBs food categories 5.1.1.2 and 5.1.1.3, and ‘beef liver – raw’, ‘horse meat – raw’, ‘hare – raw’, ‘wild roe – raw’ and ‘goat meat avg. – raw’.
5.1.1.2	Meat and meat products of poultry	White meat and meat substitutes, except ‘domesticated rabbit – raw’, tempeh and tofu Ostrich meat - raw
5.1.1.3	Meat and meat products of pigs	Pork fillets - raw Pork loin cutlets - prepared Pork loin cutlets - raw Pork medallions - raw Pork rib chops - raw Pork rump - raw Pork schnitzel - unbreaded raw Pork shoulder chops – raw Pork shoulder steaks - raw Pork steaks - raw Pork stewing meat – raw Pork tenderloin - raw
5.1.2.2	Liver of bovine animals, poultry and pigs	Beef liver - raw
5.1.5	Muscle meat of fish, other fishery products and products thereof	Seafood, except ‘vineyard snails’
5.1.11	Raw milk and dairy products	Cheese and cheese substitutes Milk and dairy products
5.1.12	Hen eggs and egg products	Eggs
5.1.13	Vegetable oils and fats	Spreading and cooking fats
Polycyclic aromatic hydrocarbons (PAHs)		
6.1.9	Oils and fats intended for direct human	Spreading and cooking fats

Commission Regulation (EC) No. 1881/2006		Food group or foods of a diet according to the Wheel of Five Guidelines
Food category[b] and contaminant	Food category name	
	consumption or use as an ingredient in food	

PCBs: polychlorinated biphenyls

[a] For the following contaminants, none of the food categories with an ML in Commission Regulation (EC) No. 1881/2006 could be linked to foods of a diet according to the Wheel of Five Guidelines: patulin, citrinin, ergot sclerotia, ergot alkaloids, erucic acid, tropane alkaloids, 3-monochloropropane-1,2-diol (3-MCPD) and melamine

[b] Food categories not listed were not included in the ML scenario for the relevant contaminant(s)

[c] Main ingredient of tempeh and tofu is soybean. Soybean is a legume, but according to Commission Regulation (EC) No. 1881/2006 soybean is classified under food category 'Oil seeds'

[d] Highest ML was taken (the one for nuts instead of dried fruit)

[e] Average ML of the underlying nitrate food categories 3.3.1, 3.3.2, 3.3.3 and 3.3.4 was used in the ML scenario (=4000 mg NO_3/kg)

[f] Average ML of the underlying nitrate food categories 3.4.1 and 3.4.2 was used in the ML scenario (=2250 mg NO_3/kg)

[g] Average ML of the underlying nitrate food categories 3.5.1 and 3.5.2 was used in the ML scenario (=6500 mg NO_3/kg)

[h] ML applies to peeled potatoes

[i] For lead, there is no ML for oil seeds. Tempeh and tofu were therefore assigned to the food category 'Cereals and pulses'

[j] See section 2.5

[k] For sum of dioxins, sum of dioxins and dioxin-like PCBs and sum of non-dioxin-like PCBs, part of the MLs were expressed per gram fat. To link these MLs to food groups or underlying foods of a diet according to the Wheel of Five Guidelines, the consumption quantities of the relevant food groups or foods were converted to equivalent consumption amounts of fat using fixed fat percentages per food (group) based on information from the Dutch Food Composition Database (NEVO)

Table 2-B. Link of indicative levels for acrylamide

Food category[a]	Foods of a diet according to the Wheel of Five Guidelines
Soft bread	
a. Wheat based bread	Bread, 'Brinta' high fibre
	Brown bread, light, 'Blue Band Goede Start'
	Brown bread, tiger
	Gluten-free bread, 'Glutafin'
	Linseed bread
	Malt bread, 'Tarvo'
	Multigrain bread w various seeds avg.
	Multigrain roll, hard
	Multigrain roll, soft
	Wheat bread
	Wheat bread, low-sodium
	Wheat bread w pumpkin seeds
	Wheat bread w sunflower seeds
	Wheat bread w various seeds
	Wheat roll, hard
	Wheat roll, soft
	White bread, 'Blue Band Goede Start'
	White bread, 'C1000 Kids'
	Wholegrain bread, avg. of fine and coarse
	Wholegrain bread, sourdough
	Wholegrain bread w nuts
	Wholegrain bread w pumpkin seeds
	Wholegrain bread w sunflower seeds
	Wholegrain bread w various seeds
	Wholegrain roll, soft
b. Soft bread other than wheat based bread	Wholegrain wheat-rye bread
	Maize bread
	Maize bread w sunflower seeds
	Rye bread avg.
	Rye bread, dark

Food category[a]	Foods of a diet according to the Wheel of Five Guidelines
	Rye bread, light
Crackers with the exception of potato based crackers Crispbread Products similar to the other products in this category	Wholegrain 'Cracotte' crackers Wholegrain crispbread (*knäckebröd*) Wholegrain Dutch rusk (*beschuit*)
Roast coffee	Coffee – brewed[b]
Processed cereal based foods for infants and young children (***), excl. biscuits and rusks	7-grains ‘energy breakfast’

[a] Food categories not listed were not included in in the ML scenario
[b] Indicative level in roast coffee (as sold) was diluted by a factor of 20 (EFSA, 2015) for link to the consumption of brewed coffee
(***) As defined in Article 1(2)(a) of Directive 2006/125/EC

Table 2-C. Link of indicative levels for perchlorate

Food category[a]	Foods of a diet according to the Wheel of Five Guidelines
Fruit and vegetables with the exception of *Cucurbitaceae* and leafy vegetables except[b]	Fruit, except melon, sugar melon and watermelon Vegetables, except those listed below Chard - cooked Chard - raw Chicory - cooked Chicory - raw Courgette - cooked Courgette - raw Cucumber - cooked Cucumber w/o peel - raw Cucumber w peel - raw Endive, cooked Endive, frozen - uncooked Endive, raw Kale - cooked Kale, frozen - cooked Kale, glass Melon Mustard cabbage - raw

Food category[a]	Foods of a diet according to the Wheel of Five Guidelines
	Pak choi - raw
	Pumpkin - cooked
	Purslane - cooked
	Purslane - raw
	Seaweed kelp - raw
	Sugar melon
	Turnip greens - raw
	Watermelon
- celery and spinach grown in glasshouse/under cover[b]	Celeriac - cooked
	Celeriac - raw
	Celery - cooked
	Celery - raw
	Spinach - cooked
	Spinach, frozen - cooked
	Spinach - raw
- herbs, lettuce and salad plants, including rocket, grown in glasshouse/under cover[b]	Garden cress – raw
	Green lettuce avg. - raw
	Head lettuce + frisee lettuce
	Head lettuce - raw
	Iceberg lettuce - raw
	Lamb's lettuce - cooked
	Lamb's lettuce - raw
	Lettuce - cooked
	Mole lettuce - raw
	Red lettuce - raw
	Rocket - raw
Tea (*Camellia sinensis*), dried[c]	Tea - brewed
Foods for infants and young children – ready-to-eat	7-grains 'energy breakfast'

[a] Food categories not listed were not included in the ML scenario. Food category 'Other foods' was also not included as it is unrealistic to expect perchlorate to be present at the ML (0.05 mg/kg) in all other foods

[b] Foods in the diet according to the Wheel of Five Guidelines assigned to these subcategories were conservatively assumed to have been grown in a glasshouse or under cover. The action limits of perchlorate of these subcategories were higher than the overall action limit for the food category '*Cucurbitaceae* and leafy vegetables'

[c] ML for ‘Tea, dried’ was diluted by a factor of 60, based on the average dilution factor used by the EFSA CONTAM Panel in the intake study of lead (EFSA, 2012b), for the link to ‘Tea – brewed’

Appendix 2 Link of measured concentrations to foods of a diet according to the Wheel of Five Guidelines

To calculate the refined intake of contaminants via a diet according to the Wheel of Five Guidelines, each food (group) was linked to an average concentration of the contaminant obtained from different sources (sections 2.3 and 3.3.1; Table 8). A description of how this was done for each relevant contaminant is described below. For a detailed link as well as the average concentrations used, see the tables in this appendix.

3-MCPD
Measured concentrations of 3-MCPD were linked to the food group 'spreading and cooking fats' of the Wheel of Five Guidelines. The other measured foods were not part of the guidelines.

Acrylamide
Measured concentrations of acrylamide were grouped into comparable food groups. The average concentrations per food group were then calculated and linked to the relevant foods or food groups of a diet according to the Wheel of Five Guidelines. For the food group 'nuts and seeds', only one measured concentration for 'Duyvis peanut salted' was available in the monitoring data. Therefore, the measured concentration reported for roasted nuts by the EFSA CONTAM Panel (EFSA, 2015) was used for this food group. Measured concentrations in coffee were converted to concentrations in brewed coffee with an average dilution factor of 20 (EFSA, 2015).

The limit of detection (LOD) and/or quantification (LOQ) of the foods reported in the KAP database were not normally supplied in the selected period (2009-2014). Therefore, a fixed limit value of 8 µg/kg (as reported in Boon et al. (2009)) was used.

Aflatoxin B_1, sum of aflatoxins B_1, B_2, G_1 and G_2, aflatoxin M_1, citrinin, deoxynivalenol (DON), ergot alkaloids, sum of fumonisins B_1 and B_2 and ochratoxin A (OTA))
For these contaminants (mycotoxins), measured concentrations from the Dutch mycotoxin Total Diet Study (mTDS) were used. In this study, composite samples of comparable foods in terms of contamination from mycotoxins were analysed. The composition of the samples was based on the food consumption data from the national food consumption surveys conducted among young children (2-6 years) in 2005-2006 and persons aged 7-69 years in 2007-2011 (Sprong et al., 2016b). Two separate composite samples for a certain food group were prepared, if the consumption of foods within this food group differed between the two age groups. The measured concentrations of the composite samples were linked to the appropriate foods or food groups of a diet according to the Wheel of Five Guidelines. Foods or food groups for the target groups 1-3 years and 4-8 years were linked to the composite samples for young children, if relevant, and the composite samples for persons aged 7-69 to the foods and food groups for the other target groups.

If a food or food group of a diet according to the Wheel of Five Guidelines could not be linked to one composite sample, an average measured concentration of multiple composite samples was calculated. For example, the food ‘fruit fresh including citrus avg –‘ was linked to the average measured concentration of composite samples of various types of fruit, including citrus fruit, apples and bananas. This was based on the assumption of equal representation of the composite samples to the total measured concentration of the relevant food.

For the calculation of the intake of groups of mycotoxins (sum of aflatoxins B_1, B_2, G_1 and G_2, ergot alkaloids, and the sum of fumonisins B_1 and B_2), the measured concentrations per mycotoxin were summed per composite sample based on equivalent toxicity (Sprong et al., 2016a).

Arsenic, cadmium, lead, methylmercury and perchlorate
Most measured concentrations of arsenic, cadmium, lead, methylmercury and perchlorate were available at the raw agricultural product level. Wherever possible, these concentrations were directly linked to the foods or food groups of a diet according to the Wheel of Five Guidelines, such as fruit and vegetables. The conversion model to convert concentrations in raw products into processed or composite foods was not used for this: the Wheel of Five Guidelines contain only a few processed foods. For the link of measured concentrations of lead to the food groups ‘bread (excluding bread substitutes)’ and ‘grain/cereal products (not bread)’, use was made of the lead measured concentrations analysed in the mTDS samples (section 3.3.1).

In samples for which no LOD or LOQ was available, the limit value was equalled to 0.1 mg/kg for arsenic, 0.2 mg/kg for cadmium and 0.005 mg/kg for lead. These values were the lowest reported positive concentrations per contaminant. For methylmercury and perchlorate, the LOQ was reported for all samples.

Measured concentrations of lead in tea leaves were converted to concentrations in the drinkable product using an average dilution factor of 60 (EFSA, 2012b). For the calculation of the concentration of arsenic in coffee based on measured concentrations in coffee beans, a dilution factor of 18 was used (EFSA, 2014a). Lead and cadmium were further analysed in kidney and liver. Measured concentrations therein were converted to the corresponding concentrations in meat using conversion factors. For cadmium, the ratio 1:31:134 for meat:liver:kidney was used (Sprong & Boon, 2015). For lead, the ratio 1:1.5 for meat:liver for poultry was used and the ratio 1:4:8 for meat:liver:kidney for the other animals (Boon et al., 2017).

For processed seafood, such as fillet of haddock and fish fingers, it was assumed that it, in accordance with the Wheel of Five Guidelines, consisted of 70% fish (Brink et al., 2016).

Nitrate
As in the case of arsenic, cadmium, lead and methylmercury, most measured concentrations of nitrate are available at the level of the raw agricultural product. Where possible, the measured concentrations were

directly linked, such as fruit and vegetables. For fruit and vegetables for which no measured concentrations were available, a link was made with a comparable food. In allocating the most optimal nitrate concentration, recipes from the Dutch Food Composition Database (NEVO) were used for a number of prepared foods. For example, the food ‘mashed potatoes prepared w water w/o cooking fat’ was linked to the nitrate concentration of potatoes based on 75% potato.

For fruit, only a limited number of measured concentrations were available for some types of fruit. Since it could not be ruled out that the non-analysed types of fruit could also contain nitrate, the lowest measured concentration (5 mg/kg) was assigned to this food group.

In the link, the measured concentrations were corrected for effects of processing, as reported in Boon et al. (2009), if relevant.

3-MCPD

Food	Number of samples	% positive samples[a]	Measured concentration[b] (µg/kg)
Margarines and low-fat margarines	4	100	638
Olive oil	2	50	210
Other oils	2	100	525
Sunflower oil	1	100	630

[a] Percentage of samples with a measured concentration > limit of detection or quantification
[b] Based on measured concentrations reported in Boon & te Biesebeek (2016)

Acrylamide

Food group	Food	Number of samples	% positive samples[a]	Measured concentration (µg/kg)
Fruit	Plums w peel	1	100	25
Bread (excluding bread substitutes)	Gluten-free bread, 'Glutafin' Maize bread Maize bread w sunflower seeds White bread, 'Blue Band Goede Start' White bread, 'C1000 Kids'	12	17	7.5
	Bread, 'Brinta' high fibre Brown bread, light, 'Blue Band Goede Start' Brown bread, tiger Linseed bread Malt bread, 'Tarvo' Multigrain bread w various seeds avg. Multigrain roll, hard Multigrain roll, soft Wheat bread Wheat bread, low-sodium Wheat bread w pumpkin seeds Wheat bread w sunflower seeds Wheat bread w various seeds	9	22	8.7

Food group	Food	Number of samples	% positive samples[a]	Measured concentration (µg/kg)
	Wheat roll, hard Wheat roll, soft Wholegrain bread, avg. of fine and coarse Wholegrain bread w nuts Wholegrain bread w pumpkin seeds Wholegrain bread w sunflower seeds Wholegrain bread w various seeds Wholegrain wheat rye bread Wholegrain bread, sourdough Wholegrain roll, soft			
	Rye bread avg. Rye bread, dark Rye bread, light	4	75	28
Grain/cereal products (not bread)	Wholegrain Dutch rusk *(beschuit)*	4	75	21
	Wholegrain 'Cracotte' crackers Wholegrain crispbread (*knäckebröd*)	9	100	165
	7-grains 'energy breakfast'	61	57	29
Non-alcoholic drinks	Coffee - brewed	29	34	7.25
Nuts and seeds	Nuts, chestnuts and trail mix (*studentenhaver*)	40	100	93[b]

[a] Percentage of samples with a measured concentration > limit of detection or quantification
[b] Obtained from the EFSA CONTAM Panel (EFSA, 2015). This concentration refers to roasted nuts and seeds.

Aflatoxin B_1, sum of aflatoxins B_1, B_2, G_1 and G_2 and aflatoxin M_1

Food group	Food	Measured concentration (µg/kg)		
		Aflatoxin B_1	Sum of aflatoxin B_1, B_2, G_1 and G_2[a]	Aflatoxin M_1
Fruit		0.025[b]	0.1[b]	-
Bread (excluding bread substitutes)		0.025[b]	0.1[b]	-
Grain/cereal products (not bread)		0.025[b]	0.1[b]	
Nuts and seeds	Peanuts - dry roasted Peanuts - unsalted	0.1	0.175	-
	Mixed nuts - unsalted	0.0625	0.1375	-
	Trail mix (*studentenhaver*)	0.05	0.125	-
	Other nuts and seeds	0.025[b]	0.1[b]	-
White meat and meat substitutes	Chicken breast - cooked Chicken breast - raw Chicken drumstick w skin – raw Chicken w/o skin - raw Chicken w skin - raw Domestic rabbit - raw Turkey breast – raw Turkey - raw	0.025[b]	0.1[b]	-
Red meat		0.025[b]	0.1[b]	-
Milk and dairy products	Groats porridge, buttermilk Oatmeal porridge - prepared w semi-skimmed milk unsweetened	0.025[b]	0.1[b]	0.0005[b]
	Other milk and dairy products	-	-	
Cheese and cheese substitutes	Cheese 'Rambol'	0.025[b]	0.1[b]	0.0005[b]
	Other cheese and cheese substitutes	-	-	
Spreading and cooking fats		0.025[b]	0.1[b]	-

[a] Calculated by adding the concentrations for the individual mycotoxins based on equivalent toxicity

[b] Measured concentration < limit of detection. Based on an analysis of the MLs and literature-based contamination profiles performed by Sprong et al. (2016a), it could not be ruled out that these foods or food groups may contain the mycotoxin and measured concentrations were therefore not assumed zero.

Arsenic (inorganic)

Food group	Food	Number of samples	% positive samples[a]	Measured concentration[b] (mg/kg)
Potatoes and tubers[c]		1065	29	0.004
Bread (excluding bread substitutes)		49	2	0.02
Egg[c]		1768	24	0.006
Fruit		20	0	0.004[d]
Grain/cereal products (not bread)	Unpolished rice – cooked[c]	94	98	0.15
	Other grain/cereal products (not bread)	49	2	0.02[d]
Vegetables		34	0	0.024[d]
Cheese and cheese substitutes[c]		1278	25	0.009
Milk and dairy products[c]		5291	22	0.006
Non-alcoholic drinks[c]	Coffee - brewed	37	7	0.002
	Drinking water avg.	15383	24	0.002
	Tea - brewed	66	2	0.009
	Other non-alcoholic drinks	6969	18	0.003
Nuts and seeds[c]	Almonds, peeled - unsalted	208	18	0.01
	Brazil nuts – unsalted	726	85	0.014
	Cashew nuts – unsalted	94	4	0.01
	Chestnuts	57	12	0.008
	Hazelnuts – unsalted	77	13	0.02
	Macadamia nuts	106	4	0.016
	Mixed nuts - unsalted Pecans – unsalted Trail mix (*studentenhaver*)	726	85	0.014[e]
	Peanuts - dry roasted Peanuts - unsalted	169	19	0.018

Food group	Food	Number of samples	% positive samples[a]	Measured concentration[b] (mg/kg)
	Walnuts - unsalted	46	28	0.015
	Seeds	862	43	0.024
Legumes		9	0	0.005[d]
Red meat		194	0	0.05[f]
Spreading and cooking fats[c]	Margarines and low-fat margarines	42	48	0.008
	Oils	268	38	0.015
Seafood	Buckling - smoked Herring - salted Herring - smoked Herring (sweet) - pickled Herring fillet in tomato sauce, tin	27	96	2.0 1.4[g]
	Crab in water, tin Lobster - cooked	12	100	0.5
	Dutch shrimp - cooked Shrimp in water, tin	19	89	1.9
	Fillet of haddock - deep-fried Fillet of haddock - prepared w/o cooking fat Fish fingers - cooked Fish fingers - uncooked	507	99	0.94[d,f]
	Mackerel fillet – smoked Mackerel in oil, tin Mackerel - steamed Mackerel - prepared in microwave w/o additives	23	100	1.4
	Mussels - cooked Mussels, glass - pickled	27	100	2.3
	Oysters	12	92	3.5
	Farmed salmon - prepared in microwave w/o additives Salmon, tin Salmon - smoked	38	100	0.4

Food group	Food	Number of samples	% positive samples[a]	Measured concentration[b] (mg/kg)
	Salmon - raw Salmon trout - prepared in microwave w/o additives Trout - prepared in microwave w/o additives Salmon, pate / mousse			0.25[f]
	Sardines in oil, tin	55	100	2.1
	Tuna in oil, tin Tuna in water, tin Tuna - raw	234	99	0.91
	Other seafood	582	98	1.7[d]
White meat and meat substitutes[c]	Tempeh Tofu	15	27	0.01
	Other white meat and meat substitutes	2720	28	0.007

[a] Percentage of samples with a measured concentration > limit of detection or quantification
[b] Measured concentrations from the Netherlands, unless stated otherwise
[c] Measured concentrations from the EFSA CONTAM Panel (EFSA, 2014a)
[d] Average measured concentration of all foods belonging to the food group
[e] Concentration of the entire food group 'Tree nuts' (EFSA, 2014a)
[f] Average measured concentration of arsenic in pork
[g] Based on the assumption of 70% fish (recommendation Wheel of Five Guidelines)

Cadmium

Food group	Food	Number of samples	% positive samples[a]	Measured concentration[b] (mg/kg)
Potatoes and tubers[c]		2280	-	0.022
Bread (excl. bread substitutes)[c]		2078	-	0.015
Egg[c]		1183	-	0.0033
Fruit		20		0.002[d]
Grain and cereal products (not bread)[c]	Oatmeal 7-grains 'energy breakfast'	678	-	0.020[e]

Food group	Food	Number of samples	% positive samples[a]	Measured concentration[b] (mg/kg)
	Oat bran Unpolished rice - cooked Wheat germs Wheat bran	9297	-	0.033[f]
	Wheat flour	3388	-	0.025[g]
	Wholegrain 'Cracotte' crackers Wholegrain crispbread (*knäckebröd*) Wholegrain Dutch rusk *(beschuit)*	2078	-	0.015[h]
	Wholegrain pasta - cooked	614	-	0.022
Vegetables		61		0.03[d]
Cheese and cheese substitutes[c]		2872	-	0.011
Milk and dairy products[c]		3196	-	0.001
Non-alcoholic drinks	Coffee – brewed[c]	813	-	0.0007
	Drinking water avg.	781	1.4	0.0001
	Tea – brewed[c]	1511	-	0.0009
	Other non-alcoholic drinks[c]	2380	-	0.0004
Nuts and seeds[c]	Chestnuts and trail mix	1368	-	0.036
	Nuts and seeds	3496	-	0.371
Legumes		9	11	0.003[d]
Red meat	Beef, all types	456	99	0.005[i]
	Beef liver - raw	456	99	0.15[j]
	Goat meat avg. - raw	1282	100	0.003[d,i]
	Hare - raw	45	4	0.003
	Horse meat – raw	26	96	0.06
	Lamb <10 g fat avg. - raw Leg of lamb - raw Mutton <10 g fat avg. - raw	38	100	0.002[i]
	Ostrich meat - raw	7	29	0.02
	Pork, all types	664	100	0.002[i]

Food group	Food	Number of samples	% positive samples[a]	Measured concentration[b] (mg/kg)
	Veal, all types	123	100	0.002[i]
	Wild roe - raw	70	11	0.0037
Spreading and cooking fats[c]		163	-	0.0065
Seafood	Buckling - smoked Herring - salted Herring (sweet) - pickled Herring - smoked Herring fillet in tomato sauce, tin	27	15	0.006 0.005[k]
	Crab in water, tin Lobster - cooked	12	100	0.091
	Dutch shrimp - cooked Shrimp in water, tin	19	16	0.024
	Fillet of haddock - deep-fried Fillet of haddock - prepared w/o cooking fat Fish fingers - cooked Fish fingers - uncooked	514	72	0.024[d,k]
	Mackerel fillet – smoked Mackerel in oil, tin Mackerel - prepared in microwave w/o additives Mackerel - steamed	27	70	0.019
	Mussels - cooked Mussels, glass - pickled	27	100	0.114
	Oysters	12	100	0.703
	Farmed salmon - prepared in microwave w/o additives Salmon, tin Salmon - smoked Salmon - raw Salmon trout - prepared in microwave w/o additives	38	5	0.007

Food group	Food	Number of samples	% positive samples[a]	Measured concentration[b] (mg/kg)
	Trout - prepared in microwave w/o additives Salmon, pate / mousse			0.005[k]
	Sardines in oil, tin	55	91	0.079
	Tuna in oil, tin Tuna in water, tin Tuna - raw	234	76	0.022
	Other seafood	589	73	0.056[d]
White meat and meat substitutes	Domestic rabbit - raw	10	10	0.003
	Tempeh[c] Tofu[c]	-	-	0.023
	Other white meat and meat substitutes	417	98	0.001[l]

[a] Percentage of samples with a measured concentration > limit of detection or quantification. This information was not available for the concentrations derived from EFSA (2012a)
[b] Measured concentrations from the Netherlands, unless stated otherwise
[c] Measured concentrations from the EFSA CONTAM Panel (EFSA, 2012a). Contains no data on percentage of samples with a measured concentration > limit of detection or quantification
[d] Average measured concentration of all foods belonging to the food group
[e] Medium bound (MB) concentration for ‘Breakfast cereals’ (EFSA, 2012a)
[f] Medium bound (MB) concentration for ‘Grain milling products’ (EFSA, 2012a)
[g] Medium bound (MB) concentration for ‘Grains for human consumption’ (EFSA, 2012a)
[h] Medium bound (MB) concentration for ‘Bread and rolls’ (EFSA, 2012a)
[i] Concentration in meat calculated from measured concentrations in the kidney according to the ratio meat:kidney = 1:134
[j] Concentration in liver calculated from measured concentrations in the kidney according to the ratio liver:kidney = 31:134
[k] Based on the assumption of 70% fish (Wheel of Five Guidelines)
[l] Concentration calculated from measured concentrations in liver of poultry according to the ratio meat:liver = 1:31

Citrinin, deoxynivalenol (DON), ergot alkaloids, sum of fumonisins B_1 and B_2 and ochratoxin A (OTA)

Food group	Food	Measured concentration[a] (µg/kg)				
		Citrinin	Deoxynivalenol (DON)	Ergot alkaloids[b]	Sum of fumonisins B_1 and B_2[c]	Ochratoxin A (OTA)
Potatoes and tubers	Mashed potatoes - prepared w water w/o cooking fat	-	0.4[d]	-	-	0.25

Food group	Food	Measured concentration[a] (µg/kg)				
		Citrinin	Deoxynivalenol (DON)	Ergot alkaloids[b]	Sum of fumonisins B_1 and B_2[c]	Ochratoxin A (OTA)
	Potatoes w/o skin avg. – cooked Potatoes w skin avg. - cooked					
Vegetables	Green beans - cooked Green beans, frozen - cooked Mangetout - cooked Mangetout w carrots – cooked Peas - cooked Peas, frozen - cooked Peas w carrots, frozen - uncooked String beans - cooked String beans, frozen Sweet corn - cooked Yardlong beans - cooked	3.35[d]	16.5[d]	-	3.3[d]	0.083[d]
Fruit	Apricots w peel Avocado Blackberries Blueberries Blue grapes w skin Brambles Cherries Cranberries Dates - fresh Figs – fresh Gooseberries Grapes w skin avg. Khaki / Sharon fruit Lychee Mango Nectarine	3.35[d]	-	-	-	0.083[d]

Food group	Food	Measured concentration[a] (µg/kg)				
		Citrinin	Deoxynivalenol (DON)	Ergot alkaloids[b]	Sum of fumonisins B_1 and B_2[c]	Ochratoxin A (OTA)
	Papaya Passion fruit Peach w/o peel Pear w/o peel Pear w peel Plums w peel Pomegranate Raspberries Red berries White grapes w skin					
	Apple w/o peel avg. Apple w peel avg.					-
Brood (excluding bread substitutes)	Gluten-free bread, 'Glutafin'	3.35[d]	116/29	2.84	6.7/20.1	0.083[d]
	Maize bread Maize bread w sunflower seeds Rye bread avg. Rye bread, light		28.1/30.1	17.2/21.7	3.3[d]	
	Other bread		36.7/28.1	42.7/31.0		
Grain/cereal products (not bread)[4]	Oat bran Oatmeal Wheat bran Wheat flour 7-grains ‘energy breakfast’	3.35[d]	116/29	2.84	6.7/20.1	0.083[d]
	Wheat germs Wholegrain Dutch rusk (*beschuit*) Wholegrain 'Cracotte' crackers Wholegrain crispbread (*knäckebröd*)		36.7/28.1	42.7/31.0	3.3[d]	
	Wholegrain pasta – cooked		35	4.2		

Food group	Food	Measured concentration[a] (µg/kg)				
		Citrinin	Deoxynivalenol (DON)	Ergot alkaloids[b]	Sum of fumonisins B_1 and B_2[c]	Ochratoxin A (OTA)
	Unpolished rice - cooked		0.4[d]	2.84		
Nuts and seeds	Mixed nuts - unsalted Peanuts - dry roasted Peanuts - unsalted Other nuts and seeds	-	-	-	3.3[d]	0.083[d]
	Trail mix (*studentenhaver*)		16.5[d]		3.3[d]/7.6	
	Other nuts and seeds		-		-	
Legumes		3.35[d]	0.4[d]	-	-	1/1.7
Milk and dairy products	Groats porridge, buttermilk Oatmeal porridge, unsweetened - prepared w semi-skimmed milk	3.35[d]	116/29	2.8[d]	6.7/20	0.083[d]
Cheese and cheese substitutes	Cheese 'Rambol'	3.35[d]	-	-	-	0.083[d]
White meat and meat substitutes	Tempeh Tofu	-	0.4[d]	-	3.3[d]	-
Red meat	Beef liver – raw	-	-	-	-	0.0083[d]
Non-alcoholic drinks	Coffee - brewed	-	-	-	-	1.1
	Tea - brewed	-	-	-	3.3[d]	-

[a] In case of two measured concentrations, the first was used for the calculation of the intake in the youngest two target groups and the second for the other target groups of the Wheel of Five Guidelines

[b] Measured concentrations were calculated as the sum of the measured concentrations of agrociavine, ergocornine, ergocristine, ergocryptine, ergometrine, ergosine and ergotamine based on equivalent toxicity

[c] As [b], but then for fumonisins B_1 and B_2

[d] Measured concentrations < limit of detection. Based on an analysis of the MLs and literature-based contamination profiles performed by Sprong et al. (2016a), it could not be ruled out that these foods or food groups may contain the mycotoxin and measured concentrations were therefore not assumed zero.

Lead

Food group	Food	Number of samples	% positive samples[a]	Measured concentration[b] (mg/kg)
Potatoes and tubers[c]	Cassava - cooked	10	100	0.181
	Other potatoes and tubers	1028	51	0.02
Bread (excluding bread substitutes)[d]		9	0	0.025
Egg[c]		1194	26	0.011
Fruit	Apple w/o peel avg. Apple w peel avg. Pear w/o peel Pear w peel	28	4	0.026
	Blackberries Blueberries Blue grapes w skin Brambles Cranberries Gooseberries Grapes w skin avg. Raspberries Red berries Strawberries White grapes w skin	76	3	0.024
	Other fruit	17	49	0.025[e]
Grain /cereal products (not bread)[d]		9	0	0.025
Vegetables		59	25	0.016[f]
Cheese and cheese substitutes[c]		1262	44	0.021
Milk and dairy products[c]		3209	24	0.004
Non-alcoholic drinks	Coffee – brewed[c]	32	72	0.0004
	Tea - brewed	80	49	0.001
	Other non-alcoholic drinks	7667	46	0.0007[g]
Nuts and seeds[c]	Nuts, chestnuts and trail mix (*studentenhaver*)	983	42	0.033
	Seeds	1036	62	0.046

Food group	Food	Number of samples	% positive samples[a]	Measured concentration[b] (mg/kg)
Legumes		9	44	0.009
Red meat	Beef, all types	456	49	0.008[h]
	Beef liver - raw	456	49	0.03[i]
	Goat meat avg. – raw	1282	20	0.005[f]
	Hare – raw	45	31	1.2
	Horse meat - raw	26	0	0.025
	Lamb <10 g fat avg. - raw Leg of lamb - raw Mutton <10 g fat avg. - raw	38	53	0.009[h]
	Ostrich meat - raw	7	0	0.025
	Pork, all types	664	1	0.003[h]
	Veal, all types	123	6	0.003[h]
	Wild roe - raw	39	8	0.03[j]
Spreading and cooking fats[c]	Margarines and low-fat margarines	110	20	0.01
	Oils	924	35	0.023
Seafood	Buckling - smoked Herring - salted Herring – smoked Herring (sweet) - pickled Herring fillet in tomato sauce, tin	27	7	0.017 0.012[k]
	Mussels - cooked Mussels, pickled, glass	27	100	0.22
	Dutch shrimp - cooked Shrimp in water, tin	19	11	0.012
	Crab in water, tin Lobster - cooked	12	92	0.034
	Oysters	12	100	0.19
	Sardines in oil, tin	55	69	0.04
	Farmed salmon - prepared in microwave w/o additives	38	3	0.012

Food group	Food	Number of samples	% positive samples[a]	Measured concentration[b] (mg/kg)
	Salmon - raw Salmon - smoked Salmon, tin Salmon trout - prepared in microwave w/o additives Trout - prepared in microwave w/o additives Salmon, pate / mousse			0.008[k]
	Mackerel fillet – smoked Mackerel in oil, tin Mackerel - prepared in microwave w/o additives Mackerel - steamed	27	41	0.019
	Fillet of haddock - deep-fried Fillet of haddock - prepared w/o cooking fat Fish fingers - cooked Fish fingers - uncooked	514	51	0.015[k]
	Tuna in oil, tin Tuna in water, tin Tuna - raw	234	49	0.016
	Other seafood	589	73	0.03[f]
White meat and meat substitutes	Domestic rabbit - raw	10	0	0.025
	Tempeh[c] Tofu[c]	16	62	0.02
	Other white meat and meat substitutes	417	1	0.017[l]

[a] Percentage of samples with a measured concentration > limit of detection or quantification
[b] Measured concentrations from the Netherlands, unless stated otherwise
[c] Measured concentrations derived from the EFSA CONTAM Panel (2012b)
[d] Concentration derived from mTDS (Boon et al., 2017)
[e] Average of measured concentrations in banana, pineapple, fig, kiwi, mango, pomegranate, melon, lychee, papaya, avocado, khaki, lemon, orange and grapefruit
[f] Average measured concentration of all foods belonging to the food group
[g] Average concentration in drinking water (Table 8)

[h] Concentrations in meat calculated from measured concentrations in the kidney according to the ratio meat:kidney = 1:8
[i] Concentration in liver calculated from measured concentrations in the kidney according to the ratio liver:kidney = 1:2
[j] Average concentration in farmed deer. The concentrations of lead in wild roe were unrealistically high (up to 810 mg/kg)
[k] Based on the assumption of 70% fish (Wheel of Five Guidelines)
[l] Concentration calculated from measured concentrations in liver of poultry according to the ratio meat:liver= 1:1.5

Methylmercury

Food	Number of samples	% positive samples[a]	Measured concentration[b] (µg/kg)
Anchovies in oil, tin	5	-	62[c]
Buckling - smoked Herring -salted Herring - smoked Herring (sweet) - pickled Herring fillet in tomato sauce, tin	3	100	27.7 19.4[d]
Catfish - prepared in microwave w/o additives	1	100	121
Crab in water, tin Lobster - cooked Mussels - cooked Mussels, glass - pickled Oysters	3	100	130[c]
Cod - cooked Cod - prepared in microwave Cod - raw	5	100	102
Dutch shrimp - cooked Shrimp in water, tin	2	100	64.3
Eel - prepared in microwave w/o additives Eel -smoked	19	100	52.5[e]
Fillet of haddock - deep-fried Fillet of haddock - prepared w/o cooking fat	10	100	66[d,f]
Fat fish >10 g fat avg. – raw Lean fish 0 -2 g fat avg. - raw Moderate-fat fish >2 -10 g fat avg. - raw			45.8[g] 94.2[h] 2.5[i]
Fish fingers - cooked Fish fingers - uncooked			65.8[d,j]
Gurnard - prepared in microwave w/o additives	2	0	2.5
Marling - prepared in microwave w/o additives			94.2[e]
Pangasius - prepared in microwave w/o additives	2	0	2.5

Food	Number of samples	% positive samples[a]	Measured concentration[b] (µg/kg)
Plaice – cooked Plaice - prepared in microwave w/o additives	9	100	61
Pollack – cooked Pollack – prepared in microwave w/o additives	5	100	94
Red bream - prepared in microwave w/o additives	3	100	486
Farmed salmon - prepared in microwave w/o additives Salmon - raw Salmon - smoked Salmon, tin Salmon, pate / mousse	4	100	24.5 17.2[d]
Salmon trout - prepared in microwave w/o additives Trout - prepared in microwave w/o additives	2	100	22.5
Sardines in oil tin	16	-	58
Sole - prepared in microwave w/o additives	4	100	49.8
Squid - prepared in microwave w/o additives	1	-	37.6[c]
Tilapia - raw	2	0	2.5
Tuna in oil, tin Tuna in water, tin Tuna - raw	125	-	221[c]

[a] Percentage of samples with a measured concentration > limit of detection or quantification
[b] Measured concentrations from the Netherlands, unless stated otherwise
[c] Measured concentrations derived from the EFSA CONTAM Panel (2012d)
[d] Based on the assumption of 70% fish (Wheel of Five Guidelines)
[e] Based on the measured concentrations in wild and farmed eel, and the assumption that 95% of the consumed eel is farmed eel.
[f] Based on concentration for lean fish 0 -2 g fat avg. - raw
[g] Based on method of preparation of NEVO 116: equal proportions of eel, mackerel, salmon, herring and herring - salted
[h] Based on method of preparation of NEVO 114: equal amounts of plaice, cod, squid, pollack, tuna and sole
[i] Based on method of preparation of NEVO 115: tilapia
[j] Assumption Pollack

Nitrate

Food group	Food	Number of samples	% positive samples[a]	Measured concentration (mg/kg)[b,c]
Potatoes and tubers	Mashed potatoes - prepared w water w/o cooking fat	5	80	29[d]
	Potatoes w/o skin avg. – cooked			39
	Potatoes w skin avg. - cooked			
Vegetables	Aubergine - cooked	2	0	2.45
	Bami package avg. – cooked			83[d]
	Bean sprouts - cooked[e]	-	-	2.45
	Beefsteak tomato - cooked	2	50	6.45
	Common tomato - cooked			
	Tomato avg. - cooked			
	Beefsteak tomato – raw			7.5
	Cherry tomato - raw			
	Common tomato -raw			
	Tomato avg. - raw			
	Vine tomato - raw			
	Broad beans, frozen - uncooked			299[f]
	Broad beans - cooked			
	Yardlong beans - cooked			
	Broccoli – cooked	21	90	124
	Broccoli - raw			310
	Brussels sprouts – cooked	7	0	2.95
	Brussels sprouts, frozen - cooked			
	Bunched carrots – cooked	5	60	57
	Bunched carrots -raw			103
	Carrots avg. - cooked	-	-	51[g]
	Carrots avg. – raw			92[g]
	Cauliflower – cooked	21	81	2.49
	Cauliflower - raw			125
	Chanterelles – cooked[e]	-	-	3.2
	Mushrooms – cooked[e]			

Food group	Food	Number of samples	% positive samples[a]	Measured concentration (mg/kg)[b,c]
	Chard – cooked Chard - raw	5	100	769 1570
	Celeriac – cooked Celeriac - raw	3	100	160 390
	Celery – cooked Celery – raw	5	100	681 820
	Chicory – cooked Chicory - raw	2	100	164 335
	Chinese cabbage – cooked Chinese cabbage - raw	10	100	205 1024
	Conical cabbage – cooked Conical cabbage - raw	9	100	365 746
	Courgette – cooked Courgette - raw	5	100	744 670
	Cucumber – cooked Cucumber w/o peel - raw Cucumber w peel - raw	14	100	196 400
	Endive - cooked Endive, frozen - uncooked Endive - raw	260	100	258 1613
	Fennel – cooked Fennel - raw	1	100	354 590
	Green beans – cooked Green beans, frozen - cooked	10	100	340
	Green cabbage - cooked	-	-	57[h]
	Green lettuce avg. – raw Lamb's lettuce - cooked Lamb's lettuce – raw	30	100	1777[d] 1377 2810
	Head lettuce - raw Lettuce - cooked	204	100	2419 1185

Food group	Food	Number of samples	% positive samples[a]	Measured concentration (mg/kg)[b,c]
	Head lettuce + frisee lettuce	248	100	2164[d]
	Iceberg lettuce - raw	227	100	882
	Kale – cooked Kale, frozen – cooked Kale, glass	3	33	4.9
	Kohlrabi – cooked Kohlrabi - raw	2	100	693 1260
	Leek - cooked Leek - raw	7	100	255 471
	Mangetout – cooked Peas - cooked Peas, frozen - cooked	2	0	2.45
	Mangetout w carrots - cooked	-	-	39[i]
	Mustard cabbage – raw Pak choi	5	100	3405
	Onion lettuce - raw	2	50	223
	Peas w carrots, frozen - uncooked	-	-	30[i]
	Pumpkin - cooked	3	0	3.65
	Purslane – cooked Purslane - raw	2	100	3763 7680
	Radish - raw	1	100	2510
	Red beets - cooked	141	100	894
	Red cabbage – cooked Red cabbage - raw	10	80	77 180
	Red lettuce - raw	68	100	2044
	Rocket - raw	82	100	4696
	Salsify – cooked	-	-	2.45[e]
	Savoy cabbage – cooked	-	-	1.4[e]
	Spinach – cooked	240	100	565

Food group	Food	Number of samples	% positive samples[a]	Measured concentration (mg/kg)[b,c]
	Spinach, frozen - cooked Spinach - raw			 1823
	String beans – cooked String beans, frozen - uncooked	9	89	254
	Swedish turnip - cooked	1	100	264
	Sweet corn - cooked	-	-	2.45[e]
	Sweet pepper avg. - cooked Sweet pepper, green - cooked Sweet pepper, red – cooked Sweet pepper, yellow - cooked	8	13	2.41
	Spanish pepper – raw Sweet pepper avg. - raw Sweet pepper green - raw Sweet pepper yellow - raw Sweet pepper red - raw	8	100	22
	Turnip greens - raw	1	100	4000
	Vegetable mix, Mexico, frozen – uncooked	-	-	2.44[d]
	Vegetable mix, puszta, frozen – uncooked	-	-	44[d]
	Vegetables avg. - cooked Vegetables avg. - raw			156[d] 587[d]
	Vegetable soup avg., frozen – uncooked Vegetable soup avg. - raw			109[d] 275[d]
	White cabbage – cooked White cabbage - raw	6	83	24 118
	Winter carrots - cooked Winter carrots - raw	6	67	46 83
	Other vegetables			5[e]

Food group	Food	Number of samples	% positive samples[a]	Measured concentration (mg/kg)[b,c]
Fruit	Melon Sugar melon Watermelon	5	100	374
	Other fruit	-	-	5[e]
Non-alcoholic drinks		1181	100	5.1[j]

[a] Percentage of samples with a measured concentration > limit of detection or quantification
[b] Measured concentrations from the Netherlands, unless stated otherwise
[c] Concentrations were corrected for processing effects, if relevant
[d] Based on a recipe from the Dutch Food Composition Database (NEVO)
[e] No monitoring data available. Lowest reported medium-bound concentration selected, corrected for processing if relevant
[f] Average concentration of green beans and string beans
[g] Average concentration of carrots and winter carrots
[h] Average concentration of red and white cabbage
[i] Assuming equal amounts of peas/mangetout and carrots
[j] Average concentration in drinking water (Boon et al., 2009).

Perchlorate

Food group	Food	Number of samples	% positive samples[a]	Measured concentration (mg/kg)
Fruit	Melon Sugar melon Watermelon	4	25	0.026
	Other fruit	31	16	0.009
Vegetables	Green lettuce avg. - raw Head lettuce + frisee lettuce Head lettuce - raw Iceberg lettuce - raw Lamb's lettuce - cooked Lamb's lettuce - raw Lettuce - cooked Mole lettuce - raw	8	50	0.038

Food group	Food	Number of samples	% positive samples[a]	Measured concentration (mg/kg)
	Red lettuce - raw Rocket - raw			
	Other vegetables	16	19	0.008
Milk and dairy products		23	13	0.007

[a] Percentage of samples with a measured concentration > limit of detection or quantification

Appendix 3 Risk assessment of the sum of non-dioxin-like PCBs

RIVM risk assessment
In accordance with EFSA (2005b) and JECFA (2016), RIVM has used the body burden approach for the risk assessment of intake of the sum of non-dioxin-like PCBs. According to this approach, the body burden, i.e. the overall body concentration due to chronic (= daily) exposure, was calculated via a 1-compartment model (steady state approach). The calculated body burden was then compared to a minimum body burden obtained from animal studies in which toxic effects have been observed. This was done via the calculation of a margin of body burden (MoBB).

Non-dioxin-like PCBs cause liver and thyroid toxicity. These effects occur after repeated exposure. Therefore, based on the calculated intake per target group (Appendix 4) and the methodology described in section 2.3, a 'lifelong' intake of 0.05 ng/kg bw per day was calculated for non-dioxin-like PCBs via a diet according to the Wheel of Five Guidelines. As this intake estimate refers to the sum of non-dioxin-like PCBs, the risk assessment was also carried out for the sum of non-dioxin-like PCBs and not for the individual non-dioxin-like PCBs.

For the risk assessment, the body burden corresponding to a 'lifelong' intake of 0.05 ng/kg bw per day for a 1-compartment model was calculated. This model contains two parameters: the fraction of the substance absorbed from food in the gastrointestinal tract and the half-life (= the time in which the body burden is halved after exposure has stopped). EFSA (2005b) and JECFA (2016) do not report an absorption factor from food for non-dioxin-like PCBs in their risk assessment. This fraction was therefore equated to a maximum value of 1.0 (conservative approach). In its report, JECFA (2016) mentions human half-lives for individual non-dioxin-like PCBs, as reported by Ritter et al. (2011, Table 4-A). The average of these half-lives is equal to 9.4 years. This value was used for the sum of non-dioxin-like PCBs in the current risk assessment. Based on these two parameters, the 'lifelong' intake of 0.05 ng/kg bw per day for the sum of non-dioxin-like PCBs was converted to a body burden in humans of 248 ng/kg bw.

This body burden was then compared with a body burden at which no toxic effects were observed in test animals (body burden corresponding to a 'no-observed adverse effect level' (NOAEL)). It should be noted that such a body burden is not available for the *sum* of non-dioxin-like PCBs, but only for individual non-dioxin-like PCBs. JECFA (2016) reports the

Table 4-A. Half-lives (years) of individual non-dioxin-like PCBs in humans (Ritter et al., 2011)

PCB-28	PCB-52	PCB-105	PCB-118	PCB-138	PCB-153	PCB-170	PCB-180	PCB-187
5.5	2.6	5.2	9.3	10.8	14.4	15.5	11.5	10.5

PCBs: polychlorinated biphenyls

Table 4-B. Calculated sub-chronic 'margins of body burden' (MoBBs) for the intake of individual non-dioxin-like PCBs through food (JECFA, 2016)

Non-dioxin-like PCB	Estimated intake via food (ng/kg bw per day, adults; high percentile, LB-UB[a])	Modelled body burden in humans (µg/kg bw)	Minimum effect dose expressed as body burden (µg/kg bw)[b]	MoBB
28	<1-1.1	0.05-1.7	70[c]	41-1400
52	<1-1.1	0.06-0.7	NA	NA
101	<1-2.5	0.14-3.7	NA	NA
138	<1-3.7	0.49-10	NA	NA
153	<1-4.3	0.66-15	120[c] 2000[d]	8-180 130-3000
180	<1-1.5	0.25-4.2	1600[e]	380-6400

LB = lower bound; NA: not available; PCBs: polychlorinated biphenyls; UB = upper bound
[a] LB = samples with a measured concentration below the limit of detection or quantification were assumed not to contain the individual non-dioxin-like PCB; UB: samples with a concentration below the limit of detection or quantification were assumed to contain the individual non-dioxin-like PCB in a concentration equal to the relevant limit value
[b] Concerns effects on the liver and kidney for which JECFA claims that the toxicological relevance is doubtful. RIVM considers these body burdens as 'no-observed adverse effect level' body burdens (see text)
[c] Based on a 90-day intake via food study
[d] Based on a 2-year stomach tube study
[e] Based on a 28-day stomach tube study

body burden for individual non-dioxin-like PCBs in animal studies after sub-acute (PCB-180), sub-chronic (PCB-28/PCB-128) and chronic exposure (PCB-153). These body burdens are based on the occurrence of liver and thyroid toxicity in test animals that have repeatedly been exposed to these non-dioxin-like PCBs (Table 4-B). JECFA notes that the available toxicity studies do not allow derivation of a HBGV. As a reason she states that

- only toxicity data less than chronic exposure are available (with the exception of PCB-153);
- these data do not allow scaling for the chronic toxicity of PCB-153;
- the toxicological significance of the liver and thyroid toxicity found is doubtful.

For the various non-dioxin-like PCBs, Table 4-B provides an overview of the minimal effect dose for liver and thyroid toxicity expressed as body burden, as reported by JECFA. This is the body burden after repeated exposure in test animals. In the interpretation of these effects, RIVM joins JECFA in concluding that it is doubtful whether they form a toxicological risk. The body burden found with these effects was therefore considered by RIVM as a NOAEL, i.e. with negligible toxicological risk.

The lowest NOAEL body burden equalled 70,000 ng/kg bw for PCB-28[6] (Table 4-B). Comparing this body burden with the calculated body burden of a 'lifelong' intake of the *sum* of non-dioxin-like PCBs of 248 ng/kg bw resulted in a sub-chronic MoBB of 70,000/248 = 282. This approach is conservative by using the lowest NOAEL body burden for an individual non-dioxin-like PCB.

However, exposure to non-dioxin-like PCBs is not sub-chronic, but chronic. A sub-chronic → chronic assessment factor of eight was therefore used to extrapolate the sub-chronic MoBB to a chronic MoBB. This factor is based on an empirically derived distribution from the International Programme on Chemical Safety (IPCS) and has 95% coverage: with a certainty of 95%, this factor is sufficiently high to cover possible differences between sub-chronic and chronic effects[7]. The chronic MoBB then becomes 282/8 = 35.

The minimum value of the NOAEL MoBB for humans in which a negligible health risk is expected must be 25 or higher instead of the usual 100, since differences in kinetics between humans and animals are already included in the extrapolation[8] (WHO, 2005). Since the calculated MoBB was greater than 25, the intake of the sum of non-dioxin-like PCBs was expected to produce a negligible health risk when following a diet according to the Wheel of Five Guidelines.

[6] EFSA (2015) also mentions NOAEL body burdens, but these are significantly higher: 400 µg/kg bw for PCB-28, 800 µg/kg bw for PCB-128 and 1,200 µg/kg bw for PCB-153.
[7] www.who.int/ipcs/methods/harmonization/uncertainty_in_hazard_characterization.pdf?ua=1
[8] The overall interspecies extrapolation assessment factor is 10. According to WHO (2005), this factor is comprised of a kinetic subfactor of four and a dynamic subfactor of 2.5. The extrapolation implicitly already takes into consideration intraspecies differences in kinetics, i.e. the body burden in animals and the non-dioxin-like PCB kinetics in humans. Therefore, the interspecies subfactor for kinetics of four becomes redundant, and the interspecies extrapolation for differences in dynamic of 2.5 remains. Together with the intraspecies assessment factor of 10, this results in a factor of 2.5 x 10 = 25 for the total extrapolation.

Appendix 4 Intake of contaminants via a diet according to the Wheel of Five Guidelines calculated with maximum levels (MLs), and the intake also expressed as exceedance factor (e-f) of the HBGV

Target group (gender and age in years)	Cadmium		Deoxynivalenol (DON)		Sum of dioxins		Sum of dioxins and dioxin-like PCBs		Erucic acid		Sum of fumonisins B_1 and B_2		Methylmercury	
	Intake[a]	e-f	Intake[b]	e-f	Intake[c]	e-f	Intake[c]	e-f	Intake[d]	e-f	Intake[b]	e-f	Intake[a]	e-f
Women														
1-3	19	7.7[e]	1.4	1.4	0.0039	0.002	0.0073	0.004	125	0.25	0.0034	0.002	2.2	1.7
4-8	15	6.1	1.2	1.2	0.0027	0.001	0.0052	0.003	68	0.14	0.0019	0.001	1.3	1.0
9-13	13	5.2	0.9	0.95	0.0023	0.001	0.0044	0.002	51	0.10	0.0027	0.001	1.4	1.1
14-18	11	4.2	0.7	0.73	0.0017	0.001	0.0033	0.002	35	0.07	0.0019	0.001	0.98	0.75
19-30	9.3	3.7	0.6	0.62	0.0015	0.001	0.0030	0.001	31	0.06	0.0017	0.001	0.88	0.67
31-50	9.3	3.7	0.6	0.62	0.0015	0.001	0.0030	0.001	31	0.06	0.0017	0.001	0.88	0.67
51-69	8.4	3.3	0.5	0.48	0.0016	0.001	0.0031	0.002	31	0.06	0.0017	0.001	0.88	0.67
70+	7.6	3.1	0.4	0.38	0.0016	0.001	0.0031	0.002	27	0.05	0.0007	0.0003	0.81	0.62
Men														
1-3	18	7.1	1.3	1.3	0.0036	0.002	0.0068	0.003	115	0.23	0.0032	0.002	2.0	1.5
4-8	15	6.1	1.2	1.2	0.0027	0.001	0.0052	0.003	68	0.14	0.0019	0.001	1.3	1.0
9-13	15	5.9	1.2	1.2	0.0026	0.001	0.0048	0.002	63	0.13	0.0033	0.002	1.6	1.2
14-18	11	4.3	0.9	0.87	0.0017	0.001	0.0033	0.002	43	0.09	0.0023	0.001	0.87	0.67
19-30	7.7	3.1	0.5	0.52	0.0014	0.001	0.0027	0.001	42	0.08	0.0024	0.001	0.73	0.56
31-50	7.7	3.1	0.5	0.52	0.0014	0.001	0.0027	0.001	42	0.08	0.0024	0.001	0.73	0.56
51-69	7.3	2.9	0.5	0.46	0.0015	0.001	0.0028	0.001	42	0.08	0.0024	0.001	0.73	0.56
70+	7.1	2.8	0.4	0.43	0.0014	0.001	0.0028	0.001	36	0.07	0.0009	0.0004	0.68	0.52

Target group (gender and age in years)	Sum of non-dioxin-like PCBs		Nitrate		Ochratoxin A (OTA)		Perchlorate		Tin (inorganic)		Zearalenone	
	Intake[b]	MoBB[f]	Intake[d]	e-f	Intake[g]	e-f	Intake[b]	e-f	Intake[d]	e-f	Intake[b]	e-f
Women												
1-3	0.11	16	1.7	0.46	66	0.55	2.53	8.4	0.06	0.03	0.09	0.35
4-8	0.07	25	1.5	0.41	60	0.50	1.82	6.1	0.09	0.05	0.08	0.32
9-13	0.06	29	1.2	0.32	55	0.46	1.45	4.8	0.10	0.05	0.04	0.14
14-18	0.04	44	1.1	0.31	42	0.35	1.25	4.2	0.07	0.04	0.03	0.11
19-30	0.04	44	1.4	0.38	43	0.36	1.22	4.1	0.06	0.03	0.03	0.12
31-50	0.04	44	1.4	0.38	43	0.36	1.22	4.1	0.06	0.03	0.03	0.12
51-69	0.04	44	1.4	0.38	34	0.29	1.21	4.0	0.06	0.03	0.02	0.10
70+	0.04	44	0.95	0.26	30	0.25	1.07	3.6	0.03	0.02	0.03	0.11
Men												
1-3	0.10	18	1.6	0.42	61	0.51	2.33	7.8	0.06	0.03	0.08	0.32
4-8	0.07	25	1.5	0.41	60	0.50	1.82	6.1	0.09	0.05	0.08	0.32
9-13	0.07	25	1.3	0.34	67	0.56	1.58	5.3	0.10	0.05	0.04	0.17
14-18	0.05	35	1.0	0.27	50	0.42	1.13	3.8	0.07	0.03	0.03	0.13
19-30	0.04	44	1.2	0.32	38	0.32	1.03	3.4	0.05	0.02	0.03	0.10
31-50	0.04	44	1.2	0.32	38	0.32	1.03	3.4	0.05	0.02	0.03	0.10
51-69	0.04	44	1.2	0.32	34	0.28	1.02	3.4	0.05	0.02	0.02	0.09
70+	0.04	44	0.79	0.21	34	0.28	0.91	3.0	0.03	0.01	0.03	0.12

MoBB: Margin of Body Burden; PCBs: polychlorinated biphenyls; TEQ: toxic equivalent; WHO: World Health Organisation
[a] Expressed in µg/kg bw per week
[b] Expressed in µg/kg bw per day
[c] Expressed in pg WHO TEQ/kg bw per day. This is the unit in which the sum of dioxins and the sum of dioxins and dioxin-like PCBs are jointly expressed in terms of toxicity (van den Berg et al., 2006)
[d] Expressed in mg/kg bw per day
[e] Intake per contaminant and target group that was higher than the relevant HBGV is shown in red (e-f > 1). For the sum of non-dioxin-like PCBs, the minimum value of the MoBB is 25 (Table 5)
[f] In the case of the sum of non-dioxin-like PCBs, the MoBB was calculated
[g] Expressed in ng/kg bw per week

Appendix 5 Intake of contaminants via a diet according to the Wheel of Five Guidelines calculated with maximum levels (MLs) and limit values, including the associated margin of exposure (MOE)[a]

Target group (gender and age in years)	Acrylamide		Aflatoxin B_1		Sum of aflatoxins B_1, B_2, G_1 and G_2		Aflatoxin M_1		Arsenic	
	Intake[b]	MOE	Intake[c]	MOE	Intake[c]	MOE	Intake[c]	MOE	Intake[d]	MOE
Women										
1-3	0.00070	240[e]	14	12	25	6.7	1.3	1400	0.22	13
4-8	0.00062	270	11	16	20	8.4	0.7	2300	0.20	15
9-13	0.00067	250	9.8	17	19	8.7	0.6	2800	0.27	11
14-18	0.00051	330	7.4	23	15	12	0.4	4000	0.21	14
19-30	0.00268	63	6.8	25	13	13	0.3	5200	0.19	16
31-50	0.00268	63	6.8	25	13	13	0.3	5200	0.19	16
51-69	0.00229	74	5.1	33	10	17	0.4	3900	0.15	20
70+	0.00216	79	5.2	33	10	17	0.5	3400	0.14	22
Men										
1-3	0.00064	260	13	13	23	7.3	1.2	1500	0.21	15
4-8	0.00062	270	11	16	20	8.4	0.7	2300	0.20	15
9-13	0.00085	200	12	14	23	7.3	0.7	2600	0.33	9
14-18	0.00060	280	8.5	20	17	10	0.5	3400	0.25	12
19-30	0.00296	57	5.7	30	11	15	0.3	6300	0.16	19
31-50	0.00296	57	5.7	30	11	15	0.3	6300	0.16	19
51-69	0.00275	62	5.1	33	10	17	0.3	5300	0.14	21
70+	0.00258	66	5.4	32	11	16	0.4	4100	0.15	20

Target group (gender and age in years)	Contaminant, intake and intake as margin of exposure (MOE)					
	Benzo(a)pyrene		Lead		Sum of PAHs	
	Intake[b]	MOE	Intake[d]	MOE	Intake[b]	MOE
Women						
1-3	0.0000050	14000	4.7	0.11[f]	0.000025	14000
4-8	0.0000027	26000	3.4	0.15	0.000014	25000
9-13	0.0000021	34000	2.9	-	0.000010	33000
14-18	0.0000014	50000	2.3	-	0.000007	48000
19-30	0.0000013	56000	2.0	0.24	0.000006	54000
31-50	0.0000013	56000	2.0	0.24	0.000006	54000
51-69	0.0000013	56000	2.0	0.32	0.000006	54000
70+	0.0000011	64000	1.9	0.33	0.000005	62000
Men						
1-3	0.0000046	15000	4.3	0.12	0.000023	15000
4-8	0.0000027	26000	3.4	0.15	0.000014	25000
9-13	0.0000025	28000	3.3	-	0.000013	27000
14-18	0.0000017	41000	2.3	-	0.000009	40000
19-30	0.0000017	41000	1.7	0.36	0.000008	40000
31-50	0.0000017	41400	1.7	0.36	0.000008	40000
51-69	0.0000017	41000	1.7	0.37	0.000008	40000
70+	0.0000014	49000	1.7	0.37	0.000007	48000

PAHs: polycyclic aromatic hydrocarbons

[a] MOE was calculated by dividing the relevant lower limit of the benchmark dose (BMDL) (Table 5) by the intake per target group and contaminant

[b] Expressed in mg/kg bw per day

[c] Expressed in ng/kg bw per day

[d] Expressed in µg/kg bw per day

[e] MOEs lower than 10,000, the minimum size above which a potential health effect is negligible, are shown in red for all contaminants, except for lead and arsenic. For lead, this was done for the MOEs below one, the minimum value above which a potential health risk is (very) low (chapter 4). For arsenic, no minimum value for the MOE is specified.

[f] Calculated for effects on neurological development for the target groups 1-3 and 4-8 years (0.5 µg/kg bw per day), and women aged 19-30 and 31-50 years (0.54 µg/kg bw per day). For the other adult target groups, the MOE was calculated for effects on the kidneys (0.63 µg/kg bw per day). No relevant BMDL was available for the target groups 9-13 and 14-18 years (section 3.1). The MOEs for systolic blood pressure effects (1.5 µg/kg bw per day) varied for the adult target groups from 0.73 to 0.88.

Appendix 6 Intake of contaminants via a diet according to the Wheel of Five Guidelines calculated with measured concentrations, and intake also expressed as exceedance factor (e-f) of the HBGV

Target group (gender and age in years)	3-MCPD		Cadmium		Citrinin		Deoxynivalenol (DON)		Ergot alkaloids	
	Intake[a]	e-f	Intake[b]	e-f	Intake[a]	e-f	Intake[a]	e-f	Intake[a]	e-f
Women										
1-3	1.6	2.0[c]	5.0	2.0	0.06	0.30	0.39	0.39	0.37	0.62
4-8	0.87	1.1	3.8	1.5	0.04	0.22	0.29	0.29	0.26	0.43
9-13	0.63	0.79	3.2	1.3	0.04	0.18	0.17	0.17	0.16	0.27
14-18	0.43	0.54	2.6	1.0	0.03	0.13	0.12	0.12	0.11	0.19
19-30	0.37	0.46	2.3	0.93	0.02	0.12	0.11	0.11	0.10	0.17
31-50	0.37	0.46	2.3	0.93	0.02	0.12	0.11	0.11	0.10	0.17
51-69	0.37	0.46	2.0	0.81	0.02	0.10	0.09	0.09	0.08	0.13
70+	0.34	0.42	1.9	0.78	0.02	0.11	0.09	0.09	0.08	0.13
Men										
1-3	1.5	1.8	4.6	1.8	0.06	0.28	0.36	0.36	0.34	0.57
4-8	0.87	1.1	3.8	1.5	0.04	0.22	0.29	0.29	0.26	0.43
9-13	0.77	0.96	3.8	1.5	0.04	0.22	0.22	0.22	0.21	0.35
14-18	0.53	0.66	2.7	1.1	0.03	0.15	0.16	0.16	0.15	0.25
19-30	0.50	0.63	2.1	0.84	0.02	0.12	0.12	0.12	0.12	0.20
31-50	0.50	0.63	2.1	0.84	0.02	0.12	0.12	0.12	0.12	0.20
51-69	0.50	0.63	2.0	0.80	0.02	0.11	0.11	0.11	0.11	0.18
70+	0.44	0.55	1.9	0.74	0.02	0.11	0.10	0.10	0.09	0.15

Target group (gender and age in years)	Sum of fumonisins B_1 and B_2		Methylmercury		Nitrate		Ochratoxin A (OTA)		Perchlorate	
	Intake[a]	e-f	Intake[b]	e-f	Intake[d]	e-f	Intake[e]	e-f	Intake[a]	e-f
Women										
1-3	0.063	0.03	0.29	0.22	2.4	0.64	19	0.16	0.37	1.2[d]
4-8	0.046	0.02	0.18	0.13	2.0	0.55	17	0.14	0.24	0.80
9-13	0.039	0.02	0.19	0.15	1.7	0.45	22	0.19	0.19	0.64
14-18	0.029	0.01	0.13	0.10	1.6	0.42	17	0.14	0.15	0.50
19-30	0.027	0.01	0.11	0.08	1.6	0.43	53	0.44	0.12	0.42
31-50	0.027	0.01	0.11	0.08	1.6	0.43	53	0.44	0.12	0.42
51-69	0.022	0.01	0.11	0.08	1.6	0.43	45	0.38	0.14	0.47
70+	0.020	0.01	0.10	0.08	1.3	0.36	44	0.36	0.14	0.48
Men										
1-3	0.058	0.03	0.27	0.21	2.2	0.59	18	0.15	0.35	1.2
4-8	0.046	0.02	0.18	0.13	2.0	0.55	17	0.14	0.24	0.78
9-13	0.050	0.02	0.21	0.16	1.9	0.51	27	0.23	0.21	0.69
14-18	0.035	0.02	0.12	0.09	1.4	0.39	19	0.16	0.15	0.50
19-30	0.028	0.01	0.09	0.07	1.4	0.37	57	0.47	0.10	0.35
31-50	0.028	0.01	0.09	0.07	1.4	0.37	57	0.47	0.10	0.35
51-69	0.026	0.01	0.09	0.07	1.4	0.36	53	0.44	0.11	0.37
70+	0.023	0.01	0.08	0.06	1.1	0.31	50	0.42	0.12	0.40

3-MCPD: 3-monochloropropane-1,2-diol
[a] Expressed in µg/kg bw per day
[b] Expressed in µg/kg bw per week
[c] Intake per contaminant and target group that was higher than the relevant HBGV is shown in red (e-f > 1)
[d] Expressed in mg/kg bw per day
[e] Expressed in ng/kg bw per week

Appendix 7 Intake of contaminants via a diet according to the Wheel of Five Guidelines calculated with measured concentrations, including the associated margin of exposure (MOE)[a]

Target group (gender and age in years)	Contaminant, intake and intake as margin of exposure											
	Acrylamide		Aflatoxin B_1		Sum of aflatoxins B_1, B_2, G_1 and G_2		Aflatoxin M_1		Arsenic (inorganic)		Lead	
	Intake[b]	MOE	Intake[c]	MOE	Intake[c]	MOE	Intake[c]	MOE	Intake[d]	MOE	Intake[d]	MOE[f]
Women												
1-3	0.00033	520[e]	0.76	220	2.99	57	0.012	140000	1.6	1.8	1.0	0.48
4-8	0.00025	680	0.46	370	1.82	94	0.006	280000	1.1	2.7	0.71	0.70
9-13	0.00015	1100	0.37	450	1.53	110	0.005	340000	1.1	2.8	0.59	-
14-18	0.00011	1600	0.26	670	1.06	160	0.003	570000	0.79	3.8	0.44	-
19-30	0.00015	1100	0.23	730	0.95	180	0.002	850000	0.73	4.1	0.39	1.4
31-50	0.00015	1100	0.23	730	0.95	180	0.002	850000	0.73	4.1	0.39	1.4
51-69	0.00012	1400	0.21	830	0.84	200	0.005	340000	0.69	4.4	0.36	1.8
70+	0.00010	1700	0.21	830	0.81	210	0.003	570000	0.72	4.2	0.35	1.8
Men												
1-3	0.00030	560	0.70	240	2.76	62	0.011	150000	1.5	2.0	0.95	0.52
4-8	0.00025	680	0.46	370	1.82	94	0.006	280000	1.1	2.7	0.71	0.70
9-13	0.00018	930	0.45	380	1.80	94	0.005	340000	1.2	2.4	0.69	-
14-18	0.00013	1300	0.29	600	1.17	150	0.004	430000	0.81	3.7	0.48	-
19-30	0.00015	1100	0.22	760	0.94	180	0.002	850000	0.65	4.6	0.36	1.7
31-50	0.00015	1100	0.22	760	0.94	180	0.002	850000	0.65	4.6	0.36	1.7
51-69	0.00014	1200	0.22	790	0.90	190	0.002	850000	0.63	4.7	0.35	1.8
70+	0.00011	1500	0.20	850	0.80	210	0.003	570000	0.67	4.5	0.33	1.9

[a] MOE was calculated by dividing the relevant lower limit of the benchmark dose (BMDL) (Table 5) by the intake per target group and contaminant.

[b] Expressed in mg/kg bw per day
[c] Expressed in ng/kg bw per day
[d] Expressed in µg/kg bw per day
[e] MOEs lower than 10,000, the minimum size above which a potential health effect is negligible, are shown in red for all contaminants, except for lead and arsenic. For lead, this was done for the MOEs below one, the minimum value above which a potential health risk is (very) low (chapter 4). For arsenic, no minimum value for the MOE is specified.
[f] Calculated for effects on neurological development for the target groups 1-3 and 4-8 years (0.5 µg/kg bw per day), and women aged 19-30 and 31-50 years (0.54 µg/kg bw per day). For the other adult target groups, the MOE was calculated for effects on the kidneys (0.63 µg/kg bw per day). No relevant BMDL was available for the target groups 9-13 and 14-18 years (section 3.1). The MOEs for effects on systolic blood pressure (1.5 µg/kg bw per day) varied from 4.2 to 4.5 for the relevant adult target groups.

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