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HUMAN DIETARY INTAKE OF DIOXINS AND PLANAR PCBs IN THE NETHERLANDS - AVERAGE, POPULATION GROUPS AND TIME TRENDS

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ABSTRACT

Human dietary intake of dioxins and planar PCBs in The Netherlands - average, population groups and time trends

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In the present study the dietary exposure of humans to dioxins (PCDDs), furans (PCDFs) and planar PCBs was calculated for the Dutch population. To provide estimates of recent average Dutch dietary intakes and to investigate time trends over the last years, results of chemical analysis (levels in 1990/1991 and 1994/1996) and individual consumption patterns (consumption in 1987/88 and 1992/93) are combined. Results indicate a median Dutch daily intake of 2,3,7,8 chlorine substituted dioxins, furans and planar PCBs during this time period 1.2-2.4 pg (total)-TEQ/kg bw/day (95%: 5.9-7.5), 0.5-1.1 pg (i)-TEQ/kg bw/day (95%:1.1-1.3) and 0.7-1.3 pg (PCB)-TEQ/kg bw/day (95%: 4.0-4.5).

Dioxin intake calculations using the consumption data of 1987/88 has been published before by the National Institute of Public Health and the Environment. Calculations with the 1992 food consumption database, however, has not been reported until now. Recently the Ministry of Agriculture, Nature Management and Fisheries has released new data on dioxin levels, analysed in primary agricultural products sampled in the period 1994 till 1996.

In 1996 a new procedure of intake calculation has been introduced by the State Institute for Quality Control of Agricultural Products (RIKILT-DLO). Until then, there has been difficulties combining residue data of primary agricultural products with consumable food especially for complex dishes and ready to eat food. An extensive recipe database has been used. With the new dioxin data and the aim of the new procedure of intake calculation it became possible to calculate time trends in dioxin intake. Over the years, the estimated median Dutch intake of dioxins and planar PCBs showed a total decrease of approximately 55%. This decline can be explained with changes in dietary habits (resulting in a decline of about 15%) and changes in dioxin concentrations in foods (resulting in a decline of about 40%).

Foods of animal origin, including milk, meat, fish and eggs are the predominant sources of dietary exposure to dioxin-like components in the Netherlands.

Generally mean, median and 95 percentile intake of dioxins by the Dutch population are well below the (WHO)-TDI of 10 pg TEQ/kg bw/day. The intake per kg body weight and was highest for children. In the age of 1 to 4 year the median intake was 2.8-5.4 (total) TEQ/kg bw/daty (95% 9.6 -12.5). A proposed exposure limit for humans of 1 pg TEQ/kg bw/day of the Health Council of the Netherlands, will be exceeded by the majority of the Dutch population, when (total)-TEQ is calculated.

Keywords: dioxins, planar PCBs, dietary intake, exposure, food safety

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SAMENVATTING

Inname van dioxinen en planaire PCB's via de voeding door de Nederlandse bevolking - gemiddeld, populatiegroepen en trends

In dit project is de blootstelling van de Nederlandse bevolking aan dioxinen (PCDD's), furanen (PCDF's) en planaire PCB's via de voeding berekend. Om een recente gemiddelde innameschatting te maken en een trend over de laatste jaren te onderzoeken zijn resultaten van chemische analyses (gehalten in 1990/1991 and 1994/1996) en individuele consumptie patronen (consumptie in 1987/88 en 1992) gecombineerd.
De resultaten geven een mediane Nederlandse dagelijkse inname van 2,3,7,8 gechloreerde dioxinen, furanen en planaire PCB's over deze tijdsperiode van 1.2-2.4 pg (total)-TEQ/kg l.g./dag (95%: 5.9-7.5), 0.5-1.1 pg (i)-TEQ/kg l.g./dag (95%: 1.1-1.3) and 0.7-1.3 pg (PCB)-TEQ/kg l.g./dag (95%: 4.0-4.5).
Gegevens over de dioxine-inname, berekend met de voedselconsumptiedata van 1987/88, zijn reeds gepubliceerd door het Rijksinstituut voor Volksgezondheid en Milieu. Berekeningen naar de blootstelling aan dioxine en planare PCB's, gebaseerd op voedselconsumptie-onderzoek van 1992, worden in dit rapport gepresenteerd. Het ministerie van Landbouw, Natuurbeheer en Visserij heeft in 1994-1996 de belangrijkste primaire agrarische producten laten analyseren op dioxinegehaltes. Met deze nieuwe dataset zijn eveneens berekeningen gemaakt, waardoor het mogelijk werd om een trend in de tijd te schatten. Bij de berekeningen is gebruik gemaakt van het ontwikkelde conversiemodel, waarmee consumeerbare producten eenduidig gekoppeld worden aan residugegevens geanalyseerd in primaire agrarische producten.
Over de jaren heen, neemt de geschatte mediane Nederlandse inname van dioxinen en planaire PCB's met ongeveer 55% af. Deze daling kan verklaard worden door veranderingen in voedingsgewoonten (resulterend in een afname van ongeveer 15%) en veranderingen in dioxinen concentraties (resulterend in een afname van ongeveer 40%) in de loop van de tijd.
Voedingsmiddelen van dierlijke oorsprong, zoals melk, vlees en vis zijn de voornaamste bronnen van blootstelling aan dioxine-achtige stoffen via de voeding in Nederland.
Over het algemeen is de gemiddelde en 95 percentiel inname van dioxinen over de gehele Nederlandse bevolking beneden de (WHO)-TDI van 10 pg TEQ/kg l.g./dag. De inname per kg lichaamsgewicht is het hoogste voor de subpopulatie kinderen. Voor kinderen van 1 tot 4 jaar bedraagt de mediane inname 2.8-5.4 (totaal) TEQ/kg l.g./dag (95% 9.6-12.5). De door de Nederlandse Gezondheidsraad voorgestelde verlaging van de blootstellingslimiet voor de mens van 1 pg TEQ/kg l.g./dag, zal door de meerderheid van de Nederlandse populatie worden overschreden, uitgaande van (total)-TEQ.

1 INTRODUCTION

Dioxin-like compounds are frequently present in the environment and food in the form of mixtures of many polychlorinated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs) and the dioxin-like polychlorinated biphenyls (planar PCBs). They are referred to in the text as dioxins and planar PCBs. It is generally accepted that dietary intakes account for most of human exposure (> 90%) to these compounds. Other sources and pathways, like air, soil, drinking-water and non-food, are of minor importance.

The objective of this study is to assess the (distribution of) dietary exposure to dioxins and planar PCBs for the Dutch population. This information can be used within the framework of the EU Scientific co-operation on questions relating to food (SCOOP) and evaluations regarding the Tolerable Daily Intake (TDI). RIKILT-DLO has carried out this project under the assignment of the Inspectorate for Health Protection.

The National Institute of Public Health and the Environment (RIVM) has published the results of the dioxin intake calculation using the residue levels of 1990/91 and the consumption data of 1987/88 [Liem et al, 1991]. A few products, sampled in the period 1991 till 1995 has been measured again. A renewed intake calculation was done [Liem et al, 1996].

The RIVM has also measured the levels of dioxins, furans and PCBs in composite samples of duplicate diets, collected by some hundred volunteers in the periods 1978, 1984/84 and 1994 [Liem et al, 1995c]. The recent published dissertation of Liem and Theelen gives an extensive overview of the relationship between the emission of dioxins into the environment and the risk for humans [Liem and Theelen, 1997].

Calculations with the 1992 food consumption database has not been published until now and recently the Ministry of Agriculture, Nature Management and Fisheries has released new data on dioxin levels, analysed in primary agricultural products sampled in the period 1994 till 1996.

In 1996 a new procedure of intake calculation has been introduced by the State Institute for Quality Control of Agricultural Products (RIKILT-DLO). Until then, there has been difficulties combining residue data of primary agricultural products with consumable food especially for complex dishes and ready to eat food. In 1996 a conversion model, or recipe database, translating consumable food into primary agricultural products was created to overcome these problems [Dooren-Flipsen et al, 1996].

With the new data and the aim of the new procedure of intake calculation the Inspectorate for Public Health has asked the RIKILT-DLO to up date dioxin intake calculations. In line of this assignment the intake calculation of the RIVM was redone using the new procedure of intake calculation and the same residue data (1990/91) and consumption data (1987/88).

To provide estimates of recent average Dutch dietary intakes and to investigate trends over the last decade, results of chemical analysis (levels in 1990/1991 and 1994/1996) and individual consumption patterns (consumption in 1987/88 and 1992/93) are combined. Information on exposure and distribution over age groups and specific consumer groups, and on the contribution of various food categories could be determined. For this purpose the applied methodology for the dietary intake calculations of dioxins and planar PCBs, and the use of data from databases of the Dutch National Food Consumption Survey in conjunction with the Conversion Model for Primary Agricultural Products are described.

2 MATERIAL AND METHODS

Databases of the Dutch National Food Consumption Survey and the Program for the Quality of Agricultural Products in conjunction with the Conversion Model for Primary Agricultural Products are used in estimating the intake of dioxins and planar PCBs to which the Dutch population is exposed through their diets.

2.1 Dutch national food consumption surveys

The food consumption data used in this study are derived from the Dutch National Food Consumption Survey (DNFCS). These large-scale surveys have been carried out in 1987/88 (DNFCS-97/88) and repeated in 1992 (DNFCS-92). Respondents in these surveys came from a representative sample of households with the main housekeeper younger than 75 years. A total of 5,898 people (2,475 households), aged 1-85 years, participated in the DNFCS-87/88. The second DNFCS-92 compromised 6,218 people (2,203 households), aged 1-92 years. Information on food consumption was obtained using a 2-day dietary record. The DNFCS was distributed equally over the 7 days of the week, and over a whole year, holiday periods excluded. For each individual age, sex, body weight and a series of other characteristics were recorded. The methods and procedures used in dietary data collection are described in detail elsewhere [Hulshof et al, 1991; Anonymous, 1994]. Briefly, in each household, the subject principally responsible for domestic affairs (the housekeeper) was the most important informant. The housekeeper carefully recorded in the household diary all food supplied to the members of the household. The food consumption data were coded with the Dutch NEVO-code [Foundation NEVO Dutch Nutrient Databank].

2.2 Conversion model Primary Agricultural Products

In The Netherlands, the government and agribusiness intensively monitor primairy agricultural products for residues and contaminants. While (inter)national legislation provides standards for primary agricultural products, food consumption data relate to consumable products.
In 1994 the State Institute for Quality Control of Agricultural Products (RIKILT-DLO) developed a conversion model to unequivocally couple primary agricultural products and consumable foodstuffs [Dooren-Flipsen et al, 1996]. With this model it is possible to convert DNFCS-data of consumption of foods as consumed, into data of hypothetical consumption of raw agricultural products. In this manner residue intake by the population can be estimated. Furthermore this model offers the possibility to derive consumption figures for individual components of primary agricultural products. Especially components like milk fat, fish fat, beef fat, egg fat are important components analysed for dioxins.

Both food consumption data of DNFCS-87/88 and DNFCS-92 were transformed into consumption data of (fat components of) primary agricultural products. For the construction of this raw agricultural commodity consumption database, containing consumption figures of 12.000 individuals, the Conversion model Primary Agricultural Products (2.2) was used.

2.3 Analytical data of dioxins and planar PCBs

In 1990-1991 the National Institute of Public Health and the Environment (RIVM) analysed fat samples of several food categories: milk, butter, cheese, mixed-meat product, nuts, eggs, fat sea fish, lean sea fish, fresh water fish, liver and meat of different animals. Also different types of vegetable and animal oils, which represent fat added to products by food industry, are analysed. [Liem et al, 1991]. In 1995 supplementary studies were performed. Additional levels of PCDD/Fs and three non-ortho substituted (planar) PCBs in game, cereals, vegetables and fruits were determined. Additional studies have been performed on the levels of these compounds in consumer's milk, fish oils and mutton [Liem et al, 1996]. The applied sampling strategy was aimed at deriving nation-wide representative concentrations.

Except above-mentioned studies several fish species are monitored for dioxins and planar PCBs by the 'Landelijk Platform Kritische Stoffen' (LPKS) in The Netherlands. This concerns eel, herring, cod, sole, mussel and shrimps [Klaveren et al, 1996]. Recently a survey was held in eggs, milk and different types of animal fat in suspected and unsuspected areas [Traag et al, 1997a and 1997b]. This survey was intended to evaluate the trend of PCB-concentrations over the last decade. Only data from unsuspected samples of the study of Traag et al, are used in the calculations.

The results of the analytical data were used as input for the first and second DNFCS. In the present study the concentrations are expressed in TEQ using (i)-TEFs and (PCB)-TEFs as reported in ANNEX 1. The applied concentrations of (i)-TEQ and (PCB)-TEQ are summarised in ANNEX 2 and ANNEX 3.

2.4 Dietary intake calculations for dioxins

In the present study dietary exposure to dioxins and planar PCBs is assessed using combinations of the mentioned information sources (paragraph 2.1, 2.2 and 2.3).
The dietary intake estimations can be distinguished in three calculations, related to variable food consumption data and different dioxin concentrations. With this approach a time trend is derivable. Table 1 shows the combinations of input used for the different calculations.

Table 1 *Combinations of consumption and concentration data.*

Consumption Data	Concentrations (most important products)	Calculation
DNFCS-87/88	RIVM 1990-1991 (ANNEX 2)	1
DNFCS-92	RIVM 1990-1991 (ANNEX 2)	2
DNFCS-92	LPKS 1994-1996 (ANNEX 3) and additional RIVM 1990-1995	3

For each individual (DNFCS-87/88, n=5,898; DNFCS-92, n=6,218) of the food consumption surveys the daily intake was calculated by multiplying the amount of consumed product (derived as the average daily consumption over the 2 day dietary record period) with the average concentration TEQ (derived from the available concentration data), and adding up the TEQs of the different products consumed. The individual intake of (i)-TEQ, (PCB)-TEQ as well as (total)-TEQ, was calculated and expressed as intake per day (pg/day). For calculating the individual intake per kg body weight per day (pg/kg bw/day) the individual body weight of the subject was used.
Calculations were carried out for age-sex groups and pregnant women in conformity with the classification of the Dutch Recommended Dietary Allowances [Netherlands Food and Nutrition Council 1992]. Further calculations for the total group of men and women and the populations groups with a different mode of life (vegetarians) were performed.
Descriptive statistics for the various populations were calculated. Beside the median and average intake of the total population a weighted average intake was calculated. With this weighing procedure a correction is made for small unbalances (sex, age) in the structure of the DNFCS-population.

Furthermore the contribution of product groups to the total average daily intake of dioxins and planar PCBs from food was calculated. For this the total intake from all products of one category of food from all subjects is calculated and expressed as a percentage of total intake from all products by all subjects.

The results of the intake calculations are compared with the Tolerable Daily Intake (TDI) to estimate the percentage of the population exceeding this safety limit. Initially the comparison was done with the TDI set by the World Health Organisation For (i)-TEQ, (PCB)-TEQ and (total)-TEQ a TDI of 10 pg TEQ/kg bw/day was used. This (WHO)-TDI was recommended for 2,3,7,8-TCDD by an expert group convened by the WHO/EURO in 1990 [World Health Organisation, 1990]. However this (WHO) TDI has recently been discussed by the Health Council in the Netherlands and they proposed to lower the TDI to 1 pg/kg body weight [Health Council of the Netherlands, 1996]. At second stage the results of the intake calculation were also compared with this proposed limit.

In the present study only dietary intake estimations are made. Exposure from other sources like air, soil and non-food are not taken into account.

3 RESULTS

Descriptive statistics for the dietary intake of (i)-TEQ, (PCB)-TEQ and (total)-TEQ are given for calculation 1 (ANNEX 4A-4C), calculation 2 (ANNEX 5A-5C) and calculation 3 (ANNEX 6A-6C).
The calculated mean intake of (i)-TEQ, (PCB)-TEQ and (total)-TEQ for different populations groups is given together with the proportion of persons exceeding the TDI.

3.1 Average daily dietary intake of (i)-TEQ, (PCB)-TEQ and (total)-TEQ

The results show a median Dutch daily intake of 2,3,7,8 chlorine substituted dioxins and furans in the range of the 3 calculations of 72-142 pg (total)-TEQ (95%: 375-414), equivalent with 1.2-2.4 pg (total)-TEQ/kg bw/day (95%: 5.9-7.5). For (i)-TEQ these figures are 41-65 pg (i)-TEQ (95%: 118-157), equivalent with 0.5-1.1 pg (i)-TEQ/kg bw/day (95%: 1.1-3.1). For planar PCBs these figures are 42-77 pg (PCB)-TEQ (95%: 251-264), equal to 0.7-1.3 pg (PCB)-TEQ/kg (95%: 4.0-4.5).
Figure 1 shows the mean intakes for the total Dutch population of all 3 calculations.
The results (ANNEX 4-6) show higher daily intakes per kg body weight in young children for both mean as 95 percentile intake of (i)-TEQ, (PCB)-TEQ and (total)-TEQ. Figure 2 shows the median intake per kg body weight per day of (i)-TEQ, (PCB)-TEQ and (total)-TEQ for different age-groups.
There is no significant difference in average intake per kg body weight between males and females.
The mean intake of pregnant women and vegetarians is not notably different from that of the total population.

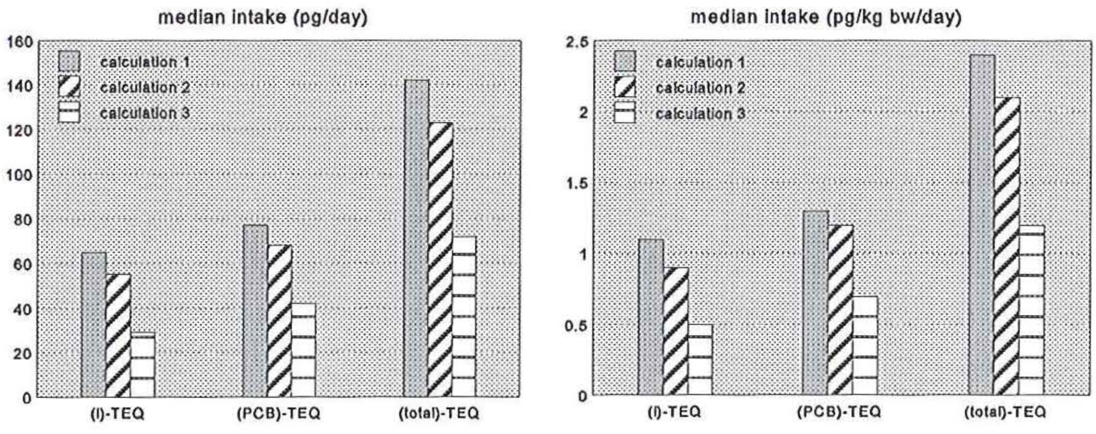


Figure 1: Median intake of dioxins, planar PCBs and total dioxins for the total population, calculation 1, 2 and 3.
Calculation 1 DNFCS-87/88 - residue data 90-91
Calculation 2 DNFCS-92 - residue data 90-91
Calculation 3 DNFCS-92 - residue data 94-96 and 90-91

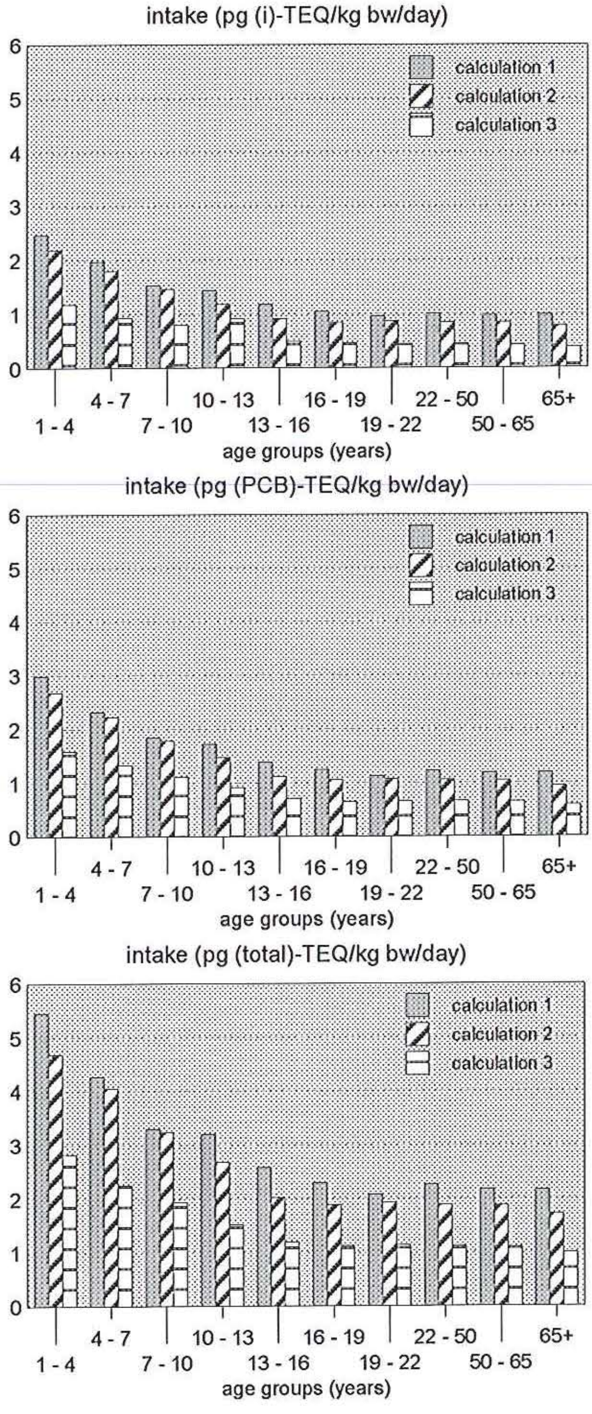


Figure 2: *Median intake of dioxins, planar PCBs and total dioxins (pg/kg bw/day) for differrent age groups, calculation 1, 2 and 3.*
Calculation 1 DNFCS-87/88 - residue data 90-91
Calculation 2 DNFCS-92 - residue data 90-91
Calculation 3 DNFCS-92 - residue data 94-96 and 90-91

3.2 Time trends in exposure

Calculation 1 - Calculation 2: Changes in food consumption

When comparing calculation 1 with calculation 2 the estimated median Dutch intake of dioxins and planar PCBs has fallen for (i)-TEQ from 65 to 55, for (PCB)-TEQ from 77 to 68 and for (total)-TEQ from 142 to 123 pg/day, (total)-TEQ has fallen from 414 to 410 pg/day (figure 1). The results expressed in pg/kg bw/day show the same trend. High level intakes (95 percentile intake) of dioxins and dioxin-like components have also decreased, but not as much as on an average level.

The decline of the estimated mean Dutch dietary intake is nearly 15% and can be ascribed to changes in food choices. The two calculations differ in input of consumption data, namely DNFCS-87/88 and DNFCS-92. The residue data used in the both calculations date from 1990-1991. Only the applied residue values for oils and fats are different according to the proportion of consumption or deliveries to the Dutch food industry (see ANNEX 2).

Calculation 2- Calculation 3: Changes in dioxin concentrations

When a comparison is made between calculation 2 and 3 the estimated median Dutch intake of dioxins and planar PCBs has fallen for (i)-TEQ from 55 to 29, for (PCB)-TEQ from 68 to 42 and for (total)-TEQ from 123 to 72 pg/day (figure 1). Again the results expressed in pg/kg bw/day show the same trend. High level intakes (95 percentile intake) of dioxins and dioxin-like components have also decreased considerably, for (i)-TEQ from 144 to 118, for (PCB)-TEQ from 264 to 251 and for (total)-TEQ from 410 to 375 pg/day.

The decrease of estimated mean dioxin intake is approximately 40% and is only attributable to changes in the dioxin concentrations determined in the various food items.

3.3 Contribution of food categories

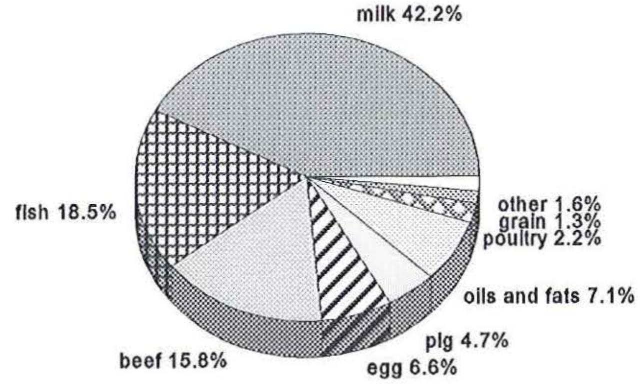
Table 2 shows the sources of (i)-TEQ, (PCB)-TEQ and (total)-TEQ for the total population. Animal products are the most important sources of dietary intake of dioxins and planar PCBs (> 90%). Food of vegetable origin is of minor importance. Among the group animal products, milk, fish, meat (mainly beef) and eggs contributed most to dioxin and planar PCB intake.

Table 2 *Relative contribution of product groups to dietary intake of (i)-TEQ, (PCB)-TEQ en (total) TEQ, calculation 1, 2 and 3.*

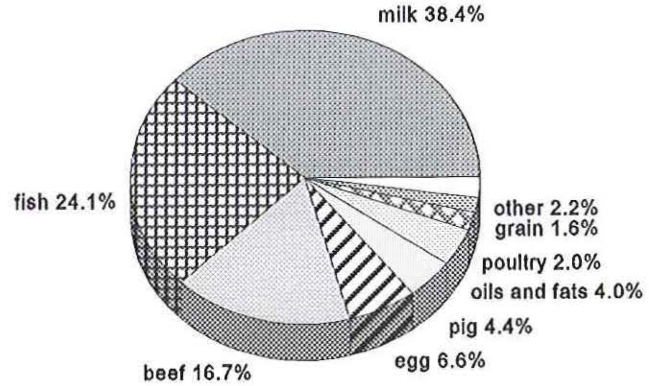
Primary agricultural product	(i)-TEQ			(PCB)-TEQ			(total)- TEQ		
Calculation	1	2	3	1	2	3	1	2	3
milk	45.4	41.2	17.9	39.9	36.5	23.3	42.2	38.4	21.3
fish	12.6	17.6	29.2	22.9	28.7	40.5	18.5	24.1	36.3
beef	15.6	16.9	19.9	16.0	16.5	15.7	15.8	16.7	17.3
calf	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
pig	8.4	8.1	9.0	2.0	1.8	3.8	4.7	4.4	5.7
poultry	2.3	2.2	1.5	2.1	1.9	1.2	2.2	2.0	1.3
mutton	0.4	0.6	0.5	0.3	0.4	0.4	0.3	0.5	0.4
horse	0.3	0.3	0.5	0.4	0.4	0.5	0.3	0.3	0.5
game	0.3	0.6	1.0	0.3	0.5	0.6	0.3	0.5	0.8
egg	7.2	7.5	12.4	6.1	6.0	4.1	6.6	6.6	7.2
vegetable and animal oils and fats	5.7	2.9	4.7	7.2	3.9	5.3	6.6	3.5	5.1
vegetable oils and fats	0.6	0.7	1.0	0.4	0.5	0.6	0.5	0.6	0.8
cereals	0.6	0.8	1.3	1.8	2.1	2.9	1.3	1.6	2.3
nuts & olives	0.3	0.5	0.8	0.4	0.6	0.8	0.4	0.5	0.8
oilseeds	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
cacao	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1

Figure 3a shows the relative contribution of the different food categories to (total)-TEQ intake for the 3 calculations. The changes in distribution of the food categories between calculation 1, 2 and 3 is rather misleading if it were presented separately from the change in total dioxin intake. Fish is contributing the most to the total intake in calculation 3, but it does not mean an increase in dioxin levels found in fish. Therefore figure 3b is added to clarify the difference between the relative and the absolute contribution. The decrease of total dioxin intake is mainly caused by a decrease in dioxin levels in milk and dairy products, but also a decrease of other animal products is notified. The absolute contribution of fish remains more or less unchanged.

Calculation 1



Calculation 2



Calculation 3

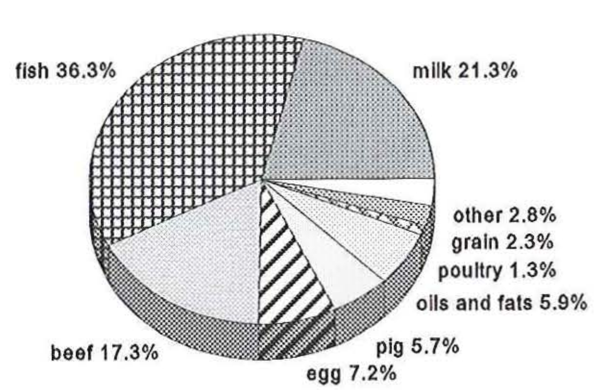


Figure 3a: ***Relative contribution of different food categories to exposure of (total)-TEQ, calculation 1, 2 and 3.***

Calculation 1 DNFCS-87/88 - residue data 90-91
Calculation 2 DNFCS-92 - residue data 90-91
Calculation 3 DNFCS-92 - residue data 94-96 and residue data 90-91

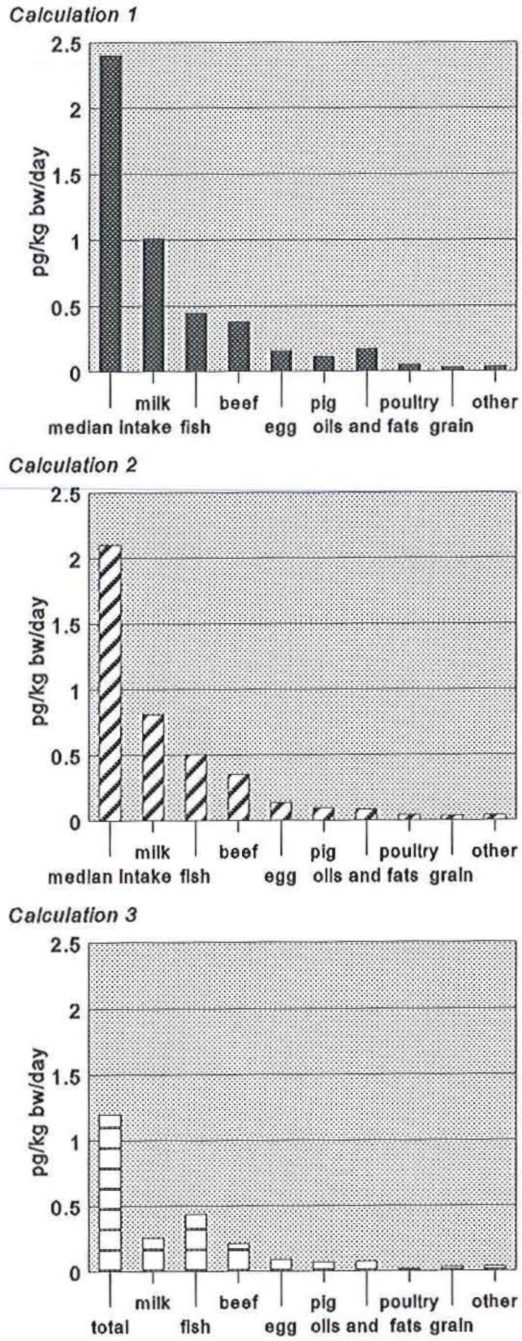


Figure 3b: Absolute contribution of different food categories to exposure of (total)-TEQ, calculation 1, 2 and 3.
Calculation 1 DNFCS-87/88 - Residue data 90-91
Calculation 2 DNFCS-92 - Residue data 90-91
Calculation 3 DNFCS-92 - Residue data 94096 and residue data 90-91

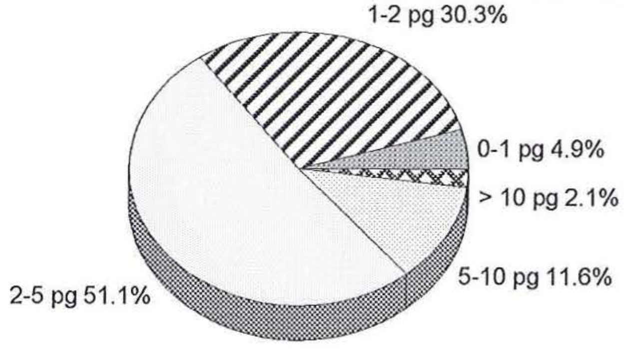
3.4 Exceedings of TDI

Mean intakes of (i)-TEQ, (PCB)-TEQ and (total)-TEQ did not exceed the TDI of 10 pg TEQ/kg bw/day in any of the population groups in any of the calculations.

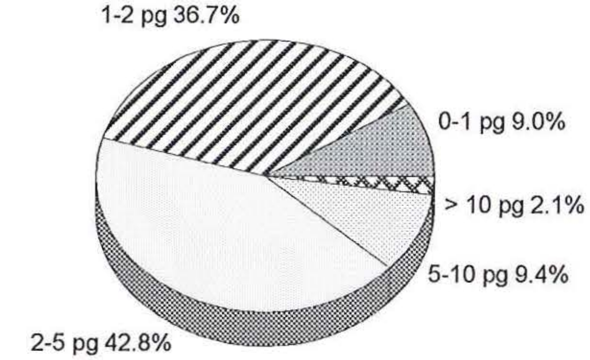
Figure 4 shows the frequency of intake of (total)-TEQ (pg/kg bw/day) of the total study for calculation 1, 2 and 3. About 2% of the total population under study exceeds the TDI of 10 pg TEQ/kg bw/day. Nearly 50% of the group of TDI-exceeders exists of children in the age between 1 and 13 years old. The prevalence of individual intakes exceeding the TDI for dioxins varied between 0 and 9% over different population groups (ANNEX 4-6).

The Health Council of the Netherlands proposed an exposure limit for humans of 1 pg of toxic equivalents per kg body weight per day, based on animal studies [Health Council of the Netherlands, 1996]. The frequency results demonstrate that the majority of the Dutch population is exposed to a dietary intake higher than 1 pg/kg bw/day. In calculation 1, 2 and 3 only 5%, 9% and 35% of the study population has an intake between 0 and 1 pg (total)-TEQ/kg bw/day respectively. For (i)-TEQ these figures are 42%, 54%, 82% and for (PCB)-TEQ 30%, 39%, 69%.

Calculation 1



Calculation 2



Calculation 3

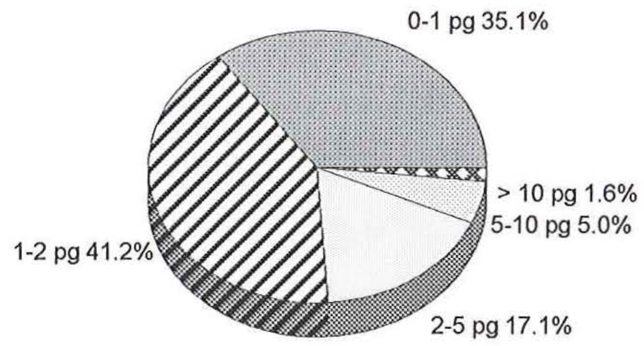


Figure 4: Frequency of intake of (total)-TEQ (pg/kgbw/day) of the total study population, calculation 1, 2 and 3.
Calculation 1 DNFCS-87/88 - residue data 90-91
Calculation 2 DNFCS-92 - residue data 90-91
Calculation 3 DNFCS-92 - residue data 94-96 and residue data 90-91

4 DISCUSSION AND CONCLUSIONS

4.1 Average daily dietary intake of (i)-TEQ, (PCB)-TEQ and (total)-TEQ

The results show a median Dutch daily intake of 2,3,7,8 chlorine substituted dioxins, furans and planar PCBs in the range of 0.5-1.1 pg (i)-TEQ/kg bw/day (95%:1.1-1.3), 0.7-1.3 pg (PCB)-TEQ/kg (95%: 4.0-4.5) and 1.2-2.4 pg (total)-TEQ/kg (95%: 5.9-7.5) as calculated using the three described procedures and data sets.

The results of the present study indicate that mean and 95 percentile intake of dioxins by the Dutch population is in general well below the TDI of 10 pg TEQ/kg bw/day. Except for the younger children (1-4 years) the 95 percentile intake of (total)-TEQ per kg body weight is almost equal or exceeding the TDI.

Dutch studies

Comparison with previous calculations of Liem and Theelen [Liem et al, 1996; Theelen et al, 1993; Liem et al, 1991] is possible for results based on food consumption data of DNFCS-87/88 (calculation 1). Table 3 shows the mean intake figures. In this study mean intakes of dioxins and planar PCBs were found to be higher than in the previous Dutch study.

Table 3: Average and median intake (pg/day), study of Liem (1996) and present study.

	Liem, 1996		Present study Calculation 1	
	pg/day average	median	pg/day average	median
(i)-TEQ	67	55	75	65
(PCB)-TEQ	90	71	100	77
(total)-TEQ	158	127	176	142

The differences between the estimated intake of the RIVM and calculation 1 in this study is around 11%. In this study the new procedure, using the conversion model, has been follewed. The differences may be to a large extent attributable to the applied methodology of coupling concentration data to consumption data, because both calculations use the same residue and consumption data. Liem et al, uses the system of classifying a selected number of edible foods stuffs, as registered in the DNFCS, in different categories of foods [Liem et al, 1991]. The present study uses the Conversion model Primary Agricultural Products that unequivocally couples all consumable foodstuffs which are on the NEVO-list [Foundation NEVO Dutch Nutrient Database], to (components of) primary agricultural products [van Dooren-Flipsen et al, 1996]. On average a consumable foodstuff contains 2 to 3 primary agricultural products. Both studies couple the dioxin content of each food category/primary agricultural product to the consumption of fat of these food categories/primary agricultural product.

Because of the compositions of some of the consumable foodstuffs it can be expected that it is complicated to choose one straightforward food category according to Liem's method. For example one individual food item like fish fingers, pancakes or fried minced-meat hot dogs can contain different types of fat e.g. fat of fish, fat of egg, milk fat, fat of beef, fat of pig, vegetable oils and fats. With the Conversion model these different types of food items are divided into these categories of (fat of) primary agricultural products. The classification to one food category could lead to an underestimation of food residue intake in the study of Liem. However taking these differences in figures into account, this does not alter the results and conclusions essentially.

In a study of Liem the content of dioxins and planar PCBs in 24-hour food duplicates, sampled in 1984 and 1985, was analysed [Liem et al, 1995c]. The age of the adults Dutch population under study (n=10) ranged from 30 to 67 years. A median intake of 138 pg (i)-TEQ/day (range: 35-1211) equivalent to 1.9 pg (i)-TEQ/kg bw/day was reported. The median intake for planar PCBs was 98 pg (WHO)-TEQ/day (range: 38-266), equivalent to 1.5 pg (WHO)-TEQ/kg bw/day (range: 0.6-3.9). Table 4 shows the median intake figures for both studies.

Table 4: Median intake of dioxins and planar PCBs according to the 24-hour duplicate food study (n=10) [Liem et al, 1995c] and present study for population aged 30-67 years (n=2,807).

	Liem, 1995 24-hour duplicate food sampling 1984/85		Present study Calculation 1: DNFCS-87/88 and residue data 90/91	
	pg/day	pg/kg bw/day	pg/day	pg/kg bw/day
(i)-TEQ	138	1.9	65	1.1
(PCB)-TEQ	98	1.5	77	1.3

The 24-hour duplicate food study shows a considerable higher intake of dioxins and planar PCBs. A possible explanation for the higher median values of the duplicate food study is the period of sampling. The 24-hour foods were sampled in 1984-1985, whereas the results of the present study are derived from food consumption data of 1987-88 in combination with contents in foods sampled in 1990-1991. Differences in food consumption and presumend decreases in dioxin levels could be responsible for the differences between the two studies. Food consumption data and residue values in the period 1984-1985 are not available in the Netherlands.

The assumption that the difference between the two studies could be explained with a preparation effect is not likely. Several studies [Schechter et al, 1996b; Zabik et al, 1995; Stachiw et al, 1988] showed reductions in TCDD levels during cooking and processing of meat and fish. A lower intake from duplicate food could be expected.

International intake

The performed calculations in this study may be compared with those for similar studies carried out in Germany, Canada, United Kingdom, United States and Spain (table 5).

The international estimates are in reasonable agreement with the average estimated dietary intake of dioxins and furans (i)-TEQ in the Netherlands. Average dietary intakes are in the order of 100 pg (i)-TEQ per day for an average person (residue data < 1990). It can be noticed that calculations with older residue data show higher average intakes, than studies with more recent data of dioxins.

Differences in intakes may reflect differences in dioxin levels, different consumption patterns and methodological differences.

Table 5: Total dietary intake of dioxins and furans (PCDD/Fs) determined in different countries.

Country	Estimated dietary intake pg TEQ/day	Estimated dietary intake pg TEQ/kg bw/day for 60 kg person	Sampling year	Reference
Canada	92*	1.5	1986 (?)	Birmingham et al, 1989
Germany	203**	3.4	< 1989	Fürst et al, 1990
	130	2.3	< 1989	Beck et al, 1992
	100	1.7	?-1994	Wesp et al, 1996
	23-96	0.2-1.7	1994-1995	Schrey et al, 1995 #
United Kingdom	88	1.5	1992	Wearne et al, 1996
	250	4.2	1982	Wearne et al, 1996
	125*	2.1	1988	MAFF, 1992
United States	n.r	0.5-2.6	1995	Schechter et al, 1996a
	18-192	0.3-3.0	1990	Schechter et al, 1994
Spain	81*	1.4	1995	Jimènez et al, 1996
Japan	175	2.9	1977-1990	Takayama et al, 1991
Netherlands				
calculation 1	75	1.3	1990/1991	present study
calculation 2	67	1.1	1990/1991	present study
calculation 3	41	0.7	1991/1996	present study

n.r. not reported
* concentrations less than the LOD are taken as equal to zero
** recalculated (WHO)-TEQ to (I)-TEQ by MAFF
\# duplicate food method

Table 5 gives an overview of dioxins intake calculations in different countries. Most countries reported (i)-TEQ dioxin activity excluding the dioxin activity of planar PCBs. The comparison has been made at the level of average intake. Due to a skewness in the distribution of the dioxin data there is a large difference between the average and median level of intake. The presentation of a median intake might be preferable because extreme intake of dioxins can be caused by possible mistakes in reporting the food consumption. It is well known that under or over reporting of real food consumption occur even if the record method has been used in the food consumption survey. In literature many articles, however, report only average intake.

4.2 Time trends in exposure

Over time, when comparing the different calculations, the estimated median Dutch intake of dioxins and planar PCBs showed a total decrease of approximately 55%. This decline is attributable to changes in dietary habits and changes in the calculated dioxin concentrations. It should be emphazised that the period of the input data (consumption and residue data) are not analogous. This will undoubtedley influence the degree of decrease.

Calculation 1 - Calculation 2: Changes in food consumption

The estimated dietary intake of dioxins and dioxins-like components decreased nearly 15% when comparing calculation 1 with calculation 2. This difference can mainly be ascribed to the different input of consumption data namely, the DNFCS-87/88 and the DNFCS-92. The results of these two food consumption surveys showed a reduced fat intake in The Netherlands between 1987/88 and 1992 [Hulshof et al, 1996]. The fall in the fat content of the Dutch diet will have contributed to the observed decreases in dietary intakes of (i)-TEQ, (PCB)-TEQ and (total)-TEQ. Differences could be explained in changes in food choice. In The Netherlands the fat content of several products has been reduced in recent years. For instance, margarine, low-fat spreads and dressings with a lower fat content have been introduced and were available to subjects during the DNFCS-92. Within the product groups 'meat and meat products', 'milk and milk products' and 'fats and oils' a shift was observed from products with a relatively high fat content to leaner varieties [Hulshof et al, 1996].

When comparing the fat consumption data of primary agricultural products, derived with the Conversion model Primary Agricultural Products [Dooren-Flipsen et al, 1996], the average consumption of milk fat decreased from 22 to 19 g/day, and fat of meat decreased from 19 to 17 g/day. An increase in proportion of dietary fat of vegetable rather than of animal origin may also have contributed to the observed decrease in dietary intakes of dioxins. The average consumption of the primary agricultural product group 'vegetable and animal oils and fats' has fallen from 21 to 18 g/day. Beside the change in consumption, the proportional concentration changed over time due to differences in quantities of types of vegetable and animals oil added by food industry and changes in the use and concentrations fish oil (ANNEX 2).

Most of the average decrease of the dioxin and planar PCB intake can be ascribed to the lower consumption of milk fat in 1992 (average intake decrease of about 12 pg (total)-TEQ/day).

With the DNFCS-97, which is currently in progress, more recent consumption data are available in 1998. With the DNFCS-87/88, DNFCS-92 and DNFCS-97 trends in consumption can be derived.

Calculation 2 - Calculation 3: Changes in dioxin concentrations

The estimated median dietary intake of dioxins and dioxins-like components decreased nearly 40% when comparing calculation 2 with calculation 3. This difference is completely attributable to changes in the calculated dioxin concentrations. Both calculations use the food consumption data of the DNFCS-92.

There was a decrease between 1990-1991 and 1996 in the concentrations of the majority of PCDD/F and PCB congeners quantified in beef, pig, poultry, mutton, milk and eggs. In this period of 5 years the decrease of (total)-TEQ for beef was 40%, for pig 14%, for poultry 58%, for mutton 40%, for milk 62% and for eggs 25%. The highest percentage of reduction was observed for (i)-TEQ of milk (73%). It should be noted that the concentrations of fish in 1994 are expressed on wet basis. The analysed concentrations of 1990-1990 are expressed on fat basis. For several frequently consumed types of fish, like pollack, plaice, tuna, salmon and mackerel no recent Dutch data were available. For these fish the data of 1990-1991 were applied in calculation 3. When comparing calculation 2 and 3 the average dioxin and planar PCB intake from fish was almost equal.
Most of the average fall of dioxin and planar PCB intake can be ascribed to the lower concentrations in milk in 1996 (average intake decrease of about 38 pg (total)-TEQ/day).
It is stressed that information on concentrations of dioxin and planar PCBs should be parallel with available consumption data. Currently the DNFCS-97 is in progress. It is recommended to perceive new analytical data on dioxins and planar PCBs in the same time period as the DNFCS-1997 so further time trends can be studied.
The observed decrease in the dietary intake is in line with results of the duplicate diet study as recently reported by Liem and Theelen [Liem et al, 1997]. In this study, the levels of PCDDs, PCDFs and PCBs have been determined in composites of archived duplicate diets collected in the periods 1978, 1984/85 and 1994, The study was aimed to determine the temporal trends in the average dietary intakes of these compounds by an adult Dutch population aged 18 years and older. The mean dietary intake was 4.2 pg (i)-TEQ/kg bw/day in 1978, 1.8 pg (i)-TEQ/kg bw/day in 1984/85 and 0,53 pg (i)-TEQ/kg bw. day in 1994. For non-ortho planar PCBs, a mean dietary intake was reported of 2.3 pg (PCB)-TEQ/kg bw/day in 1978, of 1.6 pg (PCB)-TEQ/kg bw/day in 1984/85 and of 0.66 pg (PCB)-TEQ/kg bw/day in 1994.

International time trends in dietary exposure

In two Total Diet Studies collected in 1982 and 1992 carried out by MAFF [Wearne et al, 1996], trends over the last decade were investigated. PCDD/Fs and PCBs were determined in samples of fatty foods and bread. They found a decrease between 1982 and 1992 in most of the composite food group samples. The high percentages of concentration decline of PCDD/Fs were in the range of 62% (milk) and 82% (eggs). Over one decade, the mean UK dietary intake of PCDD/Fs had been estimated to fall from 250 pg TEQ/day in 1982 to 88 pg TEQ/day in 1992 (a 65% decrease).
More recent German intake calculations [Wesp et al, 1996] showed that daily intake of PCDD/Fs (118 pg for men and 86 pg for women) is lower than was reported before (130 pg/day) [Beck et al, 1992]. This study was carried out for a re-evaluation of human exposure towards dioxins for the German population because of the decreasing PCDD/Fs concentrations in foodstuffs [Wesp et al, 1996]. In German studies a decline of PCDD/F levels in dairy products were observed. A comparison of the analytical results obtained in 1990 and 1994 show that the average PCDD/F levels of cow's milk and dairy products decreased almost 25% [Fürst et al, 1995].

Time trend studies of the exposure of the human population are also carried out by measuring levels in human milk and blood. A decline of approximately 30% is observed for PCDD/Fs in Dutch human milk in the period 1988-1993 [Liem et al, 1995a]. The results of German blood levels show that total PCDD/F and TEQ levels appeared to be decreasing between 1989 (42 pg/g) and 1994 (19 pg/g). Human milk levels also appeared to be declining, from 23 to 16 pg/g TEQ. This decrease was not consistently found in the US [Schechter et al, 1996c]. In the UK [Wearne et al, 1996] the concentrations of PCDD/Fs in human milk samples obtained in 1993-94 were approximately 35% lower than concentrations in corresponding samples collected in 1987-88. On the other hand a Danish study showed no significant change in levels of PCDD/Fs in human milk between 1986 an 1993/94 [Hilbert et al, 1996].

These international studies and the results of our study seem to indicate that human (dietary) exposure to dioxins and planar PCBs has decreased over the years. It can be suggested that efforts to reduce PCDD/F emissions, such as optimisation of waste incineration technology, are beginning to have positive effects.

4.3 Contribution of food categories

For the average Dutch dietary intake of dioxins, furans and planar PCBs the largest contributors are animal products, including milk, meat, fish and eggs. From the trend analysis, from the 3 calculations, it is demonstrated that the contribution of especially milk has declined.
A comparison with previous Dutch calculations of Liem [Liem et al, 1996] is possible for results based on food consumption data of the DNFCS-87/88 (calculation 1). Our study shows an obvious higher contribution of fish (18%), beef (16%) and egg (7%) to (total)-TEQ intake. Lower percentages are found for 'vegetable and animal oils and fats' (7%). Differences in contribution of certain categories of food in the present study can be assigned to differences in the applied methodology of categorizing food items and the conversion to primary agricultural products (see 4.1). For example product items like fish fingers, fried fillet of haddock, prepared minced meat are classified in the food category 'industrial oils and fats' [Liem et al, 1991]. In the present study the different components of fat in these food items are split up to fat components of different primary agricultural products: fat of fish, fat of beef, fat of pig, fat of egg, 'vegetable and animal oils and fats' [Dooren-Flipsen et al, 1996]. This could explain the shift of relative contribution over the different categories of food.

International studies also show that foods of animal origin are the predominant sources of dietary exposure to dioxin-like components. Usually the international studies refer to dairy products, meat and meat products, and fish and fish products [Liem et al, 1995b].
In casee of dairy products and meats this is a consequence of their importance in the diet in industialized countries and their relatively high fat content. For fish a considerable higher fat PCDD/F

content is found, compared to other animal fat. In a Japanese study it was found that daily intakes are larger than in Europe taking about 60% of the TEQ in food through fish and shellfish [Takayama et al, 1991].

4.4 High intake and exceedings

The estimated dioxin intakes in the present study are based on 2-day diet records. This period is relatively short. Average group values obtained with this method may be comparable to average chronic dietary exposure, but this is certainly not the case on an individual level. The average intake figures can be compared with the TDI which is intended for a lifelong PCDD/F-intake. However, individual intake figures, which are used in this study for estimation of the proportion of TDI-exceeders, are more representative of recent intake and not chronic intake. By increasing the number of days on which the diet is recorded the influence of intra-individual variability is reduced, resulting in a narrower distribution of intake data around the same mean. Other food consumption methodologies like a food frequency questionnaire, a dietary history methodology or food record method of more days may give a better estimation of chronic food consumption. Therefore high intake presented in this study might be an over-estimation to some extent.

In general, the difference between mean intake and the TDI is smallest for children 1-4 years old. The mean daily dietary intake of children in the age of 1-4 years was over the 3 calculations 16-35 pg (i)-TEQ/day or 1.2-2.5 pg (i)-TEQ/kg bw/day. In comparison to the adults in the same calculation the mean daily dose of children is about 2.4 fold higher.
This is mainly caused by the relatively higher food consumption by children compared to adults, as calculated on the basis of body weight.
The proposed recommended exposure limit for humans of 1 pg of toxic equivalents per kg body weight per day (Health Council of the Netherlands), was exceeded by the majority of the Dutch population, in particular younger age groups. In calculation 1, 2 and 3 almost all children involved in the study exceeded this limit for (total)-TEQ 100%, 99% and 95% respectively. For (i)-TEQ these figures are 97%, 94% and 60% and for (PCB)-TEQ 98%, 96% and 92%. The time trend showed a lower intake per kg body weight for children, but not to the extent of the critical value of 1 pg TEQ/kg bw/day. Measures to reduce the emission of PCDD/F into the environment should therefore be enforced.
Our findings are in reasonable agreement with a duplicate food study of small children of Schrey [Schrey et al, 1996]. She reported a higher mean daily dietary intake of 44 pg (i)-TEQ/day and 2.6 pg (i)-TEQ/kg bw/day in 14 duplicate foods (sampled 1995) of children at the age of 22 months to 5 years. The limit of 1 pg (i)-TEQ was exceeded by all children in her study.
In the present study no calculations of dietary intake of dioxin-like component have been made for children younger than 1 year. In comparison with the daily dose of nursed infants, which on average

is 265 pg (total)-TEQ/kg bw/day [Health Council of the Netherlands, 1996], the exposure of small children ($\geq$1 year old) to PCDD/Fs and planar PCBs via food is many times lower.

Nevertheless, the age groups in which the TDI and the proposed limit for dioxins by the Health Council of the Netherlands were exceeded concerns especially the vulnerable age groups.

Therefor it is recommended that future research is focused on the intake of dioxins and planar PCBs by younger age groups.

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ANNEX 1 *TEF-values of dioxins and planar PCBs.*

Dioxins

Component	TEF-values RIVM 1990-1991	TEF-values LPKS 1996
2,3,7,8-TCDF	0,1	0,1
2,3,7,8-TCDD	1	1
1,2,3,7,8-PeCDF	0,05	0,05
2,3,4,7,8-PeCDF	0,5	0,5
1,2,3,7,8-PeCDD	0,5	0,5
1,2,3,4,7,8-HxCDF	0,1	0,1
1,2,3,6,7,8-HxCDF	0,1	0,1
2,3,4,6,7,8-HxCDF	0,1	0,1
1,2,3,7,8,9-HxCDF	0,1	0,1
1,2,3,4,7,8-HxCDD	0,1	0,1
1,2,3,6,7,8-HxCDD	0,1	0,1
1,2,3,7,8,9-HxCDD	0,1	0,1
1,2,3,4,6,7,8-HpCDF	0,01	0,01
1,2,3,4,7,8,9-HpCDF	0,01	0,01
1,2,3,4,6,7,8-HpCDD	0,01	0,01
OCDF	0,001	0,001
OCDD	0,001	0,001

Planar PCBs

Component	TEF-values RIVM 1990-1991	TEF-values LPKS 1996
3,4,3',4'-PCB (77)	0,01	0,0005
3,4,3',4',5'-PCB (126)	0,1	0,1
3,4,5,3',4',5'-PCB (169)	0,005	0,01

ANNEX 2 Concentrations of dioxins (pg (i)-TEQ/g fat) and planar PCBs (pg (PCB)-TEQ/g fat) in different primary agricultural products (Sampled in 1990-1991).

These data are used in combination with the National Dutch Food Consumption Survey from 87/88 (Calculation 1) and 1992 (Calculation 2).

Primary agricultural product	(i)-TEQ dioxins (pg/g fat)		(PCB)-TEQ (pg/g fat)		Source
Food Consumption Survey	1987/1988	1992	1987/-1988	1992	
beef	1.75	1.75	2.45	2.45	Liem et al., 1991
cow's liver +	5.7	5.7	3.95	3.95	Liem et al., 1991
pig	0.43	0.43	0.16	0.16	Liem et al., 1991
pig's liver +	15.3	15.3	2.05	2.05	Liem et al., 1991
poultry	1.65	1.65	2.0	2.0	Liem et al., 1991
chicken's liver	3.25	3.25	2.8	2.8	Liem et al., 1991
mutton	1.85	1.85	2.0	2.0	Liem et al., 1991
horse	13.85	13.85	25.2	25.2	Liem et al., 1991
game	16.9	16.9	18.1	18.1	Liem et al., 1996
milk &	1.55	1.42	1.81	1.77	Liem et al., 1996 Liem et al., 1991
nuts	0.2	0.2	0.35	0.35	Liem et al., 1991
eggs	2.0	2.0	2.25	2.25	Liem et al., 1991
fat sea fish *	6.65	6.65	12.8	12.8	Liem et al., 1991
lean sea fish *	48.65	48.65	146.75	146.75	Liem et al., 1991
eel	28.0	28.0	6.05	6.05	Liem et al., 1991
fresh water fish *	2.4	2.4	6.05	6.05	Liem et al., 1991
grains: wheat(flour) rye other #	 0.40 0.32 0.40	 0.40 0.32 0.40	 1.55 0.93 1.55	 1.55 0.93 1.55	 Liem et al., 1996
soya bean oil rapeseed oil palm oil sunflower oil coconut fat palm fat	0.025 0.006 0.030 0.006 0.024 0.010	0.025 0.006 0.030 0.006 0.024 0.010	0.015 0.015 0.030 0.010 0.030 0.020	0.015 0.015 0.030 0.010 0.030 0.020	Liem et al., 1991
fish oil	0.98	1.26	1.75	2.67	Liem et al., 1996
vegetable oils/fats @ +	0.02	0.02	0.02	0.02	Liem et al., 1991
vegetable & animal oils and fats @	0.20	0.11	0.34	0.21	Liem et al., 1996 Liem et al., 1991
vegetables and fruit $	-	-	-	-	Liem et al., 1996 Liem et al., 1991

* Linking:

fat sea fish	herring, sardines, mackerel, anchovy
lean sea fish	tuna, cod, pollack, haddock, gurnard, sprat, flounder, plaice, sole, lemon sole, shrimps, oysters, mussel, ray, octopus
fresh water fish	salmon, trout, carp, perch, bream

\# With the conversion model the consumed germ part (fat part of grain) of different grains is calculated and linked to concentrations analysed in fat part of wheat(flour) and rye.

$ Study of curly kale is not representative for vegetables and fruit.

\+ For a number of consumed products a residue content is missing:

cacao fat, olives	concentration of vegetable oils and fats used
kidney fat cow	concentration of cow's liver used
kidney fat pig	concentration of pig's liver used

& The concentration of milk(fat) was calculated in proportion tot the quantity of the average consumption of butter, cheese and milk(products). Dioxins and planar PCBs are analysed in butter, cheese and milk(products). The conversion model primary agricultural products the consumption of milkfat is calculated from all consumable products with processed milk. For the estimation of the average dioxin and planar PCB intake from milkfat the proportional concentration (i)-TEQ and (PCB)-TEQ is calculated in proportion to the average consumption of butter, cheese and milk(products).

1987/1988 Product	Average consumption (g fat/day) [DNFCS-87/88]	Average concentration (i)-TEQ (pg/g fat) [Liem, 1991]	Proportional concentration (i)-TEQ (pg/g fat)	Average concentration (PCB)-TEQ (pg/g fat) [Liem, 1991]	Proportional concentration (PCB)-TEQ (pg/g fat)
butter	4.2	1.80	0.34	2.10	0.39
cheese	8.9	1.40	0.55	2.05	0.81
milk(products)	9.4	1.58	0.66	1.45	0.61
proportional milk-(fat)			**1.55**		**1.81**

1992 Product	Average consumption (g fat/day) [DNFCS-92]	Average concentration (i)-TEQ (pg/g fat) [Liem, 1996]	Proportional concentration (i)-TEQ (pg/g fat)	Average concentration (PCB)-TEQ (pg/g fat) [Liem, 1996]	Proportional concentration (PCB)-TEQ (pg/g fat)
butter	2.2	1.80	0.18	2.10	0.21
cheese	8.6	1.40	0.60	2.05	0.88
milk(products)	9.4	1.33	0.63	1.44	0.68
proportional milk-(fat)			**1.42**		**1.77**

@ The concentration of vegetable oils and fats was calculated for 87/88 and 92 in proportion to the quantity of the various types of oils and fats (soy bean oil, rape-seed oil, palm oil, sunflower oil, coconut fat, palm fat) delivered to food industry in the Netherlands.
The concentration of vegetable and animal oils and fats was calculated for 87/88 and 92 in proportion to the quantity of the various types of vegetable oils and fats (soy bean oil, rape-seed oil, palm oil, sunflower oil, coconut fat, palm fat) and animal oils (fish oil) delivered to food industry in the Netherlands. The concentration of fish oil is also adjusted for geographical differences.
Statistical data of the annual report 1988 and 1992 of the Product Organisation of Margarine, Fat and Oil are used for this calculation.

Product	Composition oils/fats in food (in 1000 mt)		Average concentration	
	92 [1]	87/88 [2]	(i)-TEQ (pg/g vet) [3]	(PCB)-TEQ (pg/vet) [3]
VEGETABLE				
soy bean oil	132.8	110.3	0.025	0.015
rape seed oil	59.2	75.4	0.006	0.015
palm oil	108.3	50.5	0.030	0.030
sunflower oil	46.1	27.4	0.006	0.010
coconut fat	18.8	17.7	0.024	0.030
palm fat	23.0	15.9	0.010	0.020
	388.2	279.2		
proportional vegetable oils and fats (i)-TEQ	**0.02**	**0.02**		
(PCB)-TEQ	**0.02**	**0.02**		
ANIMAL				
fish oil	30.1	66.1	1.26 (92)% 0.98 (87/88)%	2.67 (92)% 1.75 (87/88)%
proportional vegetable and animal oils and fats				
(i)-TEQ	**0.11**	**0.20**		
(PCB)-TEQ	**0.21**	**0.34**		

% Average concentration of dioxins per year according to geographical import of fish oil

ANNEX 3 Concentrations dioxins (pg (i)-TEQ) and planar PCBs (pg (PCB)-TEQ/g fat) in different primary agricultural products (Sampled in 1994-1996).

These data are used in combination with the National Dutch Food Consumption Survey from 1992 (Calculation 3).

Primary agricultural product	(i)-TEQ	(PCB)-TEQ	Dimension	Sampling year	Source
Food Consumption Survey	1992	1992			
beef	1.25	1.27	pg/g fat	1996	Traag et al, 1997
pig	0.25	0.26	pg/g fat	1996	Traag et al, 1997
poultry	0.66	0.89	pg/g fat	1996	Traag et al, 1997
mutton	0.95	1.38	pg/g fat	1996	Traag et al, 1997
milk	0.38	0.84	pg/g fat	1996	Traag et al, 1997
eggs	2.03	1.16	pg/g fat	1996	Traag et al, 1997
shrimps	1.34	2.00	pg/g product	1994	Klaveren, 1995
mussel	0.81	2.07	pg/g product	1994	Klaveren, 1995
herring	2.01	3.05	pg/g product	1994	Klaveren, 1995
cod	0.13	0.42	pg/g product	1994	Klaveren, 1995
eel	2.19	5.38	pg/g product	1994	Klaveren, 1995
sole	0.19	0.72	pg/g product	1994	Klaveren, 1995

ANNEX 4 Results calculation 1.

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ANNEX 4A: RESULTS CALCULATION 1

Statistical values dietary intake (i)-TEQ for different populations in the Netherlands

Dutch National Food Consumption Survey 1987/1988 (DNFCS-87/88)
Residue data RIVM (1990-1991)
TDI = Tolerable Daily Intake = 10 pg/kg bw/day

		pg/day					pg/kg bw/day						
Population	N	Avg	SD	Min	Median	95%	Avg	SD	Min	Median	95%	n>TDI	%>TDI
DNFCS-87/88 POPULATION	5898	75	52		65	157	1.4	1.0	.0	1.1	3.1	9	.2
MEN	2788	83	55	6	72	174	1.4	.9	.1	1.2	3.2	1	.0
WOMEN	3110	69	48		59	144	1.3	1.0	.0	1.1	3.0	8	.3
BOYS, 1-4 YEAR	163	37	15	7	35	67	2.8	1.1	.7	2.5	4.9	0	.0
GIRLS, 1-4 YEAR	140	36	17	5	34	69	2.8	1.6	.4	2.5	5.4	2	1.4
BOYS, 4-7 YEAR	128	47	23	13	42	98	2.3	1.1	.6	2.0	4.5	0	.0
GIRLS, 4-7 YEAR	128	42	26		38	75	2.1	1.5	.0	1.9	3.6	1	.8
BOYS, 7-10 YEAR	120	52	26	14	47	106	1.8	.9	.5	1.7	3.5	0	.0
GIRLS, 7-10 YEAR	133	47	23	11	43	92	1.7	.9	.4	1.5	3.4	0	.0
BOYS, 10-13 YEAR	148	64	36	14	58	115	1.7	1.0	.4	1.5	3.2	0	.0
GIRLS, 10-13 YEAR	138	65	48	9	57	133	1.6	1.1	.2	1.4	3.3	1	.7
BOYS, 13-16 YEAR	156	70	32	17	64	123	1.3	.6	.3	1.2	2.5	0	.0
GIRLS, 13-16 YEAR	149	66	34	11	62	130	1.3	.7	.2	1.1	2.7	0	.0
MEN, 16-19 YEAR	143	89	71	11	74	186	1.3	1.0	.2	1.1	2.6	1	.7
WOMEN, 16-19 YEAR	166	65	33	13	57	119	1.1	.6	.2	1.0	2.1	0	.0
MEN, 19-22 YEAR	88	76	30	26	73	121	1.1	.4	.3	1.0	1.8	0	.0
WOMEN, 19-22 YEAR	114	64	36	3	54	127	1.1	.6	.0	.9	2.1	0	.0
MEN, 22-50 YEAR	1230	92	57	6	80	180	1.2	.7	.1	1.0	2.4	0	.0
WOMEN, 22-50 YR, NOT PREGNANT	1341	73	51		64	147	1.2	.9	.0	1.0	2.3	3	.2
MEN, 50-65 YEAR	386	99	63	13	84	207	1.3	.9	.2	1.1	2.7	0	.0
WOMEN, 50-65 YEAR	484	77	49		65	165	1.1	.7	.0	.9	2.6	0	.0
MEN, 65+ YEAR	226	96	54	20	82	206	1.3	.7	.2	1.1	2.8	0	.0
WOMEN, 65+ YEAR	266	79	67	14	63	160	1.1	1.0	.2	.9	2.3	1	.4
PREGNANT WOMEN	51	67	33	19	63	135	1.0	.5	.3	.9	1.8	0	.0
VEGETARIANS	67	75	62	18	59	201	1.4	.9	.3	1.1	3.1	0	.0
VEGET., VEGANISTS, MACROBIOTS, ANTROP.	68	74	62	14	58	184	1.4	.9	.2	1.1	3.1	0	.0

26 rows selected.

Statistical values dietary intake (i)-TEQ total population after weighing procedure for gender and age

		pg/day		pg/kg bw/day	
Population	N	Weighted avg	Weighted SD	Weighted avg	Weighted SD
DNFCS-87/88 POPULATION	5898	77	58	1.3	1.0

ANNEX 4B: RESULTS CALCULATION 1

Statistical values dietary intake (PCB)-TEQ for different populations in the Netherlands

Dutch National Food Consumption Survey 1987/1988 (DNFCS-87/88)
Residue data RIVM (1990-1991)
TDI = Tolerable Daily Intake = 10 pg/kg bw/day

Population	N	pg/day Avg	SD	Min	Median	95%	pg/kg bw/day Avg	SD	Min	Median	95%	n>TDI	%>TDI
DNFCS-87/88 POPULATION	5898	100	102		77	259	1.8	1.8	.0	1.3	4.5	37	.6
MEN	2788	111	111	4	86	284	1.9	1.7	.1	1.4	4.8	19	.7
WOMEN	3110	91	93		70	231	1.7	1.8	.0	1.3	4.2	18	.6
BOYS, 1-4 YEAR	163	48	29	4	42	89	3.5	2.1	.4	3.0	6.8	5	3.1
GIRLS, 1-4 YEAR	140	47	39	5	40	98	3.7	3.6	.4	3.0	8.6	6	4.3
BOYS, 4-7 YEAR	128	59	39	13	51	130	2.8	1.8	.7	2.4	6.0	1	.8
GIRLS, 4-7 YEAR	128	52	30	1	44	96	2.6	1.8	.0	2.2	4.7	2	1.6
BOYS, 7-10 YEAR	120	66	46	18	58	152	2.3	1.6	.7	2.0	4.6	2	1.7
GIRLS, 7-10 YEAR	133	59	39	12	52	131	2.1	1.5	.4	1.7	4.7	1	.8
BOYS, 10-13 YEAR	148	83	62	16	68	204	2.2	1.6	.4	1.8	5.9	0	.0
GIRLS, 10-13 YEAR	138	82	61	11	69	210	2.0	1.4	.3	1.7	4.8	0	.0
BOYS, 13-16 YEAR	156	86	46	22	78	173	1.6	1.0	.4	1.5	3.3	0	.0
GIRLS, 13-16 YEAR	149	90	83	7	70	213	1.7	1.6	.1	1.3	3.9	1	.7
MEN, 16-19 YEAR	143	122	180	18	89	238	1.8	2.5	.3	1.3	3.8	1	.7
WOMEN, 16-19 YEAR	166	81	47	15	71	173	1.4	.8	.3	1.2	3.1	0	.0
MEN, 19-22 YEAR	88	97	56	30	85	156	1.4	.8	.3	1.2	2.3	0	.0
WOMEN, 19-22 YEAR	114	85	71	4	66	187	1.4	1.1	.1	1.1	2.9	0	.0
MEN, 22-50 YEAR	1230	124	120	10	96	293	1.6	1.6	.1	1.2	4.0	7	.6
WOMEN, 22-50 YR, NOT PREGNANT	1341	98	110		76	238	1.6	1.8	.0	1.2	3.8	6	.4
MEN, 50-65 YEAR	386	135	118	21	101	368	1.8	1.7	.2	1.3	4.9	3	.8
WOMEN, 50-65 YEAR	484	103	94		77	298	1.5	1.4	.0	1.1	4.2	1	.2
MEN, 65+ YEAR	226	136	115	20	97	375	1.8	1.5	.3	1.3	5.1	0	.0
WOMEN, 65+ YEAR	266	105	92	16	77	294	1.5	1.4	.2	1.1	4.1	1	.4
PREGNANT WOMEN	51	87	54	14	76	214	1.3	.8	.2	1.1	3.6	0	.0
VEGETARIANS	67	108	133	20	73	352	1.9	1.9	.4	1.3	5.3	2	3.0
VEGET., VEGANISTS, MACROBIOTS, ANTROP.	68	106	133	18	73	282	1.9	1.9	.3	1.3	4.7	2	2.9

26 rows selected.

Statistical values dietary intake (PCB)-TEQ total population after weighing procedure for gender and age

Population	N	pg/day Weighted avg	Weighted SD	pg/kg bw/day Weighted avg	Weighted SD
DNFCS-87/88 POPULATION	5898	103	114	1.8	1.8

ANNEX 4C: RESULTS CALCULATION 1

Statistical values dietary intake (total)-TEQ for different populations in the Netherlands

Dutch National Food Consumption Survey 1987/1988 (DNFCS-87/88)
Residue data RIVM (1990-1991)
TDI = Tolerable Daily Intake = 10 pg/kg bw/day

		pg/day					pg/kg bw/day						
Population	N	Avg	SD	Min	Median	95%	Avg	SD	Min	Median	95%	n>TDI	%>TDI
DNFCS-87/88 POPULATION	5898	176	150		142	414	3.2	2.7	.0	2.4	7.5	122	2.1
MEN	2788	194	161	11	158	453	3.3	2.6	.2	2.6	7.9	65	2.3
WOMEN	3110	160	136		130	378	3.0	2.7	.0	2.4	7.2	57	1.8
BOYS, 1-4 YEAR	163	85	42	11	76	162	6.3	3.1	1.1	5.5	11.0	15	9.2
GIRLS, 1-4 YEAR	140	84	55	10	74	172	6.5	5.1	.8	5.4	14.0	13	9.3
BOYS, 4-7 YEAR	128	106	61	27	94	238	5.2	2.8	1.3	4.5	11.1	8	6.3
GIRLS, 4-7 YEAR	128	94	54	1	82	165	4.7	3.2	.0	4.1	8.4	4	3.1
BOYS, 7-10 YEAR	120	118	70	32	106	258	4.1	2.4	1.2	3.7	8.1	3	2.5
GIRLS, 7-10 YEAR	133	106	60	25	95	219	3.8	2.3	.9	3.2	8.2	3	2.3
BOYS, 10-13 YEAR	148	147	96	31	127	326	3.9	2.6	.8	3.3	8.8	6	4.1
GIRLS, 10-13 YEAR	138	147	98	20	125	349	3.7	2.3	.5	3.1	7.6	5	3.6
BOYS, 13-16 YEAR	156	156	76	41	144	313	2.9	1.5	.8	2.7	5.8	1	.6
GIRLS, 13-16 YEAR	149	156	115	18	131	346	3.0	2.3	.3	2.5	6.1	2	1.3
MEN, 16-19 YEAR	143	211	249	28	163	425	3.1	3.4	.5	2.4	6.0	2	1.4
WOMEN, 16-19 YEAR	166	146	78	28	127	294	2.5	1.4	.5	2.2	5.1	0	.0
MEN, 19-22 YEAR	88	173	84	56	159	268	2.4	1.2	.6	2.1	4.0	0	.0
WOMEN, 19-22 YEAR	114	149	105	8	120	324	2.4	1.7	.1	2.1	5.2	1	.9
MEN, 22-50 YEAR	1230	216	171	17	177	472	2.8	2.3	.2	2.3	6.2	15	1.2
WOMEN, 22-50 YR, NOT PREGNANT	1341	171	156		141	385	2.7	2.6	.0	2.2	6.1	18	1.3
MEN, 50-65 YEAR	386	234	175	34	184	614	3.0	2.4	.4	2.4	7.8	12	3.1
WOMEN, 50-65 YEAR	484	180	138		142	473	2.6	2.0	.0	2.0	6.6	7	1.4
MEN, 65+ YEAR	226	232	165	40	180	589	3.0	2.2	.5	2.4	8.1	3	1.3
WOMEN, 65+ YEAR	266	184	152	31	141	442	2.7	2.3	.4	2.0	6.4	4	1.5
PREGNANT WOMEN	51	155	85	33	140	349	2.3	1.3	.5	2.0	5.4	0	.0
VEGETARIANS	67	183	193	38	132	553	3.3	2.8	.7	2.4	8.3	2	3.0
VEGET., VEGANISTS, MACROBIOTS, ANTROP.	68	180	192	32	132	466	3.3	2.8	.5	2.4	7.9	2	2.9

26 rows selected.

Statistical values dietary intake (total)-TEQ total population after weighing procedure for gender and age

		pg/day		pg/kg bw/day	
Population	N	Weighted avg	Weighted SD	Weighted avg	Weighted SD
DNFCS-87/88 POPULATION	5898	180	168	3.1	2.7

ANNEX 5 Results calculation 2.

ANNEX 5A: RESULTS CALCULATION 2

Statistical values dietary intake (i)-TEQ for different populations in the Netherlands

Dutch National Food Consumption Survey 1992 (DNFCS-92)
Residue data RIVM (1990-1991)
TDI = Tolerable Daily Intake = 10 pg/kg bw/day

		pg/day					pg/kg bw/day						
Population	N	Avg	SD	Min	Median	95%	Avg	SD	Min	Median	95%	n>TDI	%>TDI
DNFCS-1992 POPULATION	6218	67	61		55	144	1.2	1.0	.0	.9	2.8	8	.1
MEN	2881	74	68	3	61	154	1.2	1.0	.1	1.0	2.9	3	.1
WOMEN	3337	61	53		50	131	1.2	1.1	.0	.9	2.8	5	.1
BOYS, 1-4 YEAR	149	33	18	5	29	66	2.5	1.3	.4	2.2	4.9	0	.0
GIRLS, 1-4 YEAR	202	34	20		30	68	2.5	1.6	.0	2.2	4.9	2	1.0
BOYS, 4-7 YEAR	164	44	40	6	38	83	2.1	1.8	.3	1.9	3.6	1	.6
GIRLS, 4-7 YEAR	165	39	24	5	35	76	1.9	1.0	.3	1.7	3.4	0	.0
BOYS, 7-10 YEAR	127	47	25	3	43	92	1.7	1.0	.1	1.4	3.3	0	.0
GIRLS, 7-10 YEAR	127	45	23	5	41	96	1.6	.9	.2	1.5	3.0	0	.0
BOYS, 10-13 YEAR	136	53	23	21	47	94	1.3	.6	.5	1.2	2.5	0	.0
GIRLS, 10-13 YEAR	119	57	38	14	46	125	1.4	1.0	.3	1.2	3.3	0	.0
BOYS, 13-16 YEAR	119	55	23	15	52	106	1.0	.5	.2	1.0	1.9	0	.0
GIRLS, 13-16 YEAR	133	52	26	12	46	100	1.0	.5	.3	.9	2.1	0	.0
MEN, 16-19 YEAR	128	68	40	15	59	120	1.0	.6	.2	.9	1.9	0	.0
WOMEN, 16-19 YEAR	125	59	44	13	53	113	1.0	.8	.2	.9	2.1	0	.0
MEN, 19-22 YEAR	111	77	40	14	69	145	1.0	.5	.2	1.0	1.8	0	.0
WOMEN, 19-22 YEAR	107	56	29	10	47	116	.9	.5	.2	.8	1.8	0	.0
MEN, 22-50 YEAR	1306	84	83	6	70	177	1.1	.9	.1	.9	2.2	2	.2
WOMEN, 22-50 YR, NOT PREGNANT	1493	65	51	3	54	138	1.0	.8	.1	.8	2.2	0	.0
MEN, 50-65 YEAR	405	84	63	10	71	177	1.1	.7	.1	.9	2.3	0	.0
WOMEN, 50-65 YEAR	545	70	76	5	55	150	1.0	1.2	.1	.8	2.2	2	.4
MEN, 65+ YEAR	236	85	66	14	67	194	1.1	.8	.2	.9	2.5	0	.0
WOMEN, 65+ YEAR	263	70	68	12	54	147	1.0	1.2	.1	.8	2.1	1	.4
PREGNANT WOMEN	58	72	38	18	71	150	1.0	.6	.2	.9	2.0	0	.0
VEGETARIANS	65	61	38	11	53	118	.9	.5	.2	.8	1.8	0	.0
VEGET., VEGANISTS, MACROBIOTS, ANTROP.	77	63	36	11	56	119	1.1	.7	.2	.9	2.8	0	.0

26 rows selected.

Statistical values dietary intake (i)-TEQ total population after weighing procedure for gender and age

		pg/day		pg/kg bw/day	
Population	N	Weighted avg	Weighted SD	Weighted avg	Weighted SD
DNFCS-1992 POPULATION	6218	69	74	1.2	1.1

ANNEX 5B: RESULTS CALCULATION 2

Statistical values dietary intake (PCB)-TEQ for different populations in the Netherlands

Dutch National Food Consumption Survey 1992 (DNFCS-92)
Residue data RIVM (1990-1991)
TDI = Tolerable Daily Intake = 10 pg/kg bw/day

Population	N	pg/day Avg	SD	Min	Median	95%	pg/kg bw/day Avg	SD	Min	Median	95%	n>TDI	%>TDI
DNFCS-1992 POPULATION	6218	94	118		68	264	1.7	2.1	.0	1.2	4.5	47	.8
MEN	2881	102	107	5	76	282	1.7	1.7	.1	1.2	4.5	19	.7
WOMEN	3337	87	126		62	241	1.7	2.3	.0	1.1	4.6	28	.8
BOYS, 1-4 YEAR	149	47	43	7	36	102	3.4	2.9	.5	2.8	7.9	6	4.0
GIRLS, 1-4 YEAR	202	48	47		36	126	3.6	3.8	.0	2.6	9.5	9	4.5
BOYS, 4-7 YEAR	164	56	47	10	46	129	2.7	2.2	.5	2.3	6.2	2	1.2
GIRLS, 4-7 YEAR	165	52	40	6	43	118	2.5	1.9	.4	2.1	5.9	3	1.8
BOYS, 7-10 YEAR	127	65	54	5	52	181	2.3	2.1	.2	1.8	6.1	2	1.6
GIRLS, 7-10 YEAR	127	66	51	7	50	187	2.4	1.8	.4	1.8	6.9	0	.0
BOYS, 10-13 YEAR	136	67	40	27	58	121	1.7	1.0	.6	1.5	3.1	0	.0
GIRLS, 10-13 YEAR	119	81	92	13	55	224	2.1	2.3	.4	1.4	6.6	3	2.5
BOYS, 13-16 YEAR	119	69	36	10	63	130	1.3	.8	.2	1.2	2.3	0	.0
GIRLS, 13-16 YEAR	133	68	50	13	57	141	1.3	1.0	.3	1.1	2.6	0	.0
MEN, 16-19 YEAR	128	90	69	18	74	175	1.3	1.0	.3	1.1	2.6	0	.0
WOMEN, 16-19 YEAR	125	77	79	16	66	160	1.3	1.4	.3	1.1	3.2	1	.8
MEN, 19-22 YEAR	111	108	95	18	86	262	1.4	1.2	.3	1.2	3.6	0	.0
WOMEN, 19-22 YEAR	107	75	53	15	62	166	1.2	.9	.2	.9	3.3	0	.0
MEN, 22-50 YEAR	1306	118	113	8	87	337	1.5	1.5	.1	1.1	4.1	7	.5
WOMEN, 22-50 YR, NOT PREGNANT	1493	93	121	5	66	273	1.4	1.9	.1	1.0	3.9	10	.7
MEN, 50-65 YEAR	405	120	149	10	87	321	1.5	1.7	.1	1.1	4.1	2	.5
WOMEN, 50-65 YEAR	545	108	212	6	68	300	1.6	3.4	.1	1.0	4.7	2	.4
MEN, 65+ YEAR	236	117	106	15	79	320	1.5	1.3	.2	1.0	4.1	0	.0
WOMEN, 65+ YEAR	263	89	74	9	65	250	1.3	1.1	.1	.9	3.5	0	.0
PREGNANT WOMEN	58	111	96	20	85	319	1.6	1.4	.3	1.2	4.3	0	.0
VEGETARIANS	65	93	84	15	74	213	1.5	1.2	.2	1.2	3.1	0	.0
VEGET., VEGANISTS, MACROBIOTS, ANTROP.	77	94	78	15	76	213	1.6	1.2	.2	1.2	4.1	0	.0

26 rows selected.

Statistical values dietary intake (PCB)-TEQ total population after weighing procedure for gender and age

Population	N	pg/day Weighted avg	Weighted SD	pg/kg bw/day Weighted avg	Weighted SD
DNFCS-1992 POPULATION	6218	97	133	1.7	2.1

ANNEX 5C: RESULTS CALCULATION 2

Statistical values dietary intake (total)-TEQ for different populations in the Netherlands

Dutch National Food Consumption Survey 1992 (DNFCS-92)
Residue data RIVM (1990-1991)
TDI = Tolerable Daily Intake = 10 pg/kg bw/day

		pg/day					pg/kg bw/day						
Population	N	Avg	SD	Min	Median	95%	Avg	SD	Min	Median	95%	n>TDI	%>TDI
DNFCS-1992 POPULATION	6218	161	170		123	410	2.9	3.0	.0	2.1	7.3	131	2.1
MEN	2881	177	163	8	137	458	2.9	2.6	.2	2.2	7.2	58	2.0
WOMEN	3337	148	174		113	372	2.8	3.3	.0	2.0	7.3	73	2.2
BOYS, 1-4 YEAR	149	80	60	13	65	156	5.9	4.1	.9	5.0	12.2	12	8.1
GIRLS, 1-4 YEAR	202	82	66		65	190	6.1	5.3	.0	4.8	13.7	16	7.9
BOYS, 4-7 YEAR	164	100	78	16	85	205	4.8	3.7	.8	4.1	10.4	9	5.5
GIRLS, 4-7 YEAR	165	91	61	12	77	210	4.4	2.8	.8	3.8	9.1	8	4.8
BOYS, 7-10 YEAR	127	113	77	8	94	286	4.0	3.0	.3	3.2	8.8	5	3.9
GIRLS, 7-10 YEAR	127	111	73	14	91	292	4.0	2.5	.6	3.3	10.0	6	4.7
BOYS, 10-13 YEAR	136	120	61	48	104	218	3.1	1.6	1.0	2.8	5.4	1	.7
GIRLS, 10-13 YEAR	119	138	128	27	103	334	3.5	3.2	.7	2.6	10.1	6	5.0
BOYS, 13-16 YEAR	119	124	58	26	113	237	2.3	1.2	.5	2.2	4.2	0	.0
GIRLS, 13-16 YEAR	133	119	74	25	101	239	2.3	1.4	.6	2.0	4.7	0	.0
MEN, 16-19 YEAR	128	158	106	33	132	299	2.3	1.5	.5	1.9	4.4	0	.0
WOMEN, 16-19 YEAR	125	137	119	28	119	298	2.3	2.2	.5	1.9	5.4	3	2.4
MEN, 19-22 YEAR	111	185	131	32	155	376	2.5	1.6	.4	2.1	5.2	2	1.8
WOMEN, 19-22 YEAR	107	131	79	25	106	315	2.1	1.3	.4	1.7	5.2	0	.0
MEN, 22-50 YEAR	1306	202	178	14	157	524	2.6	2.2	.2	2.0	6.6	22	1.7
WOMEN, 22-50 YR, NOT PREGNANT	1493	158	167	8	121	406	2.4	2.6	.1	1.8	6.1	22	1.5
MEN, 50-65 YEAR	405	204	208	20	159	487	2.5	2.4	.2	2.0	6.4	5	1.2
WOMEN, 50-65 YEAR	545	178	286	10	124	451	2.6	4.6	.1	1.8	7.2	8	1.5
MEN, 65+ YEAR	236	202	160	32	149	523	2.6	2.0	.4	1.9	6.5	2	.8
WOMEN, 65+ YEAR	263	159	127	27	120	418	2.3	2.0	.3	1.7	5.8	3	1.1
PREGNANT WOMEN	58	183	132	38	155	466	2.6	2.0	.5	2.1	6.3	1	1.7
VEGETARIANS	65	154	120	26	125	317	2.4	1.7	.4	2.0	4.5	1	1.5
VEGET., VEGANISTS, MACROBIOTS, ANTROP.	77	157	112	26	134	317	2.6	1.8	.4	2.1	6.3	1	1.3

26 rows selected.

Statistical values dietary intake (total)-TEQ total population after weighing procedure for gender and age

		pg/day		pg/kg bw/day	
Population	N	Weighted avg	Weighted SD	Weighted avg	Weighted SD
DNFCS-1992 POPULATION	6218	167	196	2.8	3.0

ANNEX 6 Results calculation 3.

ANNEX 6A: RESULTS CALCULATION 3

Statistical values dietary intake (i)-TEQ for different populations in the Netherlands

Dutch National Food Consumption Survey 1992 (DNFCS-92)
Residue data LPKS (1994-1996) and RIVM (1990-1991)
TDI = Tolerable Daily Intake = 10 pg/kg bw/day

		pg/day					pg/kg bw/day						
Population	N	Avg	SD	Min	Median	95%	Avg	SD	Min	Median	95%	n>TDI	%>TDI
DNFCS-1992 POPULATION	6218	41	49		29	118	.7	.8	.0	.5	2.0	4	.1
MEN	2881	46	50	2	33	131	.7	.7	.1	.5	2.1	0	.0
WOMEN	3337	37	47		27	106	.7	.9	.0	.5	1.9	4	.1
BOYS, 1-4 YEAR	149	19	15	2	17	50	1.4	1.0	.2	1.2	3.0	0	.0
GIRLS, 1-4 YEAR	202	19	16		16	40	1.4	1.3	.0	1.2	2.9	2	1.0
BOYS, 4-7 YEAR	164	24	21	6	20	52	1.2	1.0	.3	1.0	2.6	0	.0
GIRLS, 4-7 YEAR	165	22	16	1	18	57	1.1	.7	.1	.9	2.5	0	.0
BOYS, 7-10 YEAR	127	28	21	2	24	70	1.0	.8	.1	.8	2.3	0	.0
GIRLS, 7-10 YEAR	127	28	22	4	22	78	1.0	.8	.2	.8	2.5	0	.0
BOYS, 10-13 YEAR	136	29	15	7	26	61	.7	.4	.2	.7	1.3	0	.0
GIRLS, 10-13 YEAR	119	33	31	9	24	85	.8	.8	.2	.6	2.4	0	.0
BOYS, 13-16 YEAR	119	34	30	8	31	64	.7	.7	.1	.6	1.2	0	.0
GIRLS, 13-16 YEAR	133	30	19	8	23	63	.6	.4	.1	.4	1.3	0	.0
MEN, 16-19 YEAR	128	39	29	11	32	98	.6	.4	.2	.5	1.5	0	.0
WOMEN, 16-19 YEAR	125	34	33	8	28	70	.6	.6	.1	.4	1.2	0	.0
MEN, 19-22 YEAR	111	47	34	5	38	105	.6	.4	.1	.5	1.4	0	.0
WOMEN, 19-22 YEAR	107	32	21	7	27	81	.5	.3	.1	.4	1.4	0	.0
MEN, 22-50 YEAR	1306	51	53	4	38	136	.6	.7	.1	.5	1.7	0	.0
WOMEN, 22-50 YR, NOT PREGNANT	1493	39	45	2	29	110	.6	.7	.0	.4	1.7	0	.0
MEN, 50-65 YEAR	405	57	67	5	38	176	.7	.8	.1	.5	2.2	0	.0
WOMEN, 50-65 YEAR	545	46	78	3	29	133	.7	1.2	.0	.4	1.9	2	.4
MEN, 65+ YEAR	236	57	58	7	35	189	.7	.7	.1	.4	2.4	0	.0
WOMEN, 65+ YEAR	263	42	44	5	27	129	.6	.7	.1	.4	1.9	0	.0
PREGNANT WOMEN	58	45	35	11	36	111	.6	.5	.1	.5	1.6	0	.0
VEGETARIANS	65	31	26	7	22	74	.5	.4	.1	.4	1.1	0	.0
VEGET., VEGANISTS, MACROBIOTS, ANTROP.	77	31	24	7	23	74	.5	.4	.1	.4	1.2	0	.0

26 rows selected.

Statistical values dietary intake (i)-TEQ total population after weighing procedure for gender and age

		pg/day		pg/kg bw/day	
Population	N	Weighted avg	Weighted SD	Weighted avg	Weighted SD
DNFCS-1992 POPULATION	6218	43	57	.7	.9

ANNEX 6B: RESULTS CALCULATION 3

Statistical values dietary intake (PCB)-TEQ for different populations in the Netherlands

Dutch National Food Consumption Survey 1992 (DNFCS-92)
Residue data LPKS (1994-1996) and RIVM (1990-1991)
TDI = Tolerable Daily Intake = 10 pg/kg bw/day

		pg/day					pg/kg bw/day						
Population	N	Avg	SD	Min	Median	95%	Avg	SD	Min	Median	95%	n>TDI	%>TDI
DNFCS-1992 POPULATION	6218	70	117		42	251	1.2	2.0	.0	.7	4.0	41	.7
MEN	2881	77	109	3	48	274	1.2	1.6	.1	.8	3.9	20	.7
WOMEN	3337	64	123		38	234	1.2	2.2	.0	.7	4.0	21	.6
BOYS, 1-4 YEAR	149	32	41	5	22	82	2.3	2.7	.4	1.7	6.9	6	4.0
GIRLS, 1-4 YEAR	202	33	43		22	86	2.4	3.4	.0	1.6	6.6	7	3.5
BOYS, 4-7 YEAR	164	40	52	7	28	69	1.9	2.4	.3	1.4	3.5	3	1.8
GIRLS, 4-7 YEAR	165	36	39	3	26	123	1.7	1.8	.2	1.2	5.5	2	1.2
BOYS, 7-10 YEAR	127	47	52	3	34	152	1.7	2.0	.1	1.1	5.7	2	1.6
GIRLS, 7-10 YEAR	127	48	52	6	31	178	1.7	1.8	.3	1.1	6.4	0	.0
BOYS, 10-13 YEAR	136	44	35	15	37	75	1.1	.9	.3	.9	1.9	0	.0
GIRLS, 10-13 YEAR	119	58	88	12	35	191	1.5	2.2	.2	.9	5.2	3	2.5
BOYS, 13-16 YEAR	119	49	48	10	41	87	.9	1.1	.2	.8	1.5	1	.8
GIRLS, 13-16 YEAR	133	46	46	11	35	85	.9	.9	.2	.7	1.8	0	.0
MEN, 16-19 YEAR	128	62	62	15	47	193	.9	.9	.2	.7	2.7	0	.0
WOMEN, 16-19 YEAR	125	51	62	8	39	143	.9	1.1	.1	.6	2.1	0	.0
MEN, 19-22 YEAR	111	79	91	10	54	226	1.0	1.1	.1	.7	3.1	0	.0
WOMEN, 19-22 YEAR	107	52	49	8	39	152	.8	.8	.1	.6	2.7	0	.0
MEN, 22-50 YEAR	1306	87	115	7	56	300	1.1	1.4	.1	.7	3.8	5	.4
WOMEN, 22-50 YR, NOT PREGNANT	1493	67	114	3	41	242	1.0	1.7	.1	.6	3.4	5	.3
MEN, 50-65 YEAR	405	96	156	11	55	313	1.2	1.8	.1	.7	4.0	3	.7
WOMEN, 50-65 YEAR	545	83	214	6	42	288	1.2	3.4	.1	.6	4.4	3	.6
MEN, 65+ YEAR	236	97	118	11	52	361	1.2	1.4	.2	.6	4.5	0	.0
WOMEN, 65+ YEAR	263	72	92	9	40	277	1.1	1.5	.1	.6	4.0	1	.4
PREGNANT WOMEN	58	83	95	14	51	293	1.2	1.4	.2	.7	3.8	0	.0
VEGETARIANS	65	60	68	9	41	193	.9	1.0	.2	.6	2.6	0	.0
VEGET., VEGANISTS, MACROBIOTS, ANTROP.	77	59	63	9	41	193	1.0	1.0	.2	.7	2.6	0	.0

26 rows selected.

Statistical values dietary intake (PCB)-TEQ total population after weighing procedure for gender and age

		pg/day		pg/kg bw/day	
Population	N	Weighted avg	Weighted SD	Weighted avg	Weighted SD
DNFCS-1992 POPULATION	6218	73	134	1.2	2.0

ANNEX 6C: RESULTS CALCULATION 3

Statistical values dietary intake (total)-TEQ for different populations in the Netherlands

Dutch National Food Consumption Survey 1992 (DNFCS-92)
Residue data LPKS (1994-1996) and RIVM (1990-1991)
TDI = Tolerable Daily Intake = 10 pg/kg bw/day

Population	N	pg/day Avg	SD	Min	Median	95%	pg/kg bw/day Avg	SD	Min	Median	95%	n>TDI	%>TDI
DNFCS-1992 POPULATION	6218	111	164		72	375	1.9	2.7	.0	1.2	5.9	98	1.6
MEN	2881	123	157	5	81	421	2.0	2.3	.2	1.3	5.9	47	1.6
WOMEN	3337	101	169		66	336	1.9	3.0	.0	1.2	5.8	51	1.5
BOYS, 1-4 YEAR	149	51	55	7	38	119	3.7	3.6	.6	2.9	9.9	7	4.7
GIRLS, 1-4 YEAR	202	52	59		38	122	3.8	4.7	.0	2.8	9.4	10	5.0
BOYS, 4-7 YEAR	164	64	72	13	48	124	3.1	3.3	.6	2.4	5.9	7	4.3
GIRLS, 4-7 YEAR	165	58	55	5	45	173	2.8	2.6	.3	2.2	8.0	6	3.6
BOYS, 7-10 YEAR	127	75	71	5	59	265	2.7	2.8	.2	1.9	8.6	5	3.9
GIRLS, 7-10 YEAR	127	76	73	11	53	250	2.7	2.5	.5	2.0	8.7	5	3.9
BOYS, 10-13 YEAR	136	73	48	21	63	131	1.9	1.2	.6	1.6	3.1	1	.7
GIRLS, 10-13 YEAR	119	91	118	21	59	280	2.3	3.0	.5	1.5	7.5	3	2.5
BOYS, 13-16 YEAR	119	83	77	22	72	151	1.6	1.7	.3	1.3	2.7	1	.8
GIRLS, 13-16 YEAR	133	76	64	19	58	155	1.4	1.2	.4	1.1	3.0	0	.0
MEN, 16-19 YEAR	128	101	89	27	78	324	1.5	1.3	.4	1.2	4.6	0	.0
WOMEN, 16-19 YEAR	125	86	93	17	66	213	1.5	1.7	.3	1.1	3.2	2	1.6
MEN, 19-22 YEAR	111	126	123	16	93	324	1.7	1.5	.2	1.2	4.5	0	.0
WOMEN, 19-22 YEAR	107	85	69	17	66	251	1.3	1.1	.3	1.0	4.4	0	.0
MEN, 22-50 YEAR	1306	139	166	11	94	450	1.7	2.0	.2	1.2	5.7	16	1.2
WOMEN, 22-50 YR, NOT PREGNANT	1493	107	157	5	70	353	1.6	2.4	.1	1.1	4.9	14	.9
MEN, 50-65 YEAR	405	153	220	16	94	464	1.9	2.6	.2	1.2	6.1	7	1.7
WOMEN, 50-65 YEAR	545	129	291	9	71	446	1.9	4.6	.1	1.0	6.3	7	1.3
MEN, 65+ YEAR	236	154	174	18	85	499	2.0	2.2	.2	1.1	6.7	3	1.3
WOMEN, 65+ YEAR	263	114	134	14	68	400	1.7	2.1	.1	.9	5.8	3	1.1
PREGNANT WOMEN	58	128	128	25	87	405	1.8	1.9	.3	1.2	5.6	1	1.7
VEGETARIANS	65	91	93	17	63	262	1.4	1.4	.3	1.0	3.7	0	.0
VEGET., VEGANISTS, MACROBIOTS, ANTROP.	77	90	86	17	65	262	1.5	1.3	.3	1.1	3.7	0	.0

26 rows selected.

Statistical values dietary intake (total)-TEQ total population after weighing procedure for gender and age

Population	N	pg/day Weighted avg	Weighted SD	pg/kg bw/day Weighted avg	Weighted SD
DNFCS-1992 POPULATION	6218	116	189	1.9	2.9