DIOXINS AND DIOXIN-LIKE PCBS IN FOODSTUFFS: LEVELS AND DIETARY INTAKE IN THE NETHERLANDS AT THE END OF THE 20TH CENTURY

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Introduction

A survey was carried out in 1998/1999 to examine the occurence of dioxins and dioxin-like PCBs in foodstuffs in The Netherlands. In this program concentrations of dioxins (PCDDs and PCDFs) and dioxin-like PCBs (non-ortho PCBs and mono-ortho PCBs) were measured in composite consumer food categories. Data obtained in this fashion were the basis for assessment of the dietary intake of dioxins and dioxin-like PCBs in the general population (Fig. 1). The dietary intake was estimated taking into account the food consumption patterns in the population as obtained in the 1998 food consumption survey[1]. For dioxins and dioxin-like PCBs, which are persistant contaminants that tend to accumulate in the body, we were mainly interested in the long-term intake.

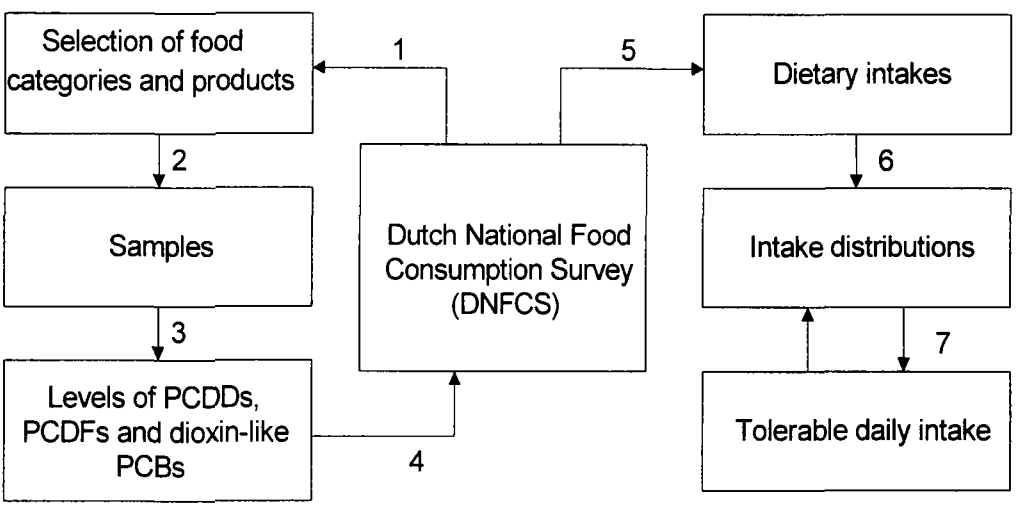

Figure 1
Design of the 1998/1999 study on dietary intake of dioxins and dioxin-like PCBs.

Methods and materials

The design of the study on dietary intake of dioxins and dioxin-like PCBs in the Netherlands is depicted in Fig. 1. In short, the database of food consumption from the Dutch National Food

Consumption Survey (DNFCS) performed in 1998 was consulted for the selection of foods based on their relative importance in the total fat consumption (1). Next, samples were collected in different regions in the Netherlands (2). In the laboratory, National representative test samples were prepared and chemically analysed (3). The results from these chemical analyses were used as input in the database of the DNFCS (4). The combination of data on levels in the selected food categories and food consumption records included in the DNCFS database resulted in dietary intakes for 6250 individuals (5). From a statistical analysis of the dietary intake data, the intake distribution was estimated (6). This distribution was evaluated by comparison with the tolerable daily intake[2].

A two-step approach was used to estimate the long-term intake in the population. First, for 6250 individuals personal daily-averaged intake was calculated for two consecutive days, using the food consumption data and concentrations in consumed products (12500 data points). Next, the relationship of long-term intake with age in the population was determined using regression analysis and nested variance analysis[3]. The regression analysis was used to quantify the intake as a function of age. From this relationship the lifelong-averaged (70 yrs) intake could be calculated. The nested variance analysis served to unravel the between-subject and the within-subject components of the total variation of daily-averaged intake in the population. (Fig. 2).

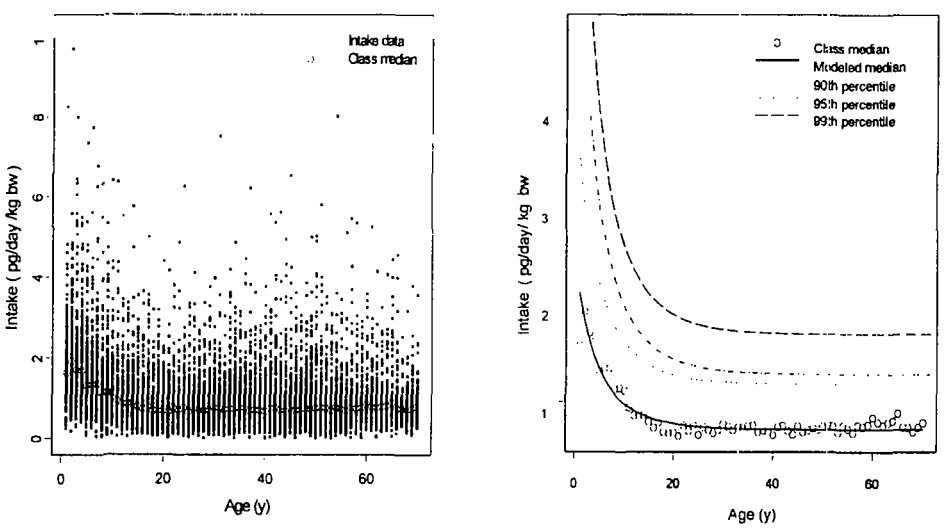

Figure 2

Relationship between dioxin (PCDDs and PCDFs) intake and age. (a) The left panel shows all the raw datapoints and the calculated median intake for each age class. (b) The right panel depicts the intake distribution for the population after performing regression and nested variance analysis on the data in the left panel. Percentiles refer to the between-subject variation.

Results

Measured average concentrations of dioxins in animal fats range from 0.24-1.52 pg WHO-TEQ/g fat. For the sum of dioxins and dioxin-like PCBs, concentrations are 1-2.5 times higher than for dioxins only (range 0.47-2.78 pg WHO-TEQ/g fat). On a product basis, concentrations of dioxins and dioxin-like PCBs in fish are higher than in most meat products. The following range of

average concentrations was found for fish: dioxins 104-921 pg WHO-TEQ /kg product, sum of dioxins and dioxin-like PCBs 267-3260 pg WHO-TEQ /kg product. Concentrations of dioxins in vegetables (85 pg WHO-TEQ/ kg product) are comparable to those in low-fat animal products. The contribution of dioxin-like PCBs to the total TEQ concentration in vegetable products is negligible compared to that of dioxins.

The median lifelong-averaged intake of dioxins in the population is estimated to be 0.8 pg WHO-TEQ /kg bw/day. The estimate for the sum of dioxins and dioxin-like PCBs is 1.5 pg WHO-TEQ /kg bw/day. The 90th percentile in the population is 1.7 times higher than the median intake. The contribution of different food groups to the average intake of TEQ (dioxins and dioxin-like PCBs) is rather evenly distributed over these groups (Fig. 3). The contribution of vegetable products to the intake of dioxins seems to be higher than was assumed a few years ago.

Discussion

A comparison was made between the results of the current survey and the results of the 1990/91 survey[4]. After correcting for methodological differences an average decrement in intake of 30% for dioxins (PCDDs and PCDFs) and 60% for mono-ortho PCBs was estimated. This considerable decrement is related to the decrease of the concentrations of dioxins (PCDDs and PCDFs) and dioxin-like PCBs in the majority of food stuffs. The downward trend in intake and concentrations was also observed in other European countries during the last decade.

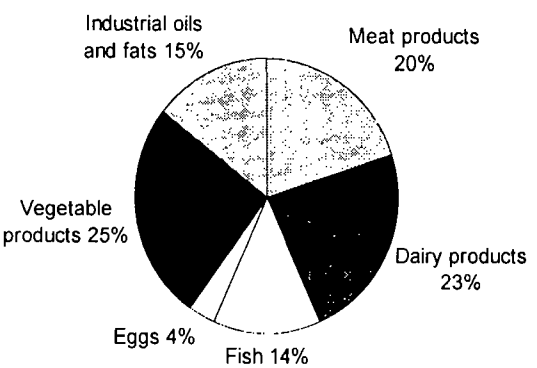

Figure 3
Estimated average contribution of food groups (%) to the intake of dioxins and dioxin-like PCBs in the Dutch population in 1998/99.

Nevertheless, a large fraction of the population is exposed to intake levels above international health safety objectives. Recently, the WHO has derived a TDI (Tolerable Daily Intake) ranging from 1-4 pg TEQ/kg bw/day. From the calculated intake distribution less than 1% of the population exceeds the upper end of 4 pg TEQ/kg bw/day. The level of 1 pg TEQ/kg bw/day is exceeded by 80% of the population.

Maximum limits (ML) for concentrations of contaminants in food commodities are often proposed as a regulatory instrument to exclude (highly) contaminated food products from the food chain. The theoretical effect of such limit values was evaluated by quantifying the percentage of

products with concentrations higher than the maximum limit. The reduction in intake associated with this maximum limit can be estimated by recalculating the average concentration and intake for a commodity after the tail of the concentration distribution for products is truncated. For the Dutch market various maximum limits proposed to exclude animal products with high levels of dioxins were evaluated. These limits appeared to have only a minor effect on the mean long-term intake of dioxins in the population. The benefit of the limit values levels would mainly be to regulate short-term high intake in case of contamination incidents. Also, it is expected that these limits will lower the long-term intake for individuals with very specific feeding patterns mainly consisting of products with high concentrations of dioxins and dioxin-like PCBs.

Conclusions

- There has been a major decrement in the levels of PCDDs and PCDFs and dioxin-like PCBs in most food commodities in the Netherlands during the last decade
- Intake of PCDDs and PCDFs and dioxin-like PCBs in the population decreased due to the lower levels in foods. However, a large fraction of the population is still exposed to levels above international health safety objectives.

References

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