INDICATOR PCBS IN FOODSTUFFS: LEVELS AND DIETARY INTAKE IN THE NETHERLANDS AT THE END OF THE 20TH CENTURY

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Introduction

We examined the occurence of indicator PCBs (IUPAC congener numbers #28, #52, #101, #118, #138, #153 and #180) in foodstuffs in The Netherlands. These were measured in composite consumer food categories, which were sampled in a survey carried out in 1998/1999 for the study on dietary intake of of dioxins (PCDDs and PCDFs) and dioxin-like PCBs (non-ortho PCBs and mono-ortho PCBs)[1]. The concentrations in foodstuffs obtained in this fashion were the basis for assessment of the dietary intake of indicator 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[2]. Just as dioxins and dioxin-like PCBs, indicator PCBs are persistent contaminants that tend to accumulate in the body, particularly in body fat. Hence, we were mainly interested in the long-term intake.

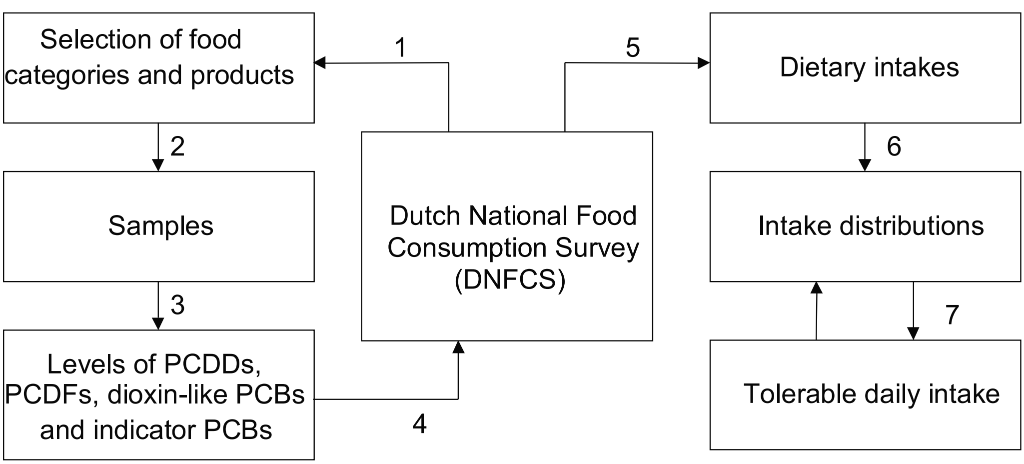


Figure 1. Design of the study on dietary intake of dioxins, furans, dioxin-like PCBs and indicator PCBs.

Methods

The design of the study on dietary intake of indicator PCBs in the Netherlands is equal to that of the 1998/1999 study on dioxins and dioxin-like PCBs and 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.

A two-step approach was used to estimate the long-term intake in the population. Firstly, for 6250 individuals the 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 the 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.

Results

The measured average concentrations of the sum of the seven indicator PCBs in animal fats range from 4 to 32 ng/g fat. These concentrations are a factor 10^4-10^5 higher than the concentrations of the sum of dioxins and dioxin-like PCBs. On a product basis, concentrations of the indicator PCBs in fish are higher (1 to 32 µg/kg) than in meat products (0.2-3 µg/kg).

The median intake, modeled by the regression analysis, ranges from 23 ng/day/kg bw for one-year old children to 5 ng/day/kg bw for adults (Fig 2).

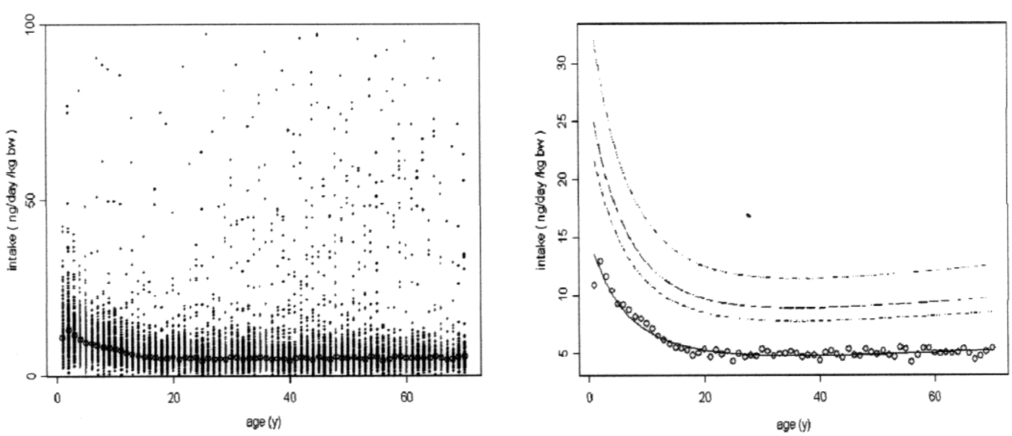
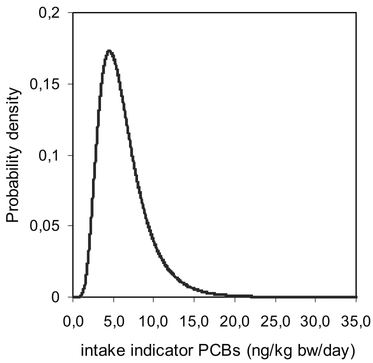


Figure 2. Relationship between intake of indicator PCBs and age. (a) The left panel shows all the raw datapoints and the calculated median intake for each age class. (b) The right panel depicts the intake distribution for the population after performing regression and nested variance analysis on the data in the left panel. Percentiles refer to the between-subject variation.

The regression analysis was also used to calculate the distribution of the intake variation of the indicator PCBs by the population (Fig. 3). The median lifelong-averaged intake is estimated to be 5.6 ng/kg bw/day, the 95th percentile in the population is 20.2 ng/kg bw/day.



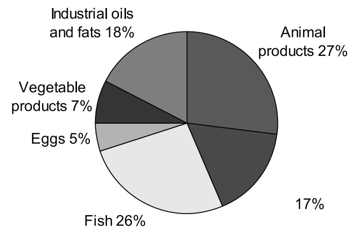


Figure 3. Left panel: Modelled distribution of lifelong-averaged (1-70 yrs) intakes (ng/kg bw/day) of the sum of indicator PCBs in the Dutch population. Right panel: Estimated average contribution of food groups (%) to the intake of indicator PCBs in the Dutch population in 1998/99.

The contribution of different food groups to the average intake is rather evenly distributed over these groups (Fig. 3). The distribution is similar to that of the dioxins and dioxin-like PCBs, although for the indicator PCBs the contribution of fish is higher (26 % instead of 16 % for the dioxins and dioxin-like PCBs) and that of dairy is lower (17 % instead of 27 %).

Discussion

To obtain a time trend, the average intake of indicator PCBs has been compared to the average intakes as measured in earlier 24-h duplicate diet studies performed by our institute. These studies show that the intake decreased enormously over the last decades: from 83 ng/kg bw/day in 1978 to 39 ng/kg bw/day in 1984/85 and to 10 ng/kg bw/day in 1994[4]. The intake of 5 ng/kg bw/day for adults (Fig. 2) calculated in the present study again shows a similar decrease.

A fraction of the population is exposed to intake levels above international health safety objectives. Recently, a TDI (Tolerable Daily Intake) of 10 ng/kg bw/day was derived[5], and from the intake distribution it can be concluded that this safety limit is exceeded by approximately 10 % of the population. This is in the same order of magnitude as the fraction of 8 % of the general population that exceeds the TDI of 2 pg/kg bw/day for dioxins and dioxin-like PCBs[1], as recently recommended by the EC's Scientific Committee on Food[6].

PCBs express their toxicity on the central nervous system, the thyroid and the endocrine system, but only after a very high incidental intake or after bioaccumulation in the body upon long term intake. The intake of people in the upper 10th precentile of the distribution curve amounts from 10 for the 90th to 20 ng PCBs per kg bw per day for the 95th percentile. However, in view of the safety factors applied in the derivation of the TDI for the PCBs[5], a relatively short period of exceeding the TDI with a factor of up to 5 is not expected to result in any clinical adverse health effects.

Even though, it might be anticipated that people consuming relatively large amounts of fish and/or meat (including products of these) are not only prone to exceeding the TDI for PCBs, but also of exceeding the TDI of dioxins. As a consequence, it can be concluded that monitoring the dietary intake of indicator PCBs is just as important as monitoring dioxins and dioxin-like PCBs. Likewise, attempts to decrease the exposure to PCBs deserve the same attention of risk management authorities as the attempted decrease of exposure to dioxins (that is, PCDDs, PCDFs and dioxin-like PCBs).

Conclusions

• In the past decades, the dietary intake of indicator PCBs in the population has decreased considerably. However, a small part of the population still exceeds the TDI, but a limited exceeding of the TDI for a limited period of time is not expected to have immediate adverse health effects.

• The contribution of different food groups to the average intake is rather evenly distributed over these groups. For both the PCBs and the dioxins animal products (including dairy products and fish), and oils and fats constitute almost 90 % of the intake of the intake of the general population.

• Since an exceeding of the TDI for PCBs is anticipated to be accompanied by an exceeding of the TDI for dioxins, monitoring the dietary intake of PCBs is just as important as monitoring the intake of dioxins. Attempts to decrease the exposure to both compound classes need continuous attention.

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