# DIETARY INTAKE OF PLOYCHLORANITED DIBENZO-P-DIOXINS (PCDDs) AND DIBENZOFURANS (PCDFs) IN POPULATIONS FROM CHINA

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## Introduction

Although high exposure to dioxins may occur in occupational situations or as a result of accidents, dietary intake represents the common route of human exposure to dioxins and PCBs. Over 90% of daily human exposure is estimated to occur through the diet, with foods from animal origin being the predominant sources, upon the data estimated in a number of industrialized countries [1, 2]. However, no data is available from developing countries. This paper presents the dietary intake of dioxins in China.

## Methods and Materials

The Chinese total diet study was carried out in 2000. The overall study design and experimental methods were similar to that carried out in 1990[3]. In brief, the food composite approach was used to study the total diet in 4 regional market baskets; each region comprised 3 provinces. The food composition pattern of a standard man (18-45 years old, 60 kg body weight) in each of 12 provinces was determined by a 3-day household dietary survey. All the foods, beverages, and water consumed by the standard man were integrated into 12 food groups: meats, eggs, aquatic foods, milk, cereals, legumes, tubers, vegetables, fruit, sugar, beverages and water, and alcoholic beverages. Food samples were collected and prepared (cooked) in each province according to the local food habits. Twelve food group composites were made for each province; the same food composites from each of the 3 provinces were combined to formulate regional market baskets. Due to foods from animal origin being the predominant sources of dioxin, composites from each of the 4 regional market baskets were combined to formulate composite samples of meats, eggs, aquatic foods, and milk. The composite samples were subjected to dioxin analysis. Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) were determined by high resolution gas chromatography coupled with high resolution mass spectrometry according to EPA 1613 with minor modification [4, 5].

## Results and Discussion

The Chinese dietary daily intake of PCDD/Fs were presented in Table 1. The calculations were performed for the sums of the Toxic Equivalences (TEQs ) of PCDD/Fs, with daily intake of total TEQ 72.48 pg. As the long half-times of PCDD/Fs result in each daily ingestion having a small or even negligible effect on overall intake. Only after consideration of the average intake of PCDD/Fs over months can their long-term risk to health be assessed. The tolerable intake should therefore be expressed as monthly value with 70 pg/kg.bw in the form of a provisional tolerable monthly intake (PTMI) according to *57$^{th}$ JECFA meeting*[2]. Comparison of PTMI with estimated intake from food tolerable intake, the Chinese dietary intake is 36.24 pg/kg.bw/month for PCDD/Fs estimated by using national food consumption surveys. The PTMI derived by JECFA is based on total TEQ exposure, e.g. dioxins, furans and dioxin-like PCBs together. However, the Chinese dietary intake does not included co-planar PCBs. Therefore it is possible that in some regions, the lifelong intake will exceed the PTMI. Even though, based on the uncertainties in the derivation of the PTMI, the JECFA concluded that long term intake slightly above the PTMI will not necessarily result in adverse health effects but would erode the safety factor build in the PTMI and should take measure to reduce the exposure.

Compared to data from a substantial number of samples analyzed in all industrialized countries, the levels of PCDD/Fs and coplanar PCBs in food decreased until the late 1990s, but this decrease had slowed or was even partly reversed recently in some food categories in several countries owing to contamination of animal feed. In addition, at the end of the 1990s, the measures taken to reduce contamination at source initiated at the beginning of the decade had weaker effect than they had earlier. For the present assessment of intake at the international level, insufficient individual data collected after 1995 were available from most countries for construction of a full distribution curve of concentrations, and most were in an aggregated format. Aggregated data were weighted as a function of the number of initial samples and then used to obtain a weighted mean concentration of PCDD/Fs and PCBs in 4 major food groups – meat, egg, fish, and milk products, which were therefore aggregated by region or country. Although insufficient data were available for the rest of the world to permit a realistic estimate of distribution of contaminants, significant differences occur within the food categories in industrialized countries, latter may not reflect the true mean for a food category. For example, mean levels of PCDD/Fs and coplanar PCB as well as consumption rates vary considerably across fish species, and it was not possible to determine if the mean represents the fish species most commonly consumed. So the data available from developing counties is much important for estimation of dietary dioxin intake. Because of the expense for determination of dioxin by HRGC-HRMS, the pooled composite samples from total diet study approach were analyzed in China. Although it does not reflect the variation in individual foods and geographical region, the result should represent the mean level in their contaminated foods. Moreover, the fraction of the dietary intake of dioxins contributed by these foods can be calculated, the result as follows: meat and meat products, 34.82 %; fish and fish product, 28.64 %; egg, 20.71 %; milk and dairy products, 15.83 % of dietary intake. The great difference between China and industrialized countries is the fish consumption, especially in Chinese eating fish in fresh water, which makes Chinese to expose to more contribution to dioxins from polluted water. The potential source of pollution is sodium pentachlorophenol as molluscicide to control epidemic Schistosomiasis in valley of Yangtze reviver. The contamination of animal feeds must also be considered and preventive measure should be taken, because animal-derived foods are frequently important dietary sources of dioxins.

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**Table 1.** The Dietary Intake of Polychlorinated Dibenzo-p-dioxins and DibenzoFurans in China

| Congener | Concentration (pg/g) | | | | Toxic Equivalence (pg/g) | | | | Daily Dietary Intake (pg TEQ/d) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Milk | Fish | Meat | Egg | Milk | Fish | Meat | Egg | Milk | Fish | Meat | Egg | Total |
| 2378-TCDD | 0.06 | 0.21 | 0.11 | 0.12 | 0.06 | 0.21 | 0.11 | 0.12 | 3.07 | 6.28 | 8.43 | 4.63 | 22.41 |
| 12378-PeCDD | 0.05 | 0.15 | 0.07 | 0.08 | 0.05 | 0.15 | 0.07 | 0.08 | 2.41 | 4.49 | 5.37 | 3.17 | 15.44 |
| 123478-HxCDD | 0.06 | 0.29 | 0.1 | 0.12 | 0.01 | 0.03 | 0.01 | 0.01 | 0.29 | 0.87 | 0.74 | 0.46 | 2.36 |
| 123678-HxCDD | 0.07 | 0.22 | 0.12 | 0.17 | 0.01 | 0.02 | 0.01 | 0.02 | 0.37 | 0.66 | 0.90 | 0.66 | 2.59 |
| 123789-HxCDD | 0.06 | 0.31 | 0.07 | 0.14 | 0.01 | 0.03 | 0.01 | 0.01 | 0.29 | 0.93 | 0.56 | 0.54 | 2.32 |
| 1234789-HpCDD | 0.21 | 2.70 | 0.47 | 1.20 | 0.00 | 0.03 | 0.01 | 0.01 | 0.11 | 0.81 | 0.35 | 0.46 | 1.73 |
| OCDD | 2.50 | 10.00 | 6.50 | 14.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.05 | 0.05 | 0.14 |
| 2378-TCDF | 0.05 | 0.13 | 0.1 | 0.12 | 0.01 | 0.01 | 0.01 | 0.01 | 0.23 | 0.39 | 0.72 | 0.46 | 1.80 |
| 12378-PeCDF | 0.04 | 0.16 | 0.09 | 0.11 | 0.00 | 0.01 | 0.00 | 0.01 | 0.11 | 0.24 | 0.34 | 0.21 | 0.90 |
| 23478-PeCDF | 0.12 | 0.16 | 0.12 | 0.12 | 0.06 | 0.08 | 0.06 | 0.06 | 3.02 | 2.39 | 4.34 | 2.32 | 12.07 |
| 123478-HxCDF | 0.10 | 0.18 | 0.16 | 0.15 | 0.01 | 0.02 | 0.02 | 0.02 | 0.50 | 0.54 | 1.17 | 0.58 | 2.79 |
| 123678-HxCDF | 0.07 | 0.16 | 0.08 | 0.10 | 0.01 | 0.02 | 0.01 | 0.01 | 0.34 | 0.48 | 0.62 | 0.38 | 1.82 |
| 123789-HxCDF | 0.04 | 0.22 | 0.05 | 0.06 | 0.00 | 0.02 | 0.01 | 0.01 | 0.19 | 0.66 | 0.40 | 0.23 | 1.48 |
| 234678-HxCDF | 0.09 | 0.29 | 0.13 | 0.16 | 0.01 | 0.03 | 0.01 | 0.02 | 0.44 | 0.87 | 0.98 | 0.62 | 2.91 |
| 1234678-HpCDF | 0.13 | 1.60 | 0.26 | 0.45 | 0.00 | 0.02 | 0.00 | 0.01 | 0.07 | 0.48 | 0.20 | 0.17 | 0.92 |
| 1234789-HpCDF | 0.03 | 2.20 | 0.07 | 0.16 | 0.00 | 0.02 | 0.00 | 0.00 | 0.02 | 0.66 | 0.06 | 0.06 | 0.80 |
| OCDF | 0.35 | 4.10 | 0.72 | 1.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.02 |
| PCDDs | | | | | 0.13 | 0.47 | 0.22 | 0.26 | 6.54 | 14.05 | 16.41 | 9.97 | 46.98 |
| PCDFs | | | | | 0.10 | 0.22 | 0.12 | 0.13 | 4.92 | 6.71 | 8.82 | 5.03 | 25.49 |
| Total PCDD/Fs | | | | | 0.23 | 0.69 | 0.34 | 0.39 | 11.47 | 20.76 | 25.24 | 15.01 | 72.48 |
| Contribution (%) | | | | | | | | | 15.83 | 28.64 | 34.82 | 20.71 | 100.00 |