# Dietary intake of PCDD/F by small children with different food consumption measured by the duplicate method

**Jürgen Wittsiepe, Petra Schrey, and Michael Wilhelm**

Ruhr-Universität Bochum, Abteilung für Hygiene, Sozial- und Umweltmedizin,
Universitätsstraße 150, D-44801 Bochum, Germany
eMail: **wittsiepe@hygiene.ruhr-uni-bochum.de**
Internet: **http://www.hygiene.ruhr-uni-bochum.de**

## Introduction

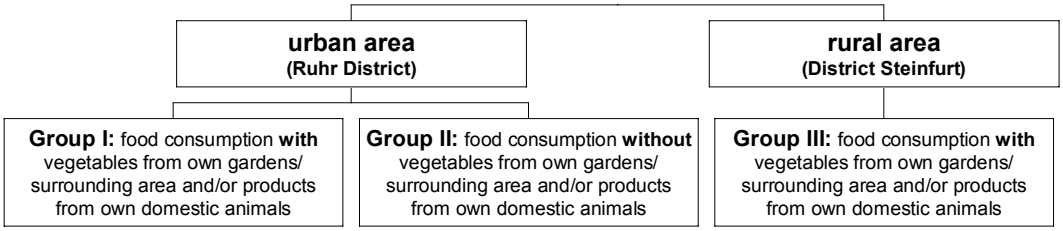
Human background exposure to PCDD/F predominantly occurs through the diet. Due to their higher food consumption in relation to the body weight children ingest higher PCDD/F doses than adults [1, 2]. The objective of the present study was to find out whether children living in an urban industrialized area with food consumption including products from the families own vegetable gardens or the surrounding area and/or products from own domestic animals ingest higher amounts of PCDD/F than children living in a rural area with similar food consumption and than children cunsuming exclusively food from the supermarket, respectively.

## Materials and methods

***Study groups***

Three comparable study groups with each 14 children, 7 male and 7 female, in the age of 14 to 47 months were recruited via leaflets, notices in kindergartens and practices of paediatricians, press and personal contacts. A first selection was made by telephone interviews with the parents concerning food consumption behaviour, general dietary habits, diseases, medication, possible gastrointestinal disorders and personal characteristics of the children. Group I and III were children living either in an urban area (Ruhr District, Northrhine-Westphalia, Germany) or in a rural area (Steinfurt District, Northrhine-Westphalia, Germany) with food consumption including a major part of products from the families own vegetable gardens or the surrounding area and/or products from own domestic animals. Group II consists of children living in the urban area cunsuming exclusively food from the supermarket. The study design is shown in Figure 1.

**Figure 1:** Study design



***Dietary survey***

Food duplicates of the 42 children were collected between May and September 1998 on 7 consecutive days for each child following the WHO guidelines and homogenized and lyophilized in the same way as described previously [1-3]. For survey of personal data, the childrens usual dietary habits, share of products from the vegetable garden/surrounding area and milk, meat, eggs and other products from domestic animals, and other relevant data the parents were interviewed using a standardized questionnaire. The parents kept a record of kind and amount of the childrens total food intake in standardized schedules as well. For motivation and minimizing changes of usual dietary habits during the sampling period the parents got an appropriate expense allowance. The childrens body weight and body height were measured by the interviewer at the beginning of the sampling period.

***Analysis***

The food analyses were performed in series of 4 or 5 samples and 1 blank each. About 60 g of the lyophilisate were spiked with 17 $^{13}C_{12}$-labelled PCDD/F-isomers and soxhlet-extracted with toluene/2-methoxyethanol (90+10) for 24 hours. The extract was evaporated at 40°C in a rotary evaporator until a constant weight was established. The residue was redissolved in hexane and cleaned-up using standard methods, including several types of modified silicagels, activated alumina and activated charcoal. The purified extract was analyzed by HRGC/HRMS. Analytical conditions are described in detail elsewhere [4].

## Results and discussion

***Personal characteristics and food intake***

Personal characteristics (age, weight and height) and food consumption of the children on a fresh weight and on a dry weight basis as well as the dry residues of the food samples are given in Table 1 for the three subgroups and for all participants. The parameters given in Table 1 showed no statistically significant differences between the three groups ($p > 0.05$). The food intake and the dry residue are very similar to the values found in our previous duplicate study with children in the age of 22 months to 5 years and a sampling period of three days [1].

***PCDD/F-concentrations in the food duplicates and daily dietary intake***

Means, medians and ranges of the PCDD/F-levels in the food duplicates and the dietary intake of the children on a dose basis are given in Table 2 for 2,3,7,8-TetraCDD, 2,3,4,7,8-PentaCDF and the calculated toxicity equivalents. A comparison of the PCDD/F-intake of the 3 subgroups is shown in Figure 2. The highest mean levels in food and the highest mean doses (I-TEq) were found in group I (112 fg/$g_{dw}$ or 1.93 pg/(kg · d)) with a maximum of 325 fg/$g_{dw}$ or 5.43 pg/(kg · d), whereas the mean values found in the groups II and III were very similar (90.3 and 87.2 fg I-TEq/$g_{dw}$ or 1.45 and 1.44 pg I-TEq/(kg · d)). There were no statistically significant differences between the three diet groups ($p > 0.05$) on the data shown in Table 2.

In our previous duplicate study, carried out in February/March 1995 with children in the age of 22 months to 5 years and a sampling period of three days [1], we found PCDD/F-levels of 62 - 430 fg I-TEq/$g_{dw}$ (mean: 160) and a daily dose of 1.1 - 7.7 pg I-TEq/(kg · d) (mean: 2.6). Not considering seasonal variations of the PCDD/F levels in food, the present study indicates a reduction of the PCDD/F-levels in food and of the dietary intake of small children of about 40% in comparison the values measured in 1995.

**Table 1:** Means, medians and ranges of personal data and food intake of children with different food consumption and dry residues of the food samples.

| Group | | Age | Body weight | Body height | Fresh weight intake | | Dry weight intake | | Dry residue |
|---|---|---|---|---|---|---|---|---|---|
| | | [months] | [kg] | [cm] | [kg/d] | [g/(kg · d)] | [kg/d] | [g/(kg · d)] | [%] |
| I | mean | 32.8 | 13.9 | 92.7 | 1.20 | 88.6 | 0.241 | 17.5 | 20.3 |
| | median | 32.5 | 14.5 | 94.5 | 1.18 | 91.0 | 0.239 | 16.8 | 20.3 |
| | minimum | 15 | 10.2 | 77 | 0.845 | 54.8 | 0.154 | 13.0 | 11.8 |
| | maximum | 47 | 17.6 | 105 | 1.58 | 128 | 0.384 | 26.3 | 25.3 |
| II | mean | 27.1 | 12.9 | 88.3 | 1.12 | 88.9 | 0.206 | 16.1 | 18.7 |
| | median | 26 | 13.25 | 90 | 1.11 | 88.2 | 0.210 | 16.4 | 19.7 |
| | minimum | 14 | 8.7 | 76 | 0.579 | 61.6 | 0.136 | 10.8 | 12.3 |
| | maximum | 46 | 16.3 | 101 | 1.54 | 157 | 0.274 | 20.3 | 23.5 |
| III | mean | 20.1 | 13.5 | 90.5 | 1.20 | 89.9 | 0.224 | 16.6 | 19.7 |
| | median | 28.5 | 13.4 | 92 | 1.07 | 75.5 | 0.207 | 16.0 | 19.6 |
| | minimum | 14 | 10.7 | 78 | 0.740 | 65.8 | 0.181 | 13.1 | 11.7 |
| | maximum | 43 | 16.0 | 99 | 2.80 | 213 | 0.327 | 25.0 | 24.9 |
| All | mean | 29.7 | 13.4 | 90.5 | 1.17 | 89.1 | 0.223 | 16.7 | 19.6 |
| | median | 29 | 13.3 | 92 | 1.08 | 81.8 | 0.219 | 16.7 | 20.1 |
| | minimum | 14 | 8.7 | 76 | 0.579 | 54.8 | 0.136 | 10.8 | 11.7 |
| | maximum | 47 | 17.6 | 105 | 2.80 | 213 | 0.384 | 26.3 | 25.3 |

## Conclusion

- No differences in the PCDD/F-levels (I-TEq) of food and in the dietary intake of PCDD/F (I-TEq) were observed between children living in urban and rural areas and with different food consumption behaviour ($p > 0.05$).
- The calculated daily dietary intake of PCDD/F of the children is within or below the range of the tolerable daily intake of 1 - 10 pg I-TEq/(kg · d), suggested by the former German Federal Health Office. The aspired limit of 1 pg I-TEq/(kg · d) however was exceeded by all children from the urban area consuming products from their own vegetable garden or the surrounding area and/or products from own domestic animals (group I) and by more than 75% of all children participating in this study.
- Except of one child the dietary intake doses were in or below the tolerable daily intake range of 1 - 4 pg I-TEq/(kg · d) established by the World Health Organization [5].
- In comparison to our study from 1995, where duplicate samples of children in the age of 22 month to 5 years were collected over three days, the mean PCDD/F-levels (I-TEq) in food are 40% and the mean dietary intake of PCDD/F (I-TEq) is 38% lower.

**Figure 2:** PCDD/F-intake by children with different food consumption calculated as I-TEq on a dose basis [pg/(kg · d)].

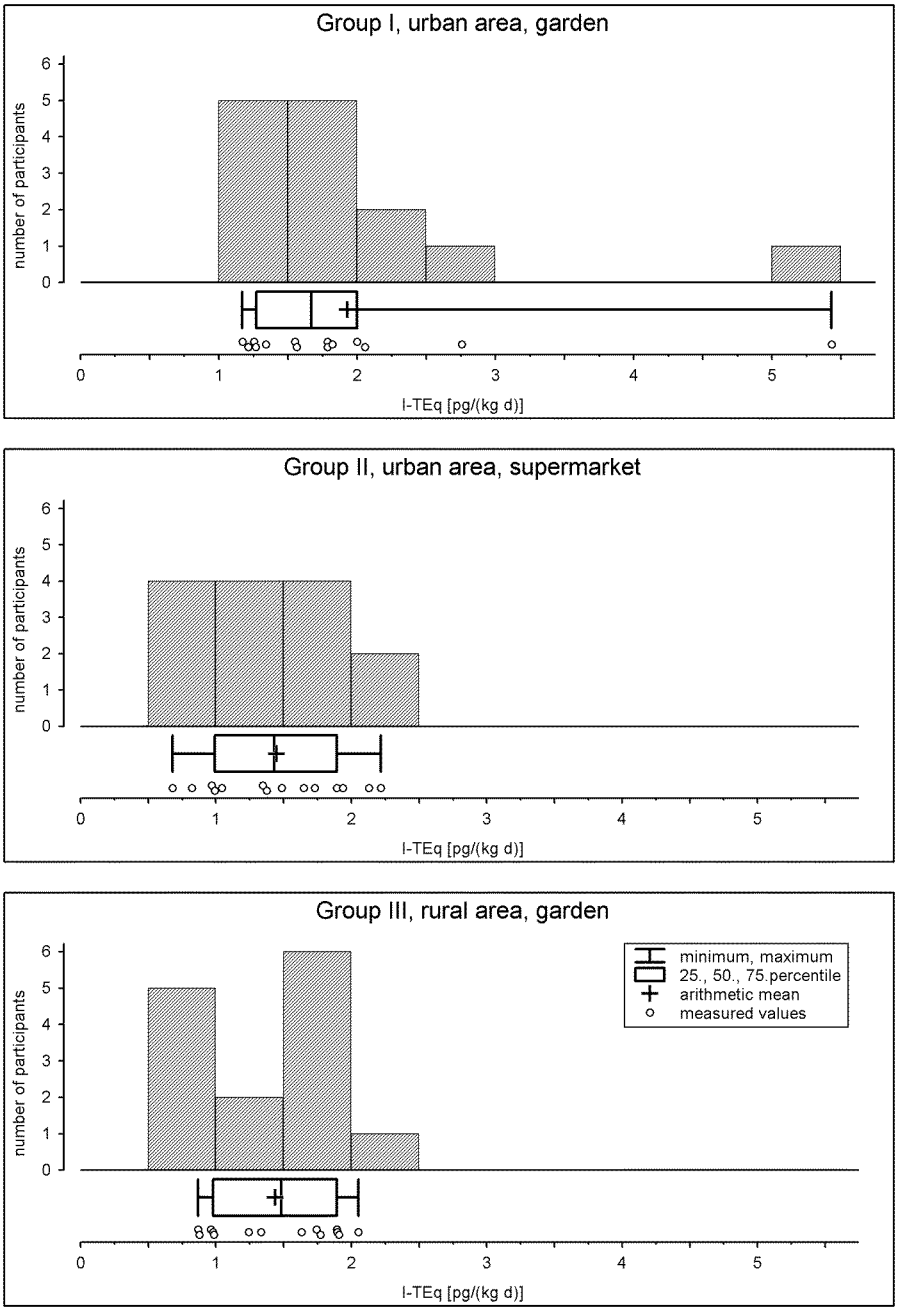


**Table 2:** PCDD/F-levels of food duplicates (dry weight basis [fg/$g_{dw}$]) and dietary intake (dose basis [pg/(kg · d)]) of children with different food consumption.

| Group | | 2,3,7,8-TetraCDD | | 2,3,4,7,8-PentaCDF | | BGA/UBA-TEq | | I-TEq | |
|---|---|---|---|---|---|---|---|---|---|
| | | [fg/$g_{dw}$] | [pg/(kg · d)] | [fg/$g_{dw}$] | [pg/(kg · d)] | [fg/$g_{dw}$] | [pg/(kg · d)] | [fg/$g_{dw}$] | [pg/(kg · d)] |
| **I** | mean | 12.8 | 0.223 | 98.7 | 1.67 | 63.6 | 1.09 | 112 | 1.93 |
| | median | 12 | 0.20 | 76.5 | 1.3 | 52.9 | 1.00 | 93.1 | 1.67 |
| | minimum | 7.2 | 0.12 | 60 | 0.90 | 39.7 | 0.667 | 74.4 | 1.17 |
| | maximum | 21 | 0.35 | 320 | 5.3 | 181 | 3.03 | 325 | 5.43 |
| **II** | mean | 16.7 | 0.266 | 68.9 | 1.10 | 55.2 | 0.889 | 90.3 | 1.45 |
| | median | 16.5 | 0.26 | 69.5 | 1.05 | 56.5 | 0.915 | 90.7 | 1.43 |
| | minimum | 5.9 | 0.099 | 37 | 0.50 | 32.3 | 0.433 | 50.8 | 0.681 |
| | maximum | 27 | 0.45 | 120 | 1.9 | 83.0 | 1.32 | 138 | 2.20 |
| **III** | mean | 13.6 | 0.221 | 70.2 | 1.15 | 51.7 | 0.848 | 87.2 | 1.44 |
| | median | 13 | 0.22 | 73.5 | 1.1 | 52.8 | 0.838 | 90.4 | 1.48 |
| | minimum | 6.4 | 0.10 | 32 | 0.54 | 23.6 | 0.489 | 39.2 | 0.870 |
| | maximum | 24 | 0.35 | 110 | 2.0 | 78.9 | 1.18 | 129 | 2.05 |
| **All** | mean | 14.4 | 0.237 | 79.3 | 1.30 | 56.8 | 0.943 | 96.6 | 1.61 |
| | median | 13 | 0.21 | 74.5 | 1.15 | 53.6 | 0.952 | 90.7 | 1.56 |
| | minimum | 5.9 | 0.099 | 32 | 0.50 | 23.6 | 0.433 | 39.2 | 0.681 |
| | maximum | 27 | 0.45 | 320 | 5.3 | 181 | 3.03 | 325 | 5.43 |

## Acknowledgement

Our thanks are expressed to the children, involved in the study, their parents and to Heidemarie Joppich, Sylvia Kmiecik, Thomas Köster, Eva Schmidt, Karsten Holinski and Jörg Restemeyer, who helped to collect, prepare and analyze the samples. We thank the Umweltbundesamt for financial support (FKZ-No. 29765124).

## References

1 **Schrey, P.; Wittsiepe, J.; Selenka, F. (1996):** *Dietary intake of PCDD/F by small children measured by the duplicate method.* Organohalogen Compounds 30, 166-171

2 **Schrey, P.; Mackrodt, P.; Wittsiepe, J.; Selenka, F. (1995):** *Dietary intake of PCDD/F measured by the duplicate method*. Organohalogen Compounds 26, 147-150

3 **WHO, GEMS: Global Environmental Monitoring System (1985),** Guidelines for the study of dietary intakes of chemical contaminants, WHO Offset Publication NO. 87

4 **Schrey, P.; Wittsiepe, J.; Ewers, U.; Exner, M.; Selenka, F. (1992):** *Age-related increase of PCDD/PCDF-levels in human blood - a study with 95 unexposed persons from Germany.* Organohalogen Compounds 9, 261-268

5 **van Leeuwen, F. X. R.; Younes, M. (1998),** *WHO revises the Tolerable Daily Intake (TDI) for dioxins.* Organohalogen Compounds 38, 295-298