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Decline of Human PCDD/F Intake via Food between 1989 and 1996

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Abstract

Based on the analysis of several hundred randomly selected food samples and the German report on nutrition a topical average daily PCDD/F intake via food of 69,6 pg I-TEq/person was estimated. A conversion to body weight results in 1 pg I-TEq/kg/day. A comparable assessment performed in 1990 with the same consumption data but the then measured PCDD/F levels in food stuffs revealed a value of 127,3 pg I-TEq/person or approximately 2 pg I-TEq/kg/day. Thus, it can be concluded that the human PCDD/F intake via food decreased by almost 50% within the past few years. This decline of exposure to PCDD/F has also positive effects for the breast fed baby. While in 1989 an average daily PCDD/F intake of 163 pg I-TEq/kg body weight via breast milk was determined, the corresponding value in 1996 amounted only to 68 pg I-TEq/kg body weight/day. These investigations demonstrate that the efforts which were undertaken to minimize dioxin emissions already show a benificial effect on the body burden of humans.

Introduction

Human PCDD/F exposure through background contamination is possible by several routes:

- inhalation of air and intake of particles from air
- ingestion of contaminated soil
- dermal absorption and
- food consumption

Based on the then known research data on environmental levels, in 1990 a WHO expert group performed an assessment of human PCDD/F intake by using a pathway analysis taking into account all known important routes of exposure[1]. The expert group concluded that all routes of exposure through background contamination in industrialized countries lead to an average daily intake of approximately 2 pg I-TEq/kg body weight of which more than 90% derives from food. At that time this value already exceeded the tolerable daily intake set by health authorities in several countries and demonstrated the need to reduce the PCDD/F emissions to levels as low as technically achievable in order to minimize the ubiquitious contamination of the environment and thus finally to achieve a reduction of the human body burden. These measures were especially mandatory to lower the PCDD/F levels in breast milk because of its importance as the first food for the newborn child. Meanwhile enormous efforts were undertaken in a number of countries to minimize dioxin emissions and to shut down known sources. The success of these measures was demonstrated by several studies including analyses of various environmental matrices and human specimens. In our institute more than 2000 food and human milk samples were analysed for PCDD/F since 1985. These data

can now be used to gain some meaningful information about the human PCDD/F intake via food and breast milk in the course of time.

Materials and Methods

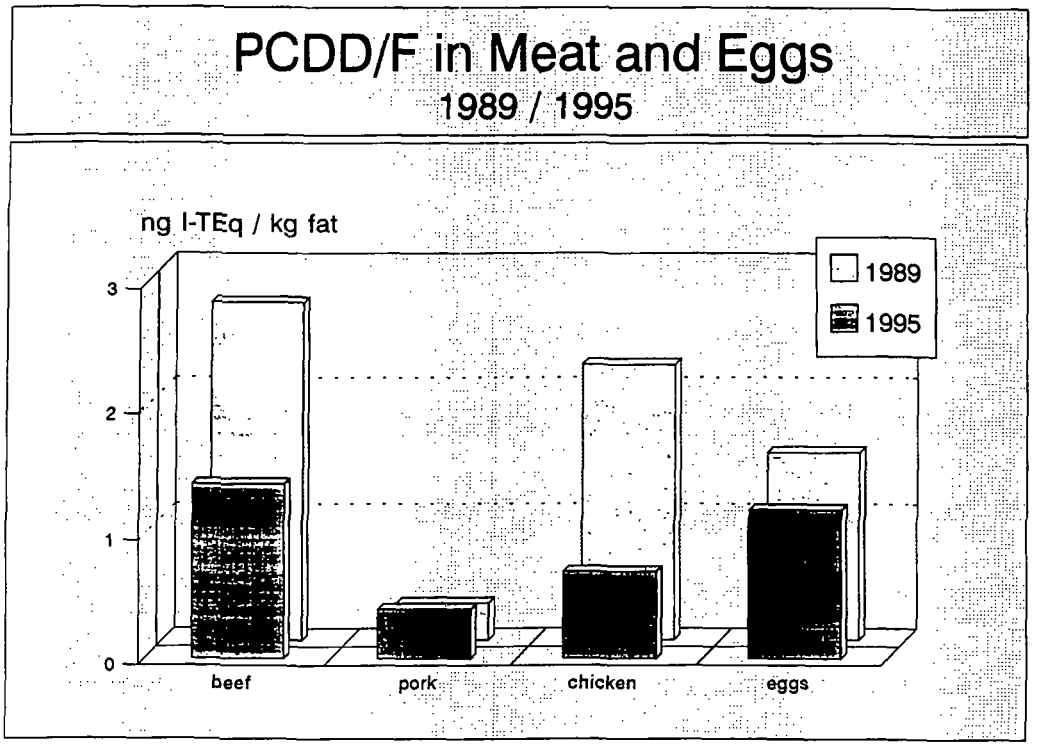
All food samples were randomly collected within the framework of official food control in Germany. Results from specimens sampled at hot spots or in connection with accidents emitting PCDD/F were disregarded for this assessment because these samples normally don't reach the consumer. The human milk samples analyzed were collected from nursing mothers living in North Rhine Westphalia. All mothers who are interested in an analysis have to fill in an extensive questionnaire. These information allow valuable conclusions about the parameters that influence the PCDD/F contamination of human milk.

Analytical determination was performed using validated standard operating procedures which have been successfully tested in a number of national and international quality control studies. For example, our laboratory qualified inter alia in the past WHO quality control studies for PCB and PCDD/F levels in fish, cow's milk and human milk. The longterm stability of the methodology is assured by analyzing three different quality control pools since several years.

Results

Two extensive surveys performed in 1990 and 1994 comprising more than 300 dairy products which were collected from all dairies in North Rhine-Westphalia indicated that the mean PCDD/F contamination of **cow's milk** has decreased by 25% during that period. Moreover, the range in 1994 was much narrower than in 1990 [2]. Compared to cow's milk, there exist only very few contamination data of randomly selected **meat** and **fish** samples. Investigation of around 90 of these food samples collected in retail and wholesale shops in 1995 revealed significantly lower PCDD/F levels compared to corresponding specimens analysed in 1989. Fig. 1 shows a comparison of the mean PCDD/F levels of those meat and fish products that are of greatest importance for human nutrition in Germany. The results of the analyses performed in 1989 and 1995 demonstrate that the strongest decline can be observed for the PCDD/F contamination of fish samples. One explanation for this finding might be that due to an overfishing of the coastal waters most of the fishing grounds nowadays lay in areas that are far away from the coast and consequently are not as polluted as the shore regions. On the other hand, the substitution of chlorine in paper pulp bleaching with other reagents should also begin to have positive effects especially on the pollution of the Baltic Sea, which represents an important fishing ground for herring.

Based on the latest PCDD/F levels determined in several hundred randomly collected food samples and the mean consumption habits of the German population an actual average daily intake of 69,6 pg I-TEq/person can be estimated. A conversion to body weight results in approximately 1 pg I-TEq/kg/day. A comparable assessment performed in 1991 revealed an average daily PCDD/F intake via food of 127,3 pg I-TEq/person or around 2 pg I-TEq/kg body weight/day. Fig. 2 shows the actual average PCDD/F intake via the most important classes of food stuffs compared to the earlier estimated intake values. Although the eating habits might have changed to a certain extent during the past few years, for better comparison the same consumption data were used for this assessment. The data clearly demonstrate that, compared to other classes of food samples, the average daily PCDD/F intake via consumption of fish shows the strongest decline over the past few years. While in 1991 fish and fish products like dairy products and meat and meat products contrib-


PCDD/F in Meat and Eggs
1989 / 1995
ng I-TEq / kg fat
3
2
1
0
1989
1995
beef
pork
chicken
eggs

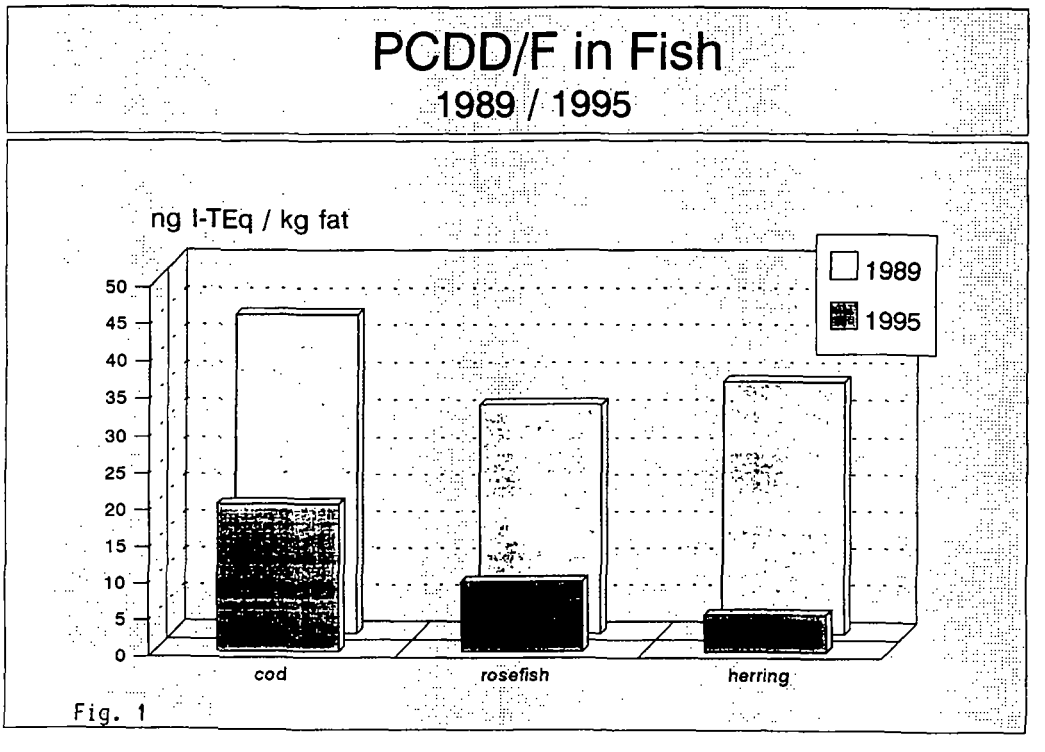

PCDD/F in Fish
1989 / 1995
ng I-TEq / kg fat
50
45
40
35
30
25
20
15
10
5
0
1989
1995
cod
rosefish
herring

Fig. 1

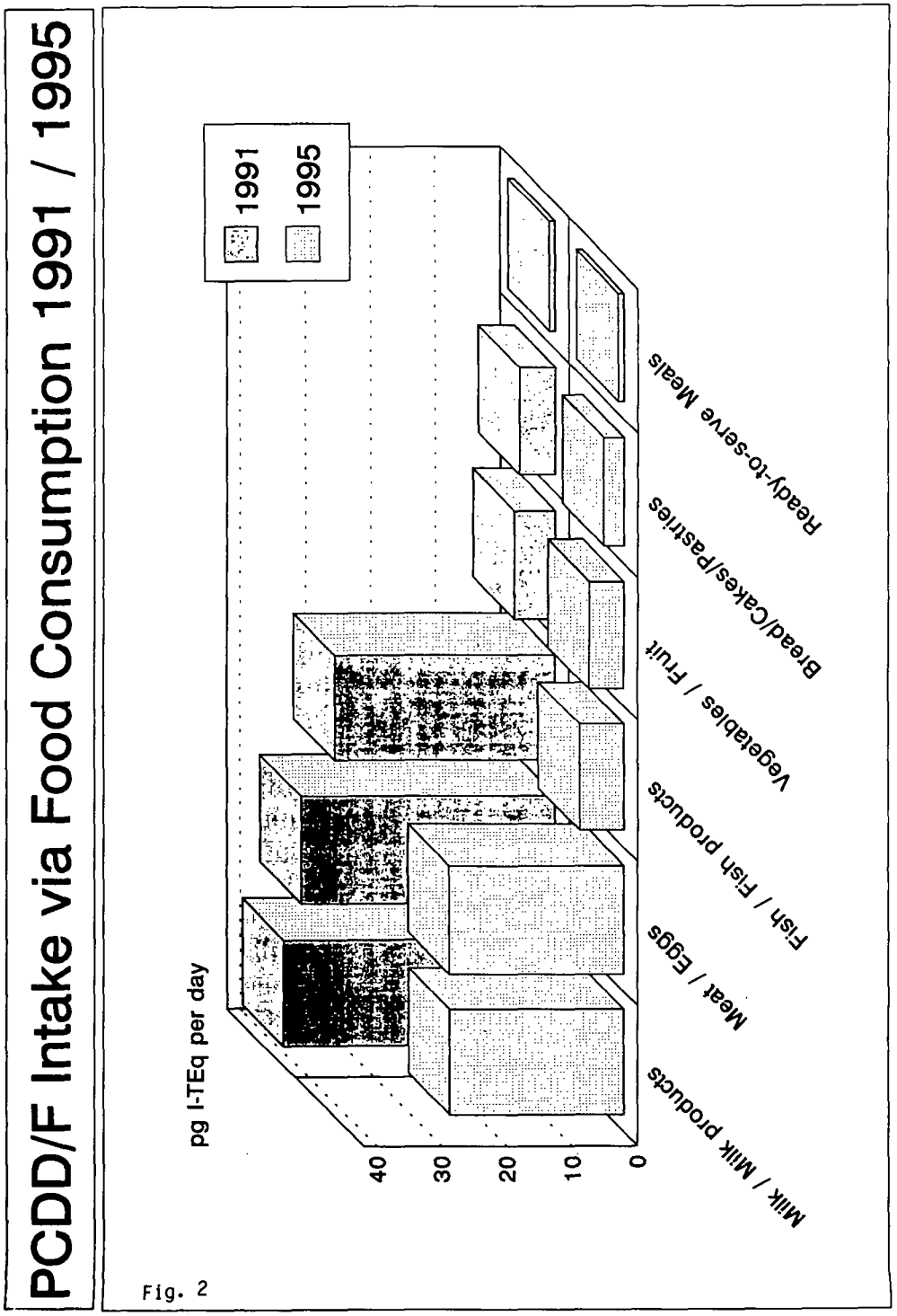

PCDD/F Intake via Food Consumption 1991 / 1995
1991
1995
pg I-TEq per day
0
10
20
30
40
Milk / Milk products
Meat / Eggs
Fish / Fish products
Vegetables / Fruit
Bread/Cakes/Pastries
Ready-to-serve Meals

Fig. 2

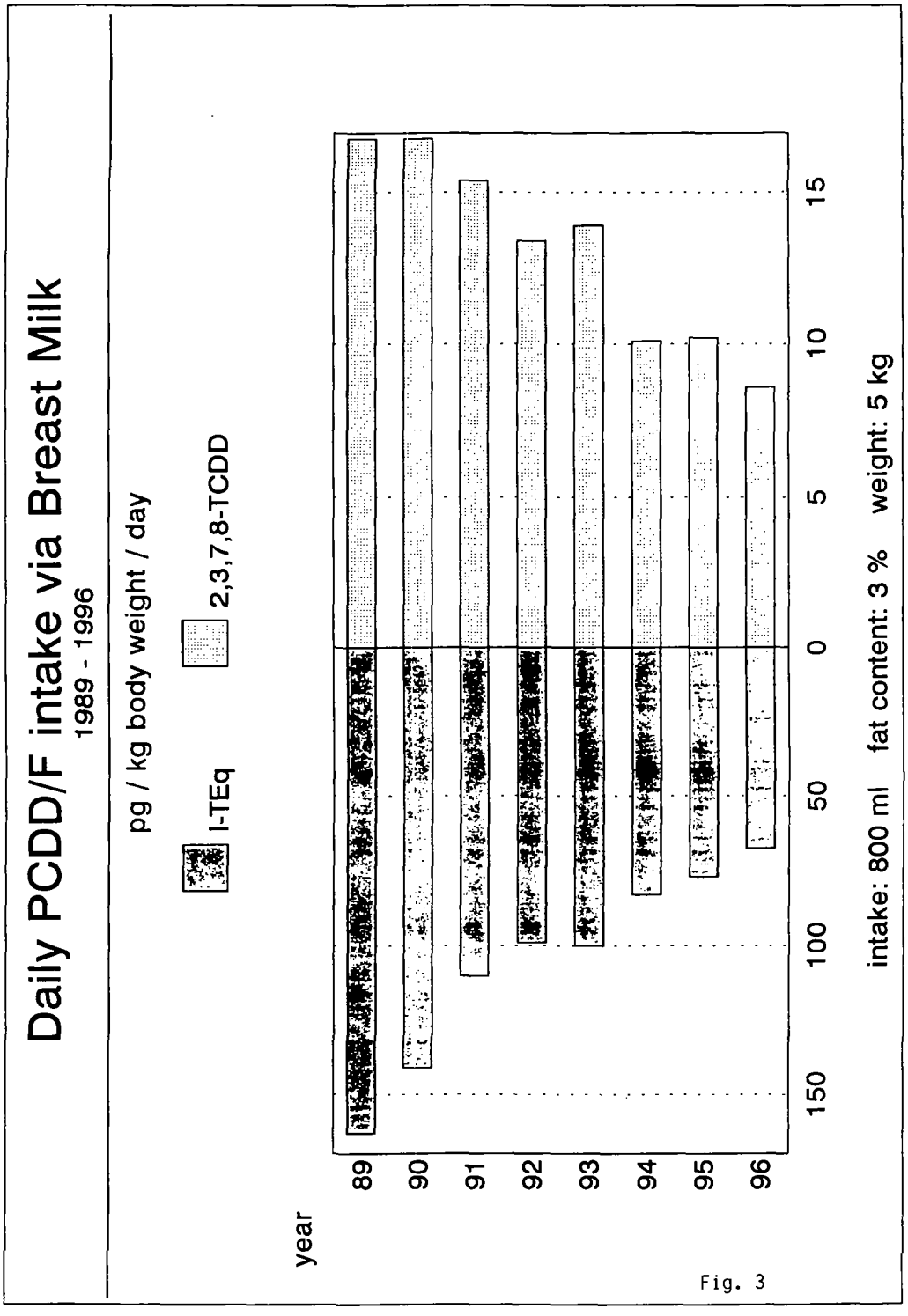

Daily PCDD/F intake via Breast Milk
1989 - 1996
pg / kg body weight / day
I-TEq
2,3,7,8-TCDD
year
89
90
91
92
93
94
95
96
150
100
50
0
5
10
15
intake: 800 ml fat content: 3 % weight: 5 kg

Fig. 3

uted approximately 30% to the daily PCDD/F intake via food, its corresponding share amounts to only 10% in 1995. However, it has to be taken into account, that this type of assessment is based on average consumption habits and mean PCDD/F levels in food stuffs. Deviant consumption habits or imbalanced nutrition, especially in the case of ingestion of contaminated food products from hot spots may lead to different intake values. This was exemplarily demonstrated by Wuthe [3] and Svensson et al.[4], who reported significantly higher human body burdens following consumption of chicken, eggs and fish from contaminated areas. Despite these limitations, the value of around 70 pg I-TEq/person/day should very well reflect the actual daily PCDD/F intake via food. A similar result was reported by Malisch[5] after having analysed food samples from the southern part of Germany. Moreover, an estimation of human PCDD/F intake by applying the duplicate method resulted in a daily intake of 23-96 pg I-TEq/person[6] and an average daily intake of 54 pg I-TEq for women and 69 pg I-TEq for men[7] respectively.

In summary, it can be concluded that for adults the average daily PCDD/F intake via food has decreased by approximately 50% within the past few years and nowadays amounts to 1 pg I-TEq/kg body weight/day. This indicates that the efforts to reduce emissions are already beginning to have positive effects on human exposure to polychlorinated dibenzo-p-dioxins and dibenzofurans. Declining PCDD/F intake levels are especially important for the final link in the food chain, the breast fed baby. Although no adverse health effects could be causally linked so far with background levels of PCDD/F in **human milk**, for reasons of preventive health care the relative high exposure of babies to these contaminants must still be considered as a matter of concern. Analyses of more than 1000 individual human milk samples from nursing mothers living in North Rhine-Westphalia revealed that the mean PCDD/F levels decreased from 34 pg I-TEq/g milk fat in 1989 to 14,2 pg I-TEq/g milk fat in 1996. Based on these results the average daily PCDD/F intake for breast fed babies can be calculated in the course of time (Fig. 3). For this estimation a daily consumption of 800 ml milk with 3% fat was assumed. Despite the permanent decline of more than 60% since 1989, the actual average PCDD/F intake via breast milk still amounts to 8,6 pg 2,3,7,8-T_4CDD/kg body weight/day and 68 pg I-TEq/kg body weight/day. Consequently, the average daily PCDD/F intake for a breast fed baby exceeds the corresponding value for adults by a factor of around 70. This relative high exposure of babies during the breast feeding period justifies further measures that will have to be taken to reduce PCDD/F emissions into the environment.

Literature

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