PCDD and PCDF levels in human blood samples related to estimates of body fat

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ABSTRACT

Combining PCDD/PCDF levels of 57 blood samples from an environmental health study in northern Germany, it can be shown that within subgroups of adults and children additionally to age bodymass as well as other indices of body fat are of significant predictive value for individual PCDD and PCDF levels. In the same way these data clearly reflect the influence of additional PCDF exposure on individual blood levels in children and adults.

INTRODUCTION

Human blood levels of polychlorinated dibenzodioxins (PCDD) and dibenzofurans (PCDF) depend on several parameters e.g. exposure, age, health status and individual metabolic aspects as absorption, distribution, metabolism and excretion.

Besides exposure, age has to be considered as an important factor of individual levels due to the long elimination half-lives of most of the 2,3,7,8-substituted PCDD/PCDF congeners[1,3,5]. Little is known how external exposure is modulated by individual biotransformation. So far, the distribution of PCDD and PCDF in different compartments of the human body could be related to health status[6].

In this study we try to asses the impact of body composition on the PCDD/PCDF blood levels in humans. Because of the heterogenous sample group, possible surplus exposition by animal food with higher concentrations of PCDD/PCDF (eggs, chicken) has to be taken into account. Background informations regarding nutritional habits, clinical data etc. were not yet available for analysis.

MATERIALS AND METHODS

Data were obtained from an environmental health study conducted in northern Germany. 30 children and adolescents as well as 27 adults participated as cases living on a contaminated land fill, or as controls. This analysis includes a selected

group of adults with probably high consumption of home grown, PCDD/PCDF contaminated animal food (for details see [4]). Table 1 illustrates the sample's characteristics:

	age	N	selection criteria
children and adolescents	-10	20	individuals grown up in an urban residential area with contaminated soil and controls from an urban residential area
	11-20	10	
N_{tot} = 30			
18 ♂, 12 ♀			
adults	21-30	15	all individuals from an urban residential area with contaminated soil; some of them with consumption of eggs and chicken produced on the contaminated soil
	31-40	4	
N_{tot} = 27	41-50	1	
14 ♂, 13 ♀	51-60	7	

Table 1: Sample description

PCDD/PCDF concentration in blood samples were determined by the ERGO company, Hamburg.

The indices of body-composition applied here are listed in table 2.

Formula*	Notes
$\frac{bodyweight}{height^2}$	Body-mass index (BMI)
$f_s \times 10^6 \times \frac{bodyweight^{1.2}}{height^{3.3}}$ ♂: f_s = 3; ♀: f_s = 4	As estimate of the proportional body fat and index of obesity the Abdel-Malek Index (AMI) includes a sex-specific constant and exponents for weight and height independent of age. This index is supposed to give the best possible estimate of the proportionate bodyfat[2].
$f_s \times (height - 100)$ ♂: f_s = .90; ♀: f_s = .85	The ideal weight deviation (IWD) was included as third indicator of body-composition. Idealweight was calculated by the generally applied equation. The difference between actual weight and ideal weight was applied for analysis.

Table 2: Indices of body-composition * bodyweight in g, height in cm

To account for the consumption of contaminated food, an indicator with respect to the proportionate consumption of home produced eggs on contaminated soil - egg consumption index (ECI) - was included. This index only allows for

consumption during the year before blood sampling; it does not reflect the length of time with respect to consumption habits.

The values of PCDD, PCDF and ITE were transformed to their natural logarithms, making them approximately normally distributed, and in this form included in analyses. Regression and correlation analyses were carried out by UnixStat. With ITE, PCDD or PCDF as dependent variables, age-category, ECI and the three indices of body-composition were examined for their impact as predictors in the total sample as well as in the younger and older subsamples.

RESULTS

The different body-fat indices are closely intercorrelated ($r > 0.70$); only in the older sample BMI and the sex-differentiating AMI reaches just $r = 0.52$. Age-category and body-fat-indices are intercorrelated only within the sample as a whole (AMI/age: $r = 0.54$, IWD/age: $r = 0.52$, BMI/age: $r = 0.72$). Within the subsamples - probably because of the categorial level of the age-relevant information - no relationships can be observed except the single value of $r = 0.54$ for BMI/age for the younger subsample.

For the total sample, the regression equation with ITE as dependent variable and age, BMI and ECI

$$\ln(\text{ITE}) = 0.40\ \text{age} + (-0.03)\ \text{BMI} + 0.14\ \text{ECI} + 2.46$$

indicates - besides age as significant predictor ($p \leq 0.0001$) - the influence of the ECI ($p \leq 0.01$). This result can be confirmed with PCDF as dependent variable, but not for PCDD. Indices of body fat have no predictive value for the level of PCDD and PCDF.

For the younger subsample, however, BMI as index of body fat is the only significant predictor for ITE, PCDD and PCDF ($p \leq 0.05$); neither ECI nor age-categogy are of detectable predictive value. The relationship between BMI and ITE, PCDD and PCDF, respectively, is negative. The index AMI reproduces consistent findings; yet, this observation does not apply for the IWD.

Within the older subsample, age-category is the dominant predictor ($p \leq 0.05$) for the blood levels of PCDD and PCDF, resp. ITE; however, the ECI influences PCDF and ITE ($p \leq 0.05$); neither BMI nor AMI are of predictive value for the dependent variables. However, in the case of PCDF as dependent variable the IWD is of significant predictive value ($p \leq 0.05$).

DISCUSSION

For the group as a whole and with respect to the sample's heterogenity described above the predictive input of the ECI is remarkable. This index is a rather crude estimate of the surplus exposure by eggs and possibly chicken with regard to some of the participants included in this data set. This path of exposition is documented

here quantitavily by significant predictors for ITE as well as PCDF. This finding should be examined with more detailed information on individual nutritional habits.

The evaluation of the results is limited by the fact that individual age data were not available; this is a shortcoming especially for the younger subsample. Nevertheless, for children and adolescents body composition seems to be a relevant factor. The interpretation of individual as well a sample data should take this relationship into account.

The application of other indices of body composition than BMI could not bring about any improvement for the prediction of ITE, PCDD or PCDF levels in this data set.

REFERENCES

1 Beck H, Droß A, Mathar W. PCDDs, PCDFs and related contaminants in the german food supply. Organohalogen Compounds 1991;6:133-144.
2 Knussmann R. Somatometrie (p.232-85). In N. Kluge (Ed.). Anthropologie. Handbuch der vergleichenden Biologie des Menschen. Vol 1. Stuttgart: Gustav Fischer Verlag, 1988
3 Sagunski H, Csicsaky M, Fertmann R, Roller M, Schümann M. Age dependent levels of PCDD and PCDF in human blood samples. Organohalogen Compounds 1992;9:211-214.
4 Sagunski H, Schümann M, Müller-Bagehl S et al. Levels and patterns of PCDF and PCDD in eggs, chicken and human blood of residents living on a contaminated area: investigation of a possible relationship. To be presented at DIOXIN '93
5 Schrey P, Wittsiepe J, Ewers U, Exner M, Selenka, F. Age-related increase of PCDD/F-levels in human blood—a study with 95 unexposed persons from Germany. Organohalogen Compounds 1992;9:261-267
6 Zober A, Päpke O. Concentrations of PCDDs and PCDFs in human tissue 36 years after accidental dioxin exposure. Organohalogen Compounds 1992;10: 247-250