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STATISTICAL ANALYSIS OF PCBs, PCDDs AND PCDFs IN HUMAN MILK IN NORWAY

A. Bartonova and J. Clench-Aas
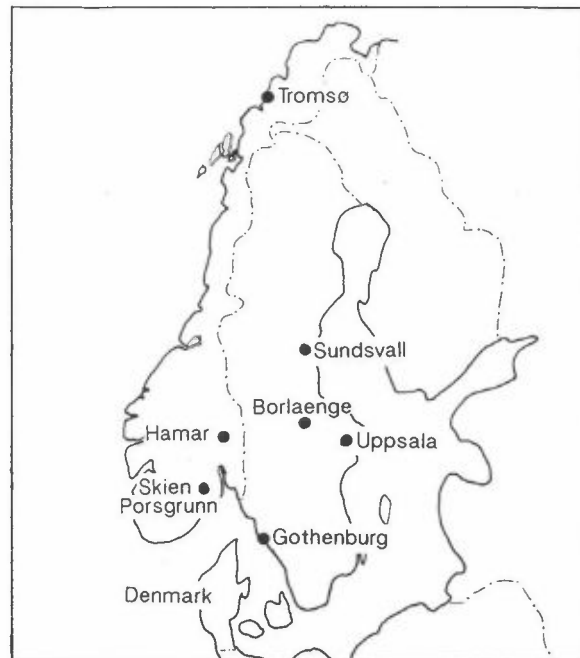
SUMMARY AND CONCLUSIONS OF THE STUDY

In winter 1985/86, an investigation of concentrations of polychlori-
nated dibenzo-p-dioxins (PCDD), dibenzofurans (PCDF) and biphenyls
(PCBs, p,p-DDE and HCB) in human milk was performed as a cross-sec-
tional study in three locations in Norway. It was organized by the
Norwegian Institute for Air Research (NILU), on request from the Royal
Norwegian Council for Industrial and Scientific Research (NTNF) and
the Norwegian National Pollution Control Authority (SFT). The study
was performed in co-operation with the National Institute for Public
Health and the Department of Pharmacology and Toxicology at the
Norwegian College of Veterinary Medicine. The samples were chemically
analyzed for 14 to 17 PCDD and PCDF congeners using high resolution
gas chromatography - high resolution mass spectrometry, at the Uni-
versity of Umeå in Sweden (27 samples) and at NILU (4 samples). The
analyses for PCBs, p,p-DDE and HCB were performed by gas chromato-
graphy - electron capture detection at the Norwegian College of
Veterinary Medicine. This report details the statistical analysis of
possible environmental influences on PCDD and PCDF concentrations. In
addition, data on PCDD and PCDF concentrations in human milk collected
by the WHO are graphically presented here. This enables a comparison
and better evaluation of the Norwegian results.

The three investigated locations in Norway were a background coastal
area around Tromsø, a background inland area around Elverum, Løten and
Hamar, and an industrial area of Skien and Porsgrunn. The choice of
locations was co-ordinated with Sweden, where a complementary study
was performed at the same time. In Sweden, Gothenburg (city), Uppsala
(a town with refuse incinerator), Sundsvall (city with aluminum indu-
stry), and a background inland area of Borlaenge were included. A
similar study was performed in Denmark at the same time that included
analysis of a pooled sample from 42 donors from 6 locations, and of 11
individual samples from 5 locations.

In Norway, 32 subjects participated in the study, 12 in Tromsø and 10
each in the other two locations. Two samples from Tromsø were joined
in a pool, therefore, 30 individual samples were available. The pro-
files of PCDD and PCDF contamination of milk differed according to the

location of the donor. Hexa-substituted PCDFs were significantly higher in samples from Skien-Porsgrunn. This difference is attributable to the known source of PCDFs in Porsgrunn. These hexa-substituted PCDFs have only a limited impact on total PCDD and PCDF content of the milk as determined by the Nordic TCDD-equivalent factor model (the weight assigned to them is 0.1 compared to 1 for 2,3,7,8-tetra CDD), subsequently, no difference was found in the total levels of PCDDs and PCDFs in milk. No regional or other differences were found in the PCBs, p,p-DDE or HCB concentrations, though it was possible to conclude that the concentrations of PCBs are continuing to decline after reaching the peak values in 1979.

The participants in the study were selected based on criteria developed in co-operation with Sweden and Denmark. Mothers enrolled were to be giving birth for the first time and to a single offspring. They were to be aged between 18 and 30 years, and having lived in the current area of residence for at least 5 years continuously previous to the study. In addition, they should be in good health, both physical and psychological, with no problems with lactation. The psychological weel-being of the study subjects was stressed. This consideration influenced the sample collection procedure - the milk sample was to be collected at mother´s convenience. In addition to the influence of age of the mother, an effect of diet, smoking and other life-style related parameters on milk contamination were investigated. Due to a difficulty in acquiring enough participants, no experimental design was followed regarding these factors. This resulted in uneven number of subjects with varying values in each location. No differences in PCDD, PCDF or PCBs concentrations related to diet or smoking habits were revealed. Higher than expected concentrations of certain PCDD and PCDF congeners were found in milk of mothers who had previously lived in Oslo, but at a low level of significance. Subjects who travelled to South Europe had also concentrations of certain congeners little higher than expected, but again on a low significance level. The low significance of these results may reflect the small size of these two groups (6 and 4, respectively). These lifestyle factors did not induce differences in the content of PCDD and PCDF in milk as measured by Nordic TCDD-equivalent factor model.

A comparison of the analytical results of individual samples from Norway (3 locations), Denmark (considered as 1 location) and Sweden (4 locations) was performed. The locations were not found to be homogeneous in the concentrations of PCDDs and PCDFs. When comparing concentrations of single congeners, homogeneity was rejected except for the 2,3,7,8-TCDD, 2,3,4,7,8-PeCDF and 2,3,4,6,7,8-HxCDF. Samples from Skien-Porsgrunn had significantly higher concentration of 1,2,3,4/6, 7,8-HxCDF than all the others except samples from Borlaenge and Denmark. Samples from Gothenburg, Uppsala and Sundsvall had significantly higher concentrations of PeCDD and HxCDDs than Skien-Porsgrunn. Samples from Gothenburg and Uppsala had higher concentrations of HpCDD and OCDD. It is interesting that the difference in concentrations of individual congeners between the Gothenburg and Uppsala samples on one hand and samples from the other sites on the other, is similar to the difference between samples from these Norwegian mothers who had previously lived in Oslo and the rest of the Norwegian samples. The concentrations of PCDDs and PCDFs in samples from the three Norwegian locations seem homogeneous (except for the HxCDFs in Skien-Porsgrunn). Other rather homogeneous group comprises the two towns Gothenburg and Uppsala in Sweden.

A comparison of the results from Scandinavia with those reported to WHO from the rest of the world shows that sampling of human milk from Norway and samples from Borlaenge, Sweden, are among the lower concentrations found in the industrialized countries, whereas concentrations of most congeners measured in samples from Denmark and Sweden seem a little higher than those from Norway.

CONTENTS

POLYCHLORINATED BIPHENYLS (PCBs), DIBENZO-p-DIOXINS (PCDDs)
AND DIBENZOFURANS (PCDFs) IN HUMAN MILK:
STATISTICAL ANALYSIS OF CROSS-SECTIONAL STUDY IN NORWAY.
COMPARISON OF CONCENTRATIONS WITH OTHER PUBLISHED DATA.

1 INTRODUCTION

In the winter 1985/86, the Norwegian Institute for Air Research (NILU)
in co-operation with the National Institute of Public Health and the
Department of Pharmacology and Toxicology at the Norwegian College of
Veterinary Medicine investigated the concentration levels of PCDD,
PCDF and PCBs, HCB and p,p-DDE in human milk from three areas in
Norway (Clench-Aas et al., 1988). The study was initiated by the
Norwegian National Pollution Control Authority (SFT) and the Royal
Norwegian Council for Scientific and Industrial Research (NTNF). It
was co-ordinated with a parallel study in Sweden, and was similar in
design to a study performed in Denmark.

This report gives a full description of the statistical analysis of
the study. The main results were given by Clench-Aas et al. (1988).
For a description of the multivariate statistical methods we refer the
reader to a suitable text. The last part of this report compares the
results from the three Scandinavian studies based on published data
(Sundhedstyrelsen, 1987; Lindström, 1988), and compares the Scandi-
navian results with other data as they were reported by the WHO (WHO,
1988) by graphical means. We believe that this is a valuable even if
limited contribution to the current knowledge of dioxin levels in
mother´s milk.

2 DESCRIPTION OF THE INVESTIGATION

The investigation was organized as a cross-sectional study. The main purpose was to collect information about the levels of the named substances (PCDD and PCDF compounds will be further on referred to as dioxins), to lay a ground for future time trends investigation in the dioxins in the same way as it is already periodically done for the PCBs. Further on, local variation in levels of milk contaminants was to be assessed together with possible impact of diet, smoking habits and other exposure-related parameters. It was hoped to identify possible risk groups in the population as well as possible environmental sources of the contaminants. To achieve this, a questionnaire was designed covering smoking habits, occupation, places of residence, holiday travelling, dietary habits, exposure to fires, and personal information on age, weight and weight loss, pregnancy and delivery (see Appendix A for the questionnaire). The mothers asked to participate were between 18 and 30 years of age, who gave birth to a first and single child. They should not have had problems with lactation, and also should be in good physical and psychological health. Further, it was required that the mother should have lived within the same geographic area for at least 5 years immediately previous to delivery.

The three investigated locations in Norway were a background coastal area round Tromsø, a background inland area around Elverum, Løten and Hamar, and an industrial area of Skien and Porsgrunn. In these locations, 12, 10 and 10 individual 350-400 ml samples of human breast milk were collected during approximately a week period in the 2nd to 4th month after the child was born. A complementary study was at the same time performed in Sweden, where the locations of Gothenburg (large city), Uppsala (a town with refuse incinerator), Sundsvall (large city with aluminum industry), and a background inland area of Borlaenge were included. Sample size in these locations was 11, 11, 9 and 10 individual samples. In Denmark in a similar study a pooled sample that included contributions from 42 donors from 6 locations and 11 individual samples from 5 locations were analyzed.

The breast milk samples were chemically analysed in 1987 for 15 dioxin compounds with chlorine substituted in positions 2,3,7,8 by high resolution gas chromatography - high resolution mass spectrometry. From the 32 individual samples, 2 from Tromsø were joined in a pool and together with 26 other individual samples were analyzed at the Department of Organic Chemistry of University of Umeå, Sweden (Lindström, 1988). Four samples were analyzed for 17 dioxin congeners at NILU (Clench-Aas et al., 1988). Analysis for PCBs, p,p-DDE and HCB was performed at the Department of Pharmacology and Toxicology at the Norwegian College of Veterinary Medicine using electron capture - gas chromatography. The analysis was performed on the same samples as were analysed for dioxins at Umeå, e.g. analyses of individual samples were available for 8 donors from Tromsø, 8 donors from Skien-Porsgrunn and for 10 donors from Elverum-Løten-Hamar. In addition, a sample pooled from two individual ones from Tromsø was also analyzed. For a complete list of chemical compounds analysed in the milk see Appendix B (Clench-Aas et al., 1988; Skaare, 1981; Skaare et al., 1987).

It is necessary to quantify, in a relatively simple way, the total toxic equivalent of an individual sample taking into account the contribution from all the dioxin congeners determined. For this purpose a toxic equivalent is used, that ascribes weights to individual congeners and expresses total toxicity as their weighted sum. In this study, Nordic TCDD-equivalent was used (Nordisk Ministerråd, 1988). For weights and relative contribution to the sum by individual congeners see Table 1.

For each participant around 20 chemical results, and 20 to 30 values of descriptive items were recorded (for a full list see Appendix B). Compared to 30 participants, and to 10 participants in each location who formed our initial groups for investigation, this is a large number. For the purpose of relating the questionnaire data to the chemical results it was therefore necessary to decide on methods of compressing the data. We used factor analysis on both the chemical and the questionnaire data. This did not seem to yield any improvement of interpretation of the questionnarie data, therefore, we also used an alternative method based on linear regression.

Table 1: Weights and relative contribution of individual compounds to
         the sum of the Nordic TCDD-equivalent model (based on the
         range measured in Norway). Units for the contributions are
         pg/g fat basis.

Congener	Weight	Contribution
2,3,7,8-tetra CDD	1.0	1.6- 5.2
1,2,3,7,8-penta CDD	0.5	1.5- 4.7
2,3,7,8 subst. hexa CDDs	0.1	1.2- 5.4
1,2,3,4,6,7,8-hepta CDD	0.01	0.2- 0.8
octa CDD	0.001	0.1- 0.4
2,3,7,8-tetra CDF	0.1	0.2- 1.0
1,2,3,7,8-penta CDF	0.01	0
2,3,4,7,8-penta CDF	0.5	3.5-16.6
2,3,7,8 subst. hexa CDFs	0.1	0.4- 3.6
2,3,7,8 subst. hepta CDFs	0.01	0
octa CDF	0.001	0

Regional differences in concentrations were investigated by multiple
analysis of variance. Other multivariate methods together with a
simple graphical presentation were used for comparing the results from
the studies in Scandinavia. The concentrations of dioxins in milk in
Norway were compared with those in the world in several plots of the
measured concentrations.

2.1 PRELIMINARY DATA HANDLING

Prior to the statistical analysis, it was necessary to recode several
items in the questionnaire. They were the following:

Kinds of fish. Fish species, especially fat bottom fishes, are consi-
dered potential accumulators of dioxins. Fish eaten by the respondents
were coded into 5 categories. The categories corresponded to different
habitats of the fish, which was believed to reflect their degree of
contamination. They are deep sea fish, bottom fish, surface fish,
freshwater fish, and cod type fish. Details of the classification are
given in Table 2. The fish were classified into a low and a high group
according to their fat content. The "low" group was identical with
the "cod type" group of the former division. For statistical analysis,

the data were divided into two groups, "eating non-cod fishes", and "eating only cod-type fishes".

Table 2: Classification of fishes according to their habitat and fat content. Norwegian name in parantheses.

LOW FAT CONTENT	COD TYPE	Cod (torsk) Coalfish (sei) Haddock (kolje, hyse) Pollack (lyr) processed fish meat
HIGH FAT CONTENT	SURFACE FISH	Herring (sild) Mackerel (makrell) Salmon (laks)
	BOTTOM TYPE	Catfish (steinbit) Flounder (flyndre) Greenland halibut (blåkveite)
	DEEP SEA	Rosefish - Norway haddock (uer)
	FRESHWATER FISH	Trout (ørret) Pike (gjedde) Vendace (lagesild)

History of smoking. Smoking involves a burning process and is a known source of various polycyclic hydrocarbons. Persons with positive answers to either current or previous smoking, were considered to have a positive smoking history. The information on tobacco consumption was transformed into an equivalent number of cigarettes, based on the assumption that approximately 45 cigarettes can be made from one package of tobacco.

Index of overweight. Since the polychlorinated hydrocarbons are easily fat-soluble, there may be a difference in their accumulation due to different amount of fathy tissues between individuals. A new variable was created by subtracting the weight before pregnancy (in kg) from the height in cm of the mother. This variable formed a basis for dichotomy "obese", i.e., the persons for whom the height minus weight value was less than 100, were classified as "obese", else as "not obese".

Household heating by open fire. Local burning process is considered a potential source of polychlorinated hydrocarbons. All households using either a fireplace or a wood stove as one of the home heating devices were classified as heating by open fire.

Living in larger towns. Increased population density is connected to activities leading to higher pollution (heating, traffic, industry). To control for this the participating mothers were asked to name their current and previous places of residence, to specify how long they have been living at each of them, and to classify them according to the population density into four groups: Oslo, large town, village, and sparsely populated area. A weighted sum of the lengths of residence (in years) in different habitats was computed from these items. The weights were 4 for Oslo, 3 for a town, 2 for a village and 1 for a sparsely populated area. These weights were chosen arbitrarily, because there is no previous knowledge about PCB, PCDD and PCDF levels with respect to population density, except for the suspicion that the densely populated areas are likely to be more polluted. In a second stage, the newly created weighted sum was used to classify participants into two groups, those exposed to "high" levels (with values of the weighted sum above its median value) and those exposed to "low" levels (with values of the weighted sum below its median).

Life in Oslo. All persons, who lived previously for some time in Oslo (major city), were assigned positive value of index of living in Oslo. The shortest time spent in Oslo was 9 months (for convenience coded as one year), the longest was 8 years.

3 STATISTICAL ANALYSIS

Chemical analyses for the PCBs were available for 26 individual milk samples and 1 sample pooled from 2. The PCDD and PCDF compounds for these samples were analyzed at one laboratory, so it seemed natural to confine the first stage of the statistical analysis to these. The individual values for all 32 participants were used to verify the results, the pooled sample (pool of 2 individuals) was regarded as a single sample. The analysis supposed that within the range of measured

concentrations the investigated relations were linear. For a description of the methods used see e.g. Armitage and Berry (1987), or Rao (1973).

The data set was divided into three blocks of variables: (1) explanatory variables from the questionnaire recoded into yes/no indices, (2) the PCBs, pp-DDE, and HCB compounds, (3) the dioxin compounds. The PCBs compounds and the dioxin congeners were separated, since they are supposed to have different sources and properties. Each of these three blocks were then subjected to factor analysis.

Multiple regression analysis was used to assess relations between the explanatory variables or factors and the chemical factors.

Multiple analysis of variance was used to assess regional differences and differences between various groups, i.e. smokers vs. non-smokers, etc. When it seemed appropriate, univariate analysis of variance was used for similar purpose. Discriminant analysis was used to separate the samples from Scandinavia.

4 RESULTS OF THE NORWEGIAN STUDY

4.1 ANALYSIS OF EXPLANATORY VARIABLES

It was not possible to select the participating mothers so that the questionnaire information could be fully used. After screening the data, the following variables related to each mother were selected for analysis:

1) mother´s age
2) area of current residence (Tromsø, Skien-Porsgrunn, Elverum-Løten-Hamar)
3) experiencing a major fire or explosion
4) residence heated partly by open fire
5) history of smoking

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6) type of fish diet (cod, resp. non-cod species)
7) substantial change of diet habits
8) dieting with weight loss of more than 10 kg
9) relation of mother's weight to her height
10) weight loss in the first week after the delivery
11) living in Oslo at some period of life
12) population density in the areas of residence of each participant (living in densely populated areas)
13) travelling in Southern Europe in the last year.

The distribution of individual variables by geographical locations is given in Table 3. Individual questionnaires were filled by the two mothers who contributed to the pooled sample.

In order to further reduce the number of explanatory variables, 10 of the variables were subjected to factor analysis (excluding mother's age, residence area and travelling to Southern Europe. Five factors were extracted - a criterium for factor extraction was to explain approx. 75% of the variability in the data. Eigenvalues of the principal components (in descending order) were 2.00, 1.89, 1.36, 1.22, .95, .78, .70, .49, .37, and .25. Communalities, factor loadings and explained variability for the 5 factors after Varimax rotation are given in Table 4. 30 participants with no missing data were included in this factor analysis. Correlation coefficients between the variables are given in the Appendix B.

The factors are hard to interpret: the first factor is high for never-smoking mothers who dieted; the second for the mothers who experienced a fire and did not change their diet (e.g. vegetarian to normal); the third associates heating by open fire with living in more densely populated areas; the fourth eating non-cod fishes with being overweight; and in the fifth factor we see an influence of large weight loss after delivery. Regional differences in the factors, were investigated by multiple analysis of variance, but the homogeneity hypothesis was not rejected (on 5% significance level), the factors do not differ significantly between locations. Their mean values are plotted in Figure 1.

Table 3: Mean values of selected variables in the three areas and distribution of participants into regions according to certain features.

	Tromsø	Hamar*	Skien*	Total
Total no. of respondents	12	10	10	32
Age of mother at delivery (yrs)	24.9	24.1	23.7	24.3
Length of residual in the area (yrs)	12	14	19	15
Age of the child (weeks)	6	7	5	6
Weight loss in the 1st week after delivery (kg)	9.4	10.2	8.5	9.4
Total volume of milk (ml)	392	370	385	383
No. of fish meals per month	7.7	4.8	4.7	5.9
Living in dense areas (yrs)	24.7	40.7	25.2	29.9
No. of mothers suffering from allergy	0	1	1	2
No. of mothers who experienced a major fire or explosion	6	2	0	8
No. of mothers with positive smoking history	10	6	2	18
No. of mothers who previously lived in Oslo	2	2	2	6
No. of mothers who travelled to Southern European countries	1	3	0	4
No. of mothers who eat non-cod fish	9	7	6	22
No. of mothers who use open fire heating	4	9	4	17
No. of mothers who have been on a reduction diet	2	2	4	8
No. of mothers who changed their diet	2	0	1	3
No. of mothers with complications at delivery	1	2	2	5
No. of mothers who are overweight	9	2	1	12

* Hamar = Elverum-Løten-Hamar, Skien = Skien-Porsgrunn.

Table 4: Summary of the results of factor analysis of the explanatory
variables.

Variable	Communality	Factor loadings				
		E1	E2	E3	E4	E5
fire,explosion	.67	.20	.72	.16	.28	.06
smoking hist.	.76	-.83	.25	-.11	.07	-.02
open fire h.	.84	-.19	-.16	.79	-.32	.23
overweight	.79	-.01	-.36	-.09	.64	.49
loss at 1st wk	.86	.06	-.03	-.02	-.05	.93
dieting	.66	.70	.17	-.30	.06	.21
diet change	.66	.16	-.74	.06	.23	.13
eating non-cod	.80	.03	.12	-.01	.88	-.13
dense areas	.85	.01	.20	.84	.20	-.23
lived in Oslo	.52	.54	.40	-.09	.15	-.22
% of explained variability		20	19	14	12	10
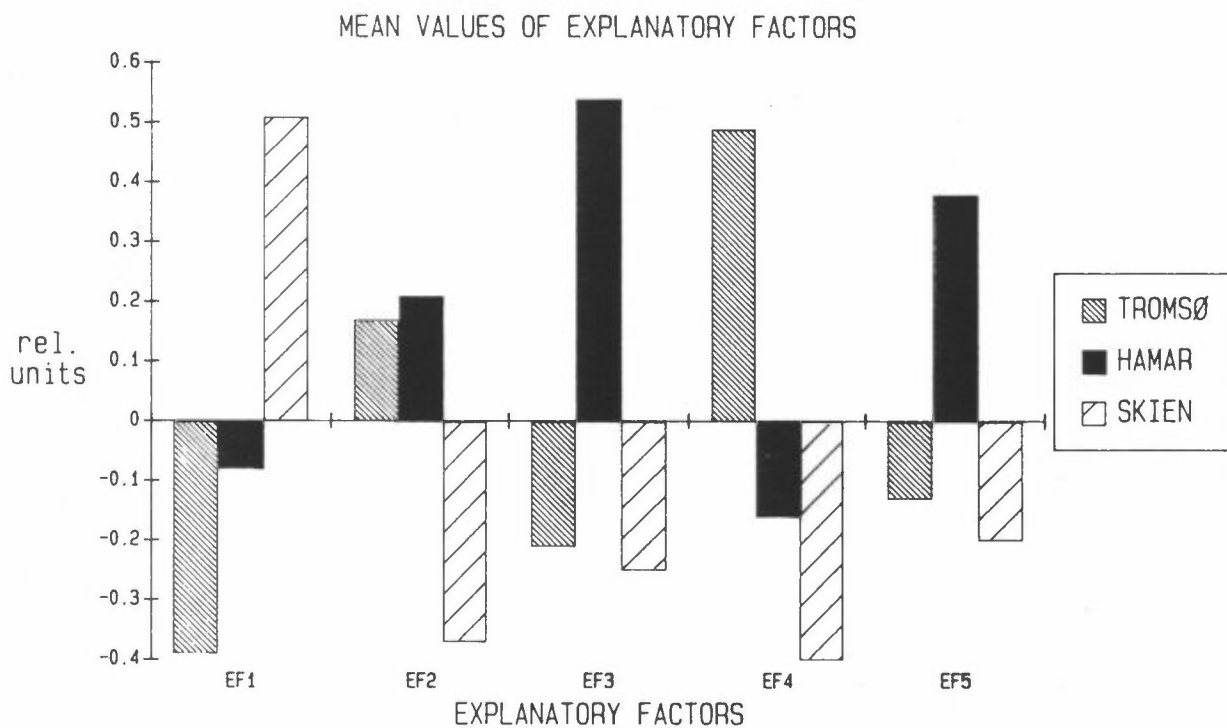
Figure 1: Mean values of the explanatory factors (in relative units).
For the percent of explained variability see the last line
of Table 3 .

4.2 PATTERNS IN CHEMICAL CONTAMINATION

The 1,2,3,7,8,9-hexa CDF and octa CDF were excluded from the analysis, because the concentrations in most samples were below the detection limit. The fat percentage in the milk was determined in two different ways by two different laboratories. When available, the results obtained in connection with the PCBs analysis were used.

First, a preliminary analysis was performed to check for confounding factors. To ensure that no effect is present due to the sequence in which the samples were analysed for dioxins, the regressions of the concentrations of individual compounds on the sequence number were evaluated, and the residuals checked. No dependency on the sequence was revealed.

The correlation matrix of the analytical results of the 26 individual samples analysed for dioxins at Umeå is presented in Appendix B.

The PCBs, pp-DDE, and HCB are expected to act independently of the dioxin variables and they were therefore transformed to one separate factor. The result of the factor analysis is given in Table 5. It seems to indicate that two factors may be more appropriate for description of the concentrations of these compounds. However, in the present analysis only the first one will be used.

Table 5: Results of factor analysis of the polychlorinated biphenyl compounds. The factor loadings can be interpreted as correlations of a compound with a factor.

Component	Communality 1 factor extracted	Factor loadings F1	Principal component no.	eigen-value
PCBs	.88	.94	1	2.07
p.p-DDE	.45	.67	2	.74
HCB	.74	.86	3	.19
% of explained variability 69				

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Fat percentage was included in the factor analysis of the dioxin data.
5 factors were set as the criterion for factor extraction, and as it
turned out, 5 factors describe the data exceptionally well. The least
communality was 0.83, and explained variability was 91%. More impor-
tantly, the factors are reasonable from chemical point of view. The
strongest factor includes penta and hexa furan congeners, the next
strongest hexa dioxin isomers, one factor where octa CDD and hepta CDF
are represented together, one factor for the tetra CDD and one factor
for the fat percentage (see Table 6, Figure 2).

Fat content of milk is negatively correlated with all the dioxin con-
geners as well as with the PCB compounds.

Table 6: Results of the factor analysis of the dioxin compounds –
5-factor solution. The factor loadings can be interpreted as
correlations of a compound with a factor.

Component	Communality	F1	F2	F3	F4	F5
				Factor loadings		
2378-tetra CDD	.96	.38	.36	.21	.79	.15
12378-penta CDD	.96	.64	.56	.05	.46	.16
1234/678-hexa CDD	.96	.38	.88	.08	.11	.13
123789-hexa CDD	.94	-.13	.94	.20	.07	-.01
1234678-hepta CDD	.87	.44	.67	.36	.22	.20
octa CDD	.89	.30	.19	.86	.15	.03
2378-tetra CDF	.76	.41	-.10	.41	.35	.54
12378-penta CDF	.94	.68	.02	.31	.57	.24
23478-penta CDF	.93	.74	.37	.00	.40	.28
123478-hexa CDF	.96	.85	.05	.34	.31	.16
123678-hexa CDF	.94	.84	.01	.36	.27	.17
234678-hexa CDF	.91	.88	.30	.09	.00	.17
1234678-hepta CDF	.83	.09	.25	.81	.08	.32
percent of fat	.93	-.23	-.17	-.18	-.10	-.90
% of variability explained		59	14	9	5	4

SQUARED FACTOR LOADINGS FOR 5—FACTOR SOLUTION (DIOXINS)

Figure 2: Graphical representation of the dioxin 5-factor solution in samples from Norway. The factors are identified by the percentage of total variability they explain (see Table 5), and they are represented by different graphical patterns. The total value of the bar for each compound represents the communality. The individual partitions of the bar correspond to the proportion of communality accounted for by the factor. The x-axis (x100) is read in percent.

We still obtain a reasonable description of the data set with three factors - namely, round 80% of the variability will be accounted for. If we exclude percent of fat from the analysis (in the 3-factor solution it is rather a confusing element), the communality for the 2,3,7,8-tetra CDD drops to .70, and for the 2,3,7,8-tetra CDF to .67. These two compounds together with the octa CDD are considered relatively little toxic. The tetra CDD factor is united with the strongest factor (see Table 7, Figure 3). However, since tetra CDD is considered a potentially toxic compound, we prefer the 5-factor solution.

Table 7: Results of factor analysis of the compounds - 3-factor solution. Factor loadings can be interpreted as correlations of a compound with a factor.

Component	Communality	Factor loadings		
		F1	F2	F3
2378-tetra CDD	.70	.68	.41	.28
12378-penta CDD	.95	.78	.58	.08
1234/678-hexa CDD	.94	.39	.88	.08
123789-hexa CDD	.94	-.11	.94	.20
1234678-hepta CDD	.86	.50	.68	.38
octa CDD	.82	.29	.20	.83
2378-tetra CDF	.67	.60	-.08	.55
12378-penta CDF	.90	.87	.05	.36
23478-penta CDF	.91	.87	.39	.05
123478-hexa CDF	.93	.89	.07	.35
123678-hexa CDF	.90	.88	.02	.36
234678-hexa CDF	.75	.81	.29	.08
1234678-hepta CDF	.82	.15	.26	.86
% of variability explained		61	15	10

SQUARED FACTOR LOADINGS FOR 3-FACTOR SOLUTION (DIOXINS)
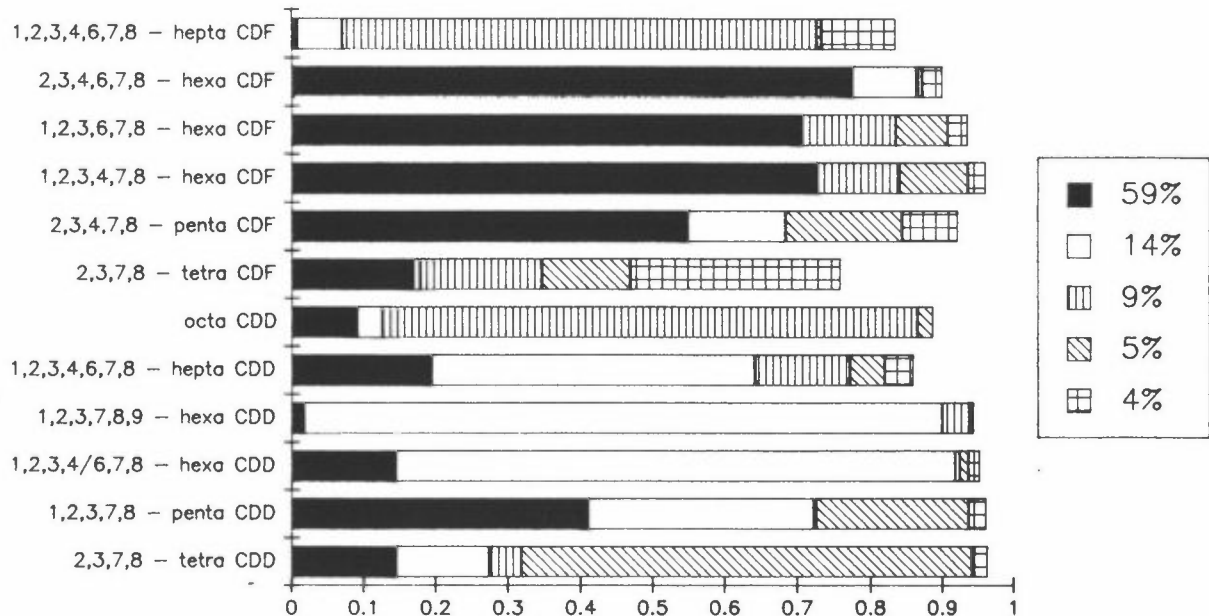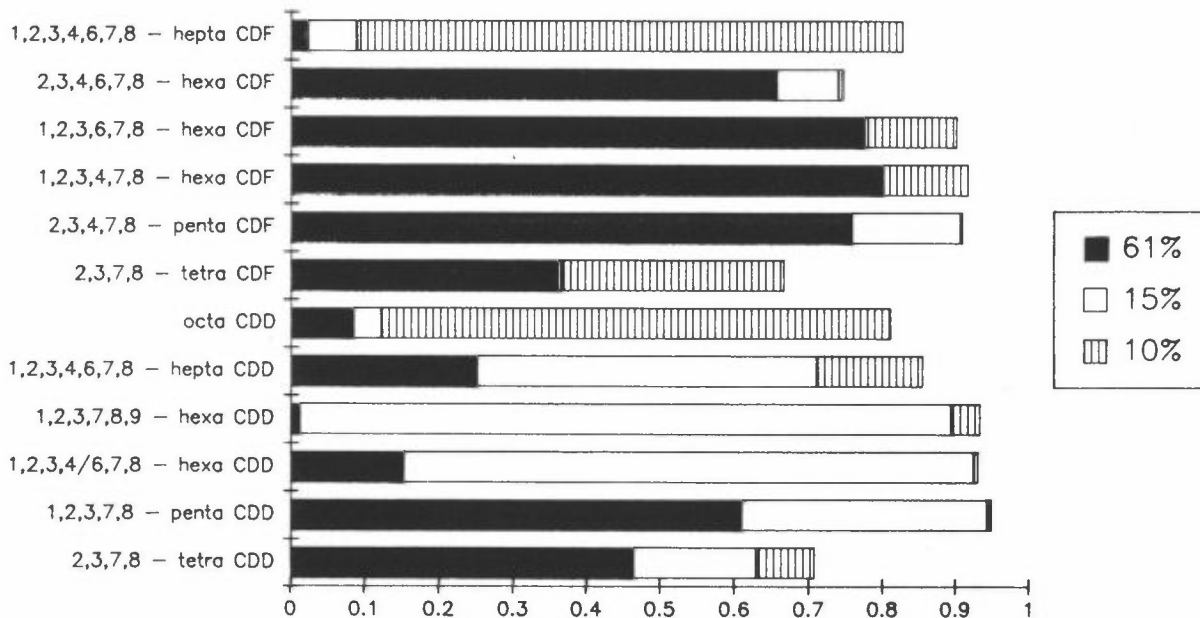

Figure 3: Graphical representation of the 3-factor dioxin solution. The factors are identified by the percentage of total variability they explain (see Table 7), and they are represented by different graphical patterns.

4.3 REGIONAL DIFFERENCES

One of the main study aims was to investigate regional differences.
The multiple analysis of variance was used on the 5 dioxin factors. It
showed non-homogeneity (at the 1% significance level) with signifi-
cantly higher values of Factor 1 in Skien-Porsgrunn area. The uni-
variate analysis of variance was used on the PCB factor and on the
TCDD equivalents. In these variables the homogeneity could not be
rejected. For mean values, see Figure 4.

MEAN VALUES OF CHEMICAL FACTORS AND TCDD EQUIVALENT
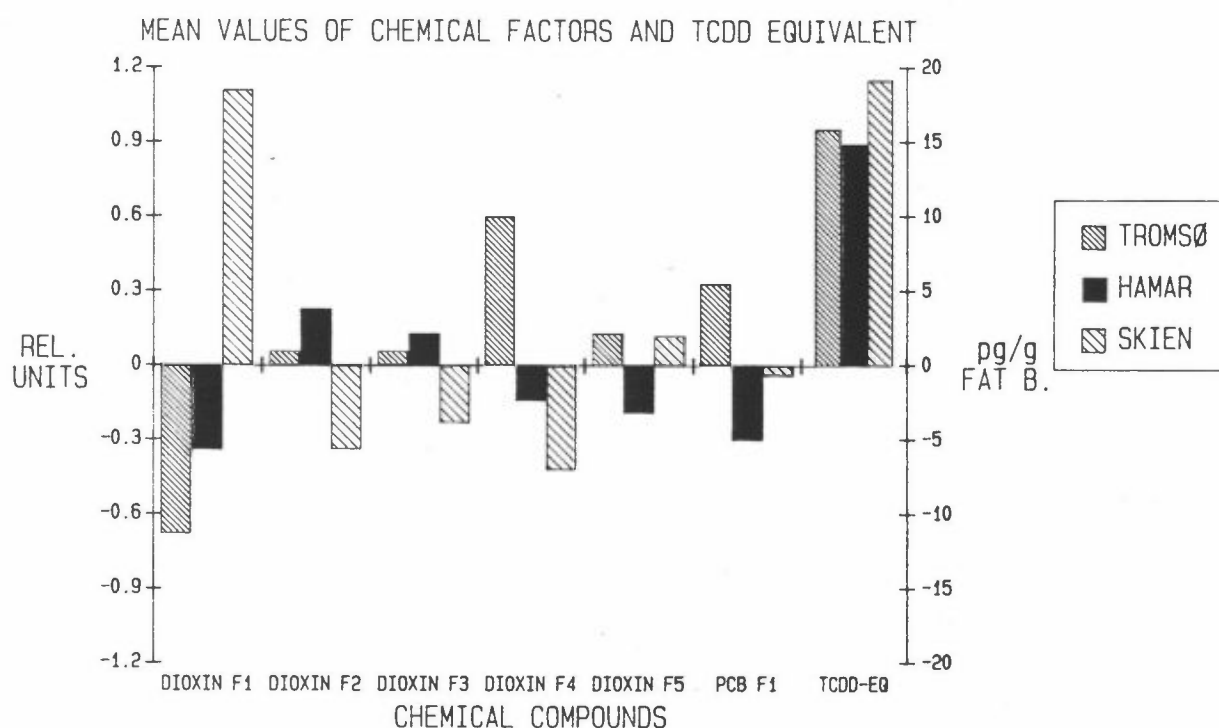
Figure 4: Mean values of 5 dioxin factors (identified by their percent
of explained variability - see Table 5), of the PCB factor,
and of the TCDD equivalent in the three locations. Units are
relative for the factors (left-hand axis) and pg/g fat
weight for the TCDD equivalent (right-hand axis).

Following this result, the data were reanalysed by the multiple ana-
lysis of variance separately on the PCB compounds and on the dioxin
congeners. A strong non-homogeneity in the dioxin compounds was dis-
covered (at the 1% multiple significance level) due to the 1,2,3,
4,7,8-hexa CDF, 1,2,3,6,7,8-hexa CDF and 2,3,4,6,7,8-hexa CDF. Concen-
trations in the Skien-Porsgrunn area were about twice as high as in

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the other two regions. Homogeneity in PCBs, p,p-DDE and HCB could not be rejected. Table 8 summarizes the results of the analysis of variance.

Table 8: Mean values of dioxins (pg/g fat weight) and PCBs (ng/g fat weight) in the three locations, and the significance of the analysis of variance test of homogeneity between the regions.

Component	Mean value Location			Significance	
	Tromsø	Hamar*	Skien*	univar. (t-test)	multivariate (Hotelling)
2378-tetra CDD	2.9	2.5	2.7	n.s.	<.01
12378-penta CDD	4.7	4.7	5.0	n.s.	
1234/678-hexa CDD	19.2	18.8	20.3	n.s.	
123789-hexa CDD	4.7	4.8	3.2	n.s.	
1234678-hepta CDD	36.0	40.3	36.3	n.s.	
octa CDD	154.6	149.9	156.0	n.s.	
2378-tetra CDF	4.3	4.1	4.9	n.s.	
12378-penta CDF	0.8	0.8	1.3	n.s.	
23478-penta CDF	12.9	11.4	17.7	.12	
123478-hexa CDF	3.6	4.6	7.8	.03	
123678-hexa CDF	2.6	2.7	5.3	.02	
234678-hexa CDF	0.9	1.0	1.7	<.01	
1234678-hepta CDF	6.2	5.5	5.6	n.s.	
PCBs	561.7	507.1	533.4	n.s.	.07
p,p-DDE	625.1	518.0	390.4	.07	
HCB	74.6	54.4	73.5	.10	

* Hamar = Elverum-Løten-Hamar. Skien = Skien-Porsgrunn.

4.4 RELATION BETWEEN THE EXPLANATORY VARIABLES AND THE CHEMICAL COMPOSITION OF SAMPLES

Stepwise multiple regression was used to study the potential influence of the explanatory variables on the chemical factors. The initial regression equation was in the form

chemical component =
constant + b1*E1 + b2*E2 + b3*E3 + b4*E4 + b5*E5 + ε

where b1,..,b5 denotes regression coefficients corresponding to the explanatory factors E1,..,E5 respectively, ε denotes an error term (for the factors E1,..,E5, see 4.1). The final, best-fitting equations are described in Table 9.

Table 9: Results of regression analysis of dependency of chemical on explanatory factors. ANOVA denotes analysis of variance test of regression adequacy (the regression is "adequate", if it explains a large part of the variability), multiple R^2 is a multivariate equivalent of the correlation coefficient, univariate t-test significance denotes the result of a test of hypothesis of zero regression coefficient, n.s. means not significantly nonzero.

Chemical factor	ANOVA f-test signif.	Mult. R^2	Revealed significant explanatory factors	Regression coeff. b	Univ. t-test signif.
dioxin F1	<.01	.43	E1	0.51	<.01
			E3	-0.42	.02
dioxin F2	n.s.		none		
dioxin F3	n.s.		none		
dioxin F4	n.s.		none		
dioxin F5	n.s.		none		
PCB F1	n.s.		none		

The regression of chemical factors on explanatory factors has good statistical properties: the explanatory factors are not intercorrelated, and are normally distributed. However, such analysis can only indicate possible relations.

The results seem to indicate that in non-smoking subjects who have not substantially dieted the concentrations of dioxins are higher, and that in subjects living in densely populated areas and using an open fire for heating they are lower, exactly opposite to expectations. We decided to investigate further and examine each individual compound. This does increase the number of tests and therefore increases the probability og revealing non-existing dependencies. We investigated the influence the following explanatory variables: smoking history, dieting, history of living in Oslo, living in densely populated areas, and using an open fire for heating on the chemical composition of milk.

Effect of smoking history. Analysis of variance of the dioxin F1 factor with respect to smoking history revealed significantly higher values of the factor in the never-smoking group. Table 11 summarizes

the mean values of the congeners, and gives the univariate signifi-
cance of t-test of differences between the two groups. The concentra-
tions of the hexa furan isomers are higher in the never-smoking group.
However, in the "never smoking" mothers group there are 2 participants
from Tromsø, 4 from Elverum-Løten-Hamar, and 8 from Skien-Porsgrunn.
Comparing the Table 10 with the Table 8 (mean values of congeners in
the three areas), it seems that the effect of smoking history is con-
fused by the influence of the source of PCDF compounds in Porsgrunn.

Table 10: Mean values of PCB compounds (ng/g fat basis) and of PCDD/
PCDF congeners (pg/g fat weight) with respect to smoking
history. Symbol "n.s." denotes not significant difference
between the groups (20% sig. level).

	Smoking history		Univariate significance of the difference
	no	yes	
Number of respondents	14	18	
% of fat	3.6	3.7	n.s.
PCBs	554.9	522.6	n.s.
pp-DDE	487.0	538.0	n.s.
HCB	70.8	65.0	n.s.
dioxin 2378-tetra	2.8	2.7	n.s.
dioxin 12378-penta	5.3	4.5	.12
dioxins 1234(6)78-hex	21.9	17.5	.06
dioxin 123789-hexa	4.1	4.4	n.s.
dioxin 1234678-hepta	43.9	32.6	.04
dioxin octa	158.5	149.7	n.s.
furan 2378-tetra	4.7	4.2	n.s.
furan 12378-penta	1.1	.9	n.s.
furan 23478-penta	15.8	12.5	.15
furan 123478-hexa	6.5	4.2	.06
furan 123678-hexa	4.2	2.9	.06
furan 234678-hexa	1.5	1.0	.02
furan hepta	6.2	5.5	n.s.
TCDD - equivalent	18.4	15.2	.11

Effect of weight reduction history. No difference in milk contamina-
tion was found between those who slimmed and those who did not slim at
the 10% multiple significance level. For mean values of the concentra-
tions of individual compounds in the two groups see Table 11. The

seemingly different concentrations of hexa CDFs may reflect that 4 out of 8 mothers who slimmed were from the Skien-Porsgrunn area.

Table 11: Mean values of concentrations of PCBs (ng/g fat weight), PCDDs and PCDFs (pg/g fat weight) in milk of respondents with and without positive weight reduction history. Symbol "n.s." denotes not significant difference between the groups (20% sig. level).

	Weight reduction history		Univariate significance of the group difference
	no	yes	
Number of respondents	24	8	
% of fat	3.7	3.5	n.s.
PCBs	528.5	554.8	n.s.
pp-DDE	499.4	594.5	n.s.
HCB	64.8	75.5	n.s.
dioxin 2378-tetra	2.6	3.1	.12
dioxin 12378-penta	4.8	5.3	n.s.
dioxins 1234(6)78-hex	19.1	20.3	n.s.
dioxin 123789-hexa	4.4	3.8	n.s.
dioxin 1234678-hepta	36.6	40.2	n.s.
dioxin octa	152.2	157.8	n.s.
furan 2378-tetra	4.5	4.3	n.s.
furan 12378-penta	.8	1.3	.07
furan 23478-penta	13.1	16.6	.18
furan 123478-hexa	4.6	7.2	.05
furan 123678-hexa	3.2	4.5	.14
furan 234678-hexa	1.1	1.4	n.s.
furan hepta	5.7	6.1	n.s.
TCDD-equivalent	15.8	18.9	.19

Influence of urban environment. Regression analysis of the cumulative index of exposure due to population density did not reveal any significant dependency. This is not surprising, given the poor quality of information in this item, and the artificial construction of the index. However, analysis of variance of the dioxin factors with respect to the indicator variable "ever lived in Oslo" showed non-homogeneity at the 10% multiple significance level, due to the 1st and 2nd factors, with higher values of these factors in the group of

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mothers who had lived in Oslo. Multiple analysis of variance was per-
formed on the individual chemical variables which confirmed the result
(at the 5% multiple significance level). The results are given in
Table 12.

Table 12: Mean values of concentrations of PCBs (ng/g fat weight),
PCDDs and PCDFs (pg/g fat weight) in milk of respondents
divided according to their history of living in Oslo. Symbol
"n.s." denotes not significant difference between the groups
(20% sig. level).

	Ever lived in Oslo		Univariate significance of the difference
	no	yes	
Number of respondents	26	6	
% of fat	3.8	3.1	n.s.
PCBs	516.9	597.2	n.s.
pp-DDE	527.6	491.0	n.s.
HCB	65.6	72.7	n.s.
dioxin 2378-tetra	2.6	3.3	.04
dioxin 12378-penta	4.6	6.2	.01
dioxins 1234(6)78-hex	18.1	24.9	.02
dioxin 123789-hexa	4.0	5.5	.06
dioxin 1234678-hepta	33.5	55.0	.01
dioxin octa	147.5	180.0	n.s
furan 2378-tetra	4.2	5.5	.07
furan 12378-penta	.8	1.5	.01
furan 23478-penta	12.5	20.2	.01
furan 123478-hexa	4.5	8.5	.01
furan 123678-hexa	3.1	5.0	.05
furan 234678-hexa	1.1	1.9	.01
furan hepta	5.7	6.6	n.s.
TCDD-equivalent	15.2	22.5	<.01

Influence of travelling to Southern Europe. Only 4 subjects travelled
to Southern Europe in the year preceeding sampling, 1 mother from the
Tromsø area and 3 from Elverum-Løten-Hamar. Multiple analysis of
variance of the dioxin factors did not reject the homogeneity hypo-
thesis, but the dioxin F2 factor seemed to show a strong univariate
non-homogeneity. This is reflected in Table 13.

Table 13: Mean values of concentrations of PCBs (ng/g fat weight), PCDDs and PCDFs (pg/g fat weight) in milk in the groups according to travelling to Southern Europe during the preceeding year.

	Travelled to Southern Europe		Univariate significance of the difference
	no	yes	
Number of respondents	28	4	
% of fat	3.7	3.1	n.s.
PCBs	520.2	650.3	n.s.
pp-DDE	514.4	565.0	n.s.
HCB	66.8	69.7	n.s.
dioxin 2378-tetra	2.7	2.7	n.s.
dioxin 12378-penta	4.8	5.8	n.s.
dioxins 1234(6)78-hex	18.3	27.3	.03
dioxin 123789-hexa	4.0	6.1	.02
dioxin 1234678-hepta	35.2	53.8	.01
dioxin octa	152.8	159.0	n.s.
furan 2378-tetra	4.5	3.9	n.s
furan 12378-penta	1.0	0.8	n.s.
furan 23478-penta	13.9	14.2	n.s.
furan 123478-hexa	5.3	4.6	n.s.
furan 123678-hexa	3.6	3.0	n.s.
furan 234678-hexa	1.2	1.2	n.s.
furan hepta	5.9	5.5	n.s.
TCDD-equivalent	16.4	18.0	n.s.

Effect of open fire heating. Analysis of variance revealed a small difference in the PCBs F1 factor between the mothers who had used open fire in the residence and chose who did not. Levels were higher (at 10% significance level) in the "no" group. This is mainly due to the HCB, (see Table 14). The significance level is low. In the dioxin F1 factor, homogeneity was rejected at 10% level, with higher concentrations of the penta CDF on the "yes" group. The importance of this result is, however, rather negligible.

Table 14: Mean values of concentrations of PCBs (ng/g fat weight), PCDDs and PCDFs (pg/g fat weight) in milk in the groups according to type of heating of residence. Symbol "n.s." denotes not significant difference between groups (20% sig. level).

	Heating partly by open fire		Univariate significance of the difference
	no	yes	
Number of respondents	15	17	
% of fat			
PCBs	581.5	493.1	.19
pp-DDE	548.5	494.9	n.s.
HCB	78.6	57.1	.01
dioxin 2378-tetra	3.0	2.5	.07
dioxin 12378-penta	5.3	4.5	.17
dioxins 1234(6)78-hex	20.3	18.6	n.s.
dioxin 123789-hexa	4.2	4.3	n.s.
dioxin 1234678-hepta	38.3	36.8	n.s.
dioxin octa	152.1	154.8	n.s.
furan 2378-tetra	4.7	4.2	n.s.
furan 12378-penta	1.1	.8	n.s.
furan 23478-penta	16.4	11.8	.04
furan 123478-hexa	5.8	4.7	n.s.
furan 123678-hexa	3.9	3.1	n.s.
furan 234678-hexa	1.4	1.0	.06
furan hepta	5.8	5.8	n.s.
TCDD-equivalent	18.5	14.9	.07

Effect of age. Relation of the chemical factors and the TCDD equivalent with age was investigated (see Table 15). A significant positive regression was found only for the PCB F1 indicating increase of compounds related to this factor in older subjects.

Table 15: Results of regression analysis of the dependency of chemical factors on age. The regession intercept is not reported. Symbol "n.s." denotes not significant difference after coefficient from zero (on 20% significance level).

Factor	Regression coefficient	t-test signif.
dioxin F1	0.07	.18
dioxin F2	0.05	n.s.
dioxin F3	-0.06	n.s.
dioxin F4	0.04	n.s.
dioxin F5	0.01	n.s.
PCBs F1	0.13	.02
TCDD equivalent	0.37	.16

4.5 SIMULTANEOUS ASSESSMENT OF DIFFERENCES IN MILK CONTAMINATION BY DIOXINS IN NORWAY

The values of the explanatory factors were found similar in the three areas. Despite this, the example of smoking shows that the regional differences were not properly accounted for. Therefore the data were reanalyzed by regression with dummy variables. The dummy variables represented the dichotomous 0/1 indices, with the 0 category (or "no" category) as reference. Two dummies were created for the locations, with a reference category Skien-Porsgrunn. For each dioxin factor, the model can be schematized as follows:

Value of factor = constant

$+ A1 *$ age

$+ A2 *$ indicator of using open fire

$+ A3 *$ indicator of positive smoking history

$+ A4 *$ indicator of exposure to fire

$+ A5 *$ indicator of being overweight

$+ A6 *$ indicator of subst. change of diet

$+ A7 *$ indicator of subst. weight loss after delivery

$+ A8 *$ indicator of dieting with weight loss of more than 10 kg

```
              + A9 * indicator of eating non-cod fishes
              + A10* indicator of  living  previously  in  densely
                     populated areas
              + A11* indicator of living previously in Oslo
              + A12* indicator of currently living in Hamar
              + A13* indicator of currently living in Tromsø
              + error term.
```

The results for the five dioxin factors are given in the next Table 16.

Table 16: Results of regression analyses of models with dummy location variables. Multiple R^2 measures multivariate correlation between the model and the dependent factor. For evaluation of the model fit we use the ratio between variability explained by the model and residual variability (d.f. denotes degrees of freedom). Significance level of the F-test of model fit is given (the symbol n.s. denotes not significant on 20% level, that is, the regression does not meaningfully describe the concentrations).

DIOXIN FACTOR	Mult. R^2	Explained variability (13 d.f.)	Residual variablility (10 d.f.)	F-test significance
F1	.83	19.7	4.2	<.05
F2	.52	12.1	11.2	n.s.
F3	.31	7.4	16.5	n.s.
F4	.46	10.5	12.5	n.s.
F5	.38	9.1	14.8	n.s.

The regression replained a significant part of variation only in the first dioxin factor. The individual coefficients for the explanatory variables are given in Table 17. They are interpreted as differences from the reference category, f.ex., a subject that is or was smoking has values of the 1st dioxin factor 0.06 x higher than never-smoking one, but the difference is not significant. For age, the coefficient represents the regression slope. The results of univariate tests of significance of each coefficient are given again as significance level. The hypothesis tested here is that of the equally of values the two groups and for age that there is no linear dependency of the dioxin factor on age. Positive sign of the regression coefficient indicates increase of the values of the dependent factor.

Table 17: Regression coefficients (differences from the reference category when plausible) for regression of concentrations of the first dioxin factor on the explanatory variables. Symbol "n.s." denotes not rejecting the homogeneity hypothesis on 20% level. The reference category (relative to which the difference is given) is given in parentheses.

Variable (reference category)	Regression coefficient	Univariate significance level
Age	.08	0.20
Open fire heating (no)	-.17	n.s.
Hist. of smoking (no)	.06	n.s.
Exposed to fire (no)	-.58	n.s.
Overweight (no)	.12	n.s.
Change of diet (no)	-.15	n.s.
Wght loss after del. (small)	-.09	n.s.
Dieting more than 10 kg (no)	-.02	n.s.
Eating non-cod fishes (no)	.37	n.s.
Prev.living in densely pop.areas (no)	-.07	n.s.
Previous living in Oslo (no)	.78	0.12
Current living in Hamar (Skien)	-1.24	<.05
Current living in Tromsø (Skien)	-1.48	<.05
Constant	-1.05	n.s.

The results indicate clearly the higher values of dioxin factor 1 (mainly hexa CDFs) in Skien (both Tromsø and Hamar values are significantly lower), and perhaps an increase of dioxin contamination with age. Previous living in Oslo seems also to have an enhancing effect on the factor values. However, if we recall Table 12, we see that the differences are not confined to congeners represented in the first dioxin factor. This explains the different significance levels obtained here as compared to the method described in 4.4. No other differences are indicated by this analysis. Compared to chapter 4.4, these results are more easy to understand, and they do not seem to

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yield spurious conclusions. The strong influence of location is clearly visible, and does not confound effects of other variables.

5   COMPARISON OF CONCENTRATIONS WITH OTHER PUBLISHED DATA

5.1   COMPARISON OF THE SCANDINAVIAN RESULTS ON DIOXINS

Individual milk samples from 4 locations in Sweden were analyzed at the University of Umeå, as were the samples fom Norway. For three of the four locations (Uppsala, 11 samples, Gothenburg, 11 samples, and Sundsvall, 9 samples), the analytical method differed a little (Lindström, 1988, Section III). The fourth location Borlaenge (10 samples) was analyzed with the same methodology as the Norwegian samples. In Denmark, 11 individual and a pool of 42 samples were analyzed. The Danish individual donors were from 5 different localities (for details see Sundhedsstyrelsen, 1987). Mean values of dioxin compounds for Sweden and Denmark are given in Table 18 (see Table 7 for Norway).

Table 18: Mean values of dioxin compounds (pg/g fat basis) in individual samples of breast milk from Sweden (Lindström, 1988) and Denmark (Sundhedsstyrelsen, 1987).

	Location				
	UPPSALA	GØTEBORG	SUNDSVALL	BORLANGE	DENMARK
2378-tetra CDD	2.9	3.2	3.3	2.8	2.4
12378-penta CDD	7.2	7.5	7.8	6.5	5.8
1234/678-hexa CDD	38.9	39.0	31.2	26.5	34.5
123789-hexa CDD	8.2	6.2	7.1	6.1	4.9
1234678-hepta CDD	72.1	67.3	52.2	41.8	52.3
octa CDD	255.0	263.0	209.0	183.7	163.1
2378-tetra CDF	3.7	4.1	3.8	3.6	1.2
12378-penta CDF(+)	.	.	.	.8	.
23478-penta CDF	17.1	19.6	19.6	17.0	12.4
123478-hexa CDF	5.3	5.2	4.0	7.0	6.8
123678-hexa CDF	4.4	3.7	3.3	3.7	5.5
123789-hexa CDF(*)	.7	.7	.7	.7	.7
234678-hexa CDF	2.4	2.6	2.0	1.3	1.5
hepta CDF	12.1	11.4	6.7	5.7	8.6
octa CDF (*)	1.2	1.2	1.2	1.2	1.2
percent of fat	2.7	3.1	3.1	3.4	4.1

(+): not measured, (*): detection limit not reached in any cases.

Multivariate analysis of variance of concentrations of all congeners between locations rejected the homogeneity hypothesis. In the individual compounds we find non-homogeneity between the locations in all congeners, except the 2,3,7,8-tetra CDD and percent of fat. To investigate more closely the differences between the locations we constructed a regression model for the concentrations of the individual congener using dummy location variables. Because most of the congeners were found to be homogeneous in their concentrations in the Norwegian locations, with some higher in Skien-Porsgrunn, we chose as a reference category the Skien-Porsgrunn area. Using this approach, the regression coefficients can be interpreted as mean differences between dioxin concentrations in milk from a given location and concentrations in milk from Skien-Porsgrunn. Figure 5 summarizes the results. The regression of most congeners on the location dummies explained a significant part of the variability in concentrations, except for 2,3,7,8-tetra CDD, 2,3,4,7,8-penta CDF and 2,3,4,6,7,8-Hx CDF. An approximate 5% two-sided confidence interval for zero difference between the location and Skien-Porsgrunn is marked in the diagrams as of threshold lines. Generally, this interval is different for each location. But due partly to the uniform numbers of subjects in each location the values are very much the same (ca 2% different), and therefore only one approximate interval is given. For several congeners only one threshold line is plotted, because all the values are lower (or higher) than in Skien-Porsgrunn, but the interval is still two-sided. The x axes for different congeners have different sizes of a unit. All concentrations are in pg/g fat.

To carry this analysis a step further, we would like to see if, based on the concentrations of the dioxin compounds, it is possible to distinguish between locations. The compounds that were found non-homogenous between locations were used in a discriminant analysis with stepwise variable selection. The procedure yielded 7 functions (for 8 locations), from which the first three improved the classification significantly, leaving only 15% of variability unacounted for. The correlation coefficients of compounds with the first three functions are given in Table 19.
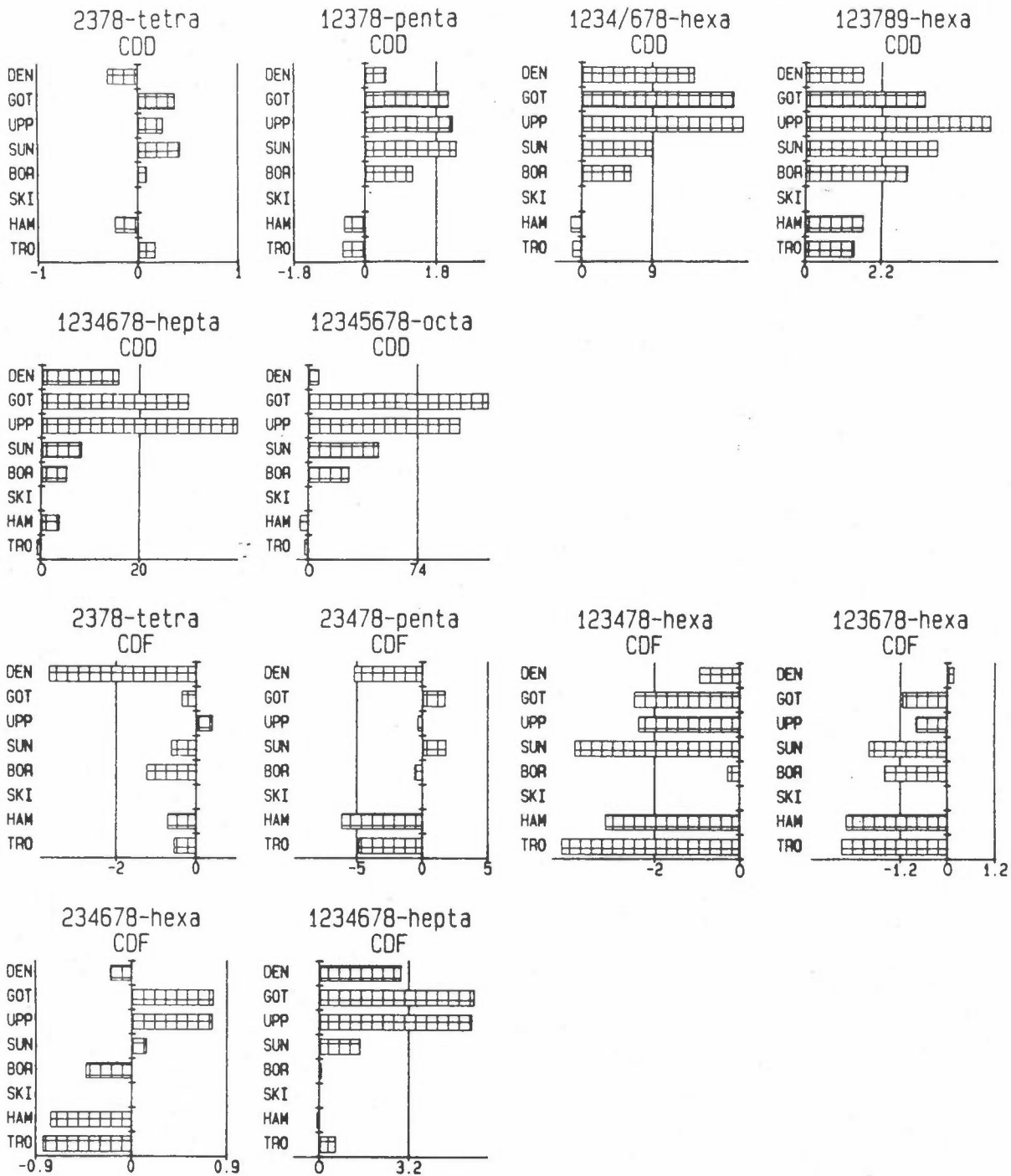
Figure 5: Mean differences in dioxin congener concentrations in mother´s milk in Scandinavian locations compared to Skien-Porsgrunn. For explanation see text. The abbreviations for locations are DEN for Denmark, GOT for Gothenburg, UPP for Uppsala, SUN for Sundsvall, BOR for Borlaenge, SKI for Skien-Porsgrunn, HAM for Elverum-Løten-Hamar and TRO for Tromsø.

Table 19: Correlation coefficients between dioxin compounds and the first three discriminant functions (C1, C2, C3) for discrimination between the eight Scandinavian locations.

Component	Corr. coeff. with function C1	C2	C3
12378-penta CDD	.24	.25	-.12
1234/678-hexa CDD	.57	.18	-.15
123789-hexa CDD	.25	.97	-.25
1234678-hepta CDD	.39	.19	.00
octa CDD	.25	.29	.05
2378-tetra CDF	-.14	.24	.33
23478-penta CDF	.05	.21	.13
123478-hexa CDF	.04	-.33	.01
123678-hexa CDF	.32	-.33	.21
234678-hexa CDF	.30	.19	.21
1234678-hepta CDF	.30	.05	.07
% of variance extracted	36	34	15

Individual samples are plotted in the co-ordinate system of the first three functions in Figure 6. Well separated are the samples from Denmark. Samples from Uppsala and Gøteborg are very close, and another rather homogenous group is formed by the samples from Tromsø and Hamar. Samples from Borlaenge are not well separated from samples from Hamar. More information about classification of the samples back into groups by locations is given in Table 20.

Table 20: Back classification of the samples. Actual and predicted number of samples in each of the 8 locations, the total number of cases is given in parentheses.

Location: predicted actual	1 (11)	2 (10)	3 (10)	4 (11)	5 (11)	6 (9)	7 (10)	8 (11)
1 Tromsø (11)	10	1	-	-	-	-	-	-
2 Elv.-L.-H. (10)	2	6	-	-	-	-	2	-
3 Sk.-Porsg. (10)	3	1	6	-	-	-	-	-
4 Uppsala (11)	-	-	-	6	2	1	-	2
5 Gøteborg (11)	1	-	1	6	2	-	-	-
6 Sundsvall (9)	1	-	-	-	-	8	-	-
7 Borlänge (10)	1	2	-	-	-	-	7	-
8 Denmark (11)	-	-	-	-	-	-	-	11
Predicted total	18	10	7	12	4	9	9	13
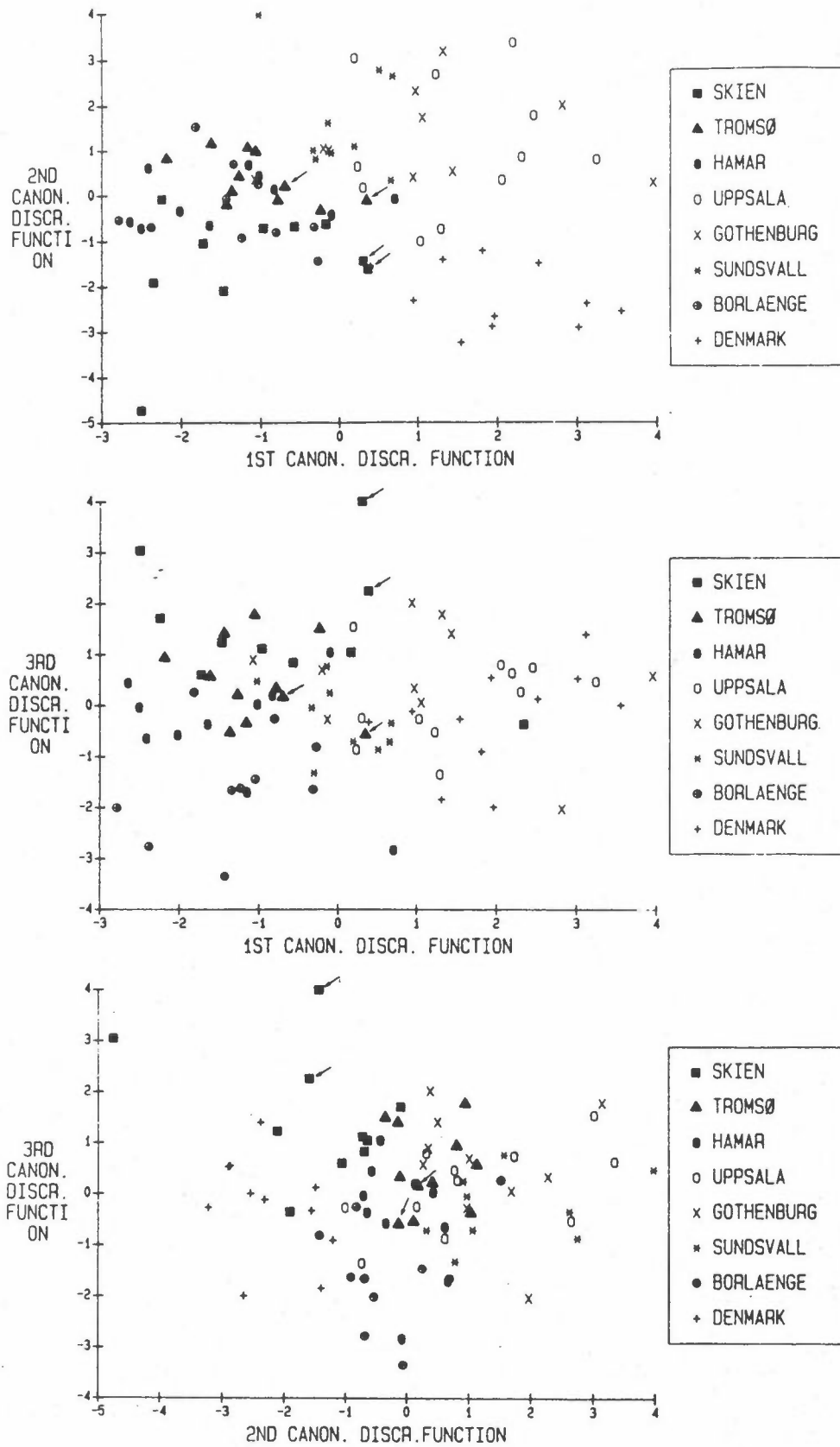
Figure 6: Discrimination between 8 Scandinavian locations based on
first three chemical discriminant functions. The arrows
point to samples analysed at NILU.

Sources of dioxin in milk may be revealed by comparing chemical factors created for each location or group of locations, e.g. for Norway and Sweden. In Denmark, the number of participants is too small for such analysis. However, no apparent similarities are found in the factor solution between Norway and Sweden - factor solution for Sweden is given in Figure 7 and in Table 21 (see Figure 2 and Table 6 for Norway). For mean values of each dioxin factor in Sweden see Figure 8. In Swedish samples, a strong PCDF factor is absent, because it is connected to the emissions in Skien-Porsgrunn. Possibly, dioxin factor 4 from Norway corresponds to factor 1 in Sweden, but other similarities are hard to see.

Table 21: Results of factor analysis of the dioxin compounds in individual milk samples from Sweden (37 samples) - factor loadings for rotated 5-factor solution.

Component	Communality	Factor loadings				
		F1	F2	F3	F4	F5
2378-tetra CDD	.81	.82	.06	.30	.21	.04
12378-penta CDD	.89	.84	.30	-.01	.25	.16
1234/678-hexa CDD	.80	.21	.69	.49	.17	.07
123789-hexa CDD	.86	-.04	.24	.88	.04	.15
1234678-hepta CDD	.79	.29	.45	.35	.54	.29
octa CDD	.86	.25	.06	.80	.27	.28
2378-tetra CDF	.72	.06	.76	.37	-.01	.11
12378-penta CDF	not measured					
23478-penta CDF	.80	.88	.08	-.02	.04	.15
123478-hexa CDF	.84	.17	-.02	.19	.21	.85
123678-hexa CDF	.88	.25	.27	.19	.56	.63
234678-hexa CDF	.80	.21	.78	-.17	.33	.11
1234678-hepta CDF	.88	.22	.12	.14	.89	.04
% of fat	.78	-.06	-.45	-.20	.29	-.67
% of variability explained		44	14	9	8	7

SQUARED FACTOR LOADINGS FOR 5—FACTOR SOLUTION SWEDEN
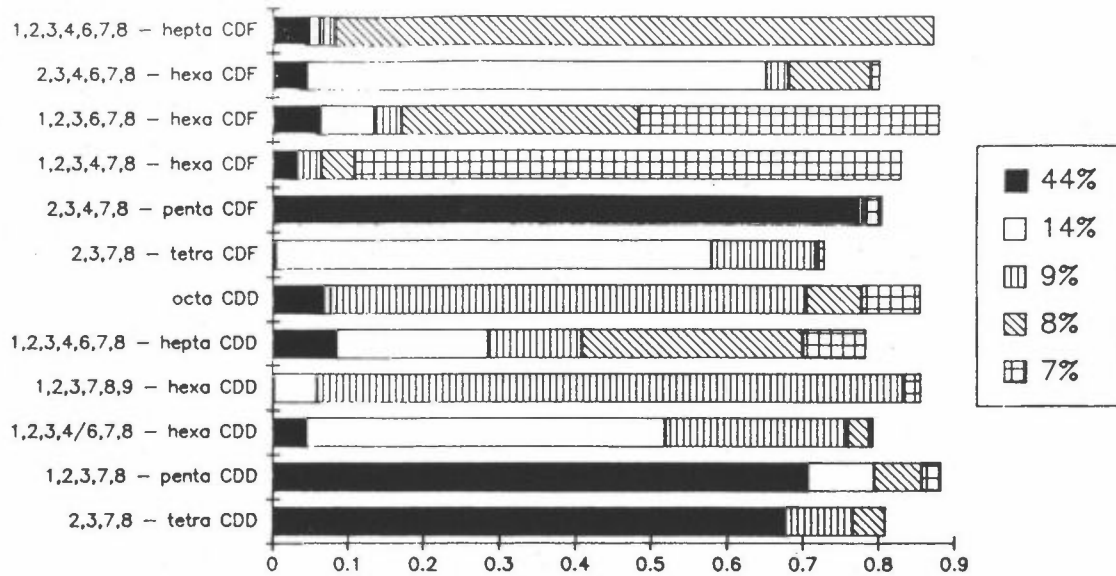
Figure 7: Graphical representation of the dioxin 5-factor solution in samples from Sweden. The factors are identified by the per-centage of total variability they explain (see Table 21), and they are represented by different graphical patterns. The total value of the bar for each compound represents the communality for the compound. The individual partitions of the bar correspond to the proportion of communality accoun-ted for by the factor. The x-axis (x100) is read in percent.
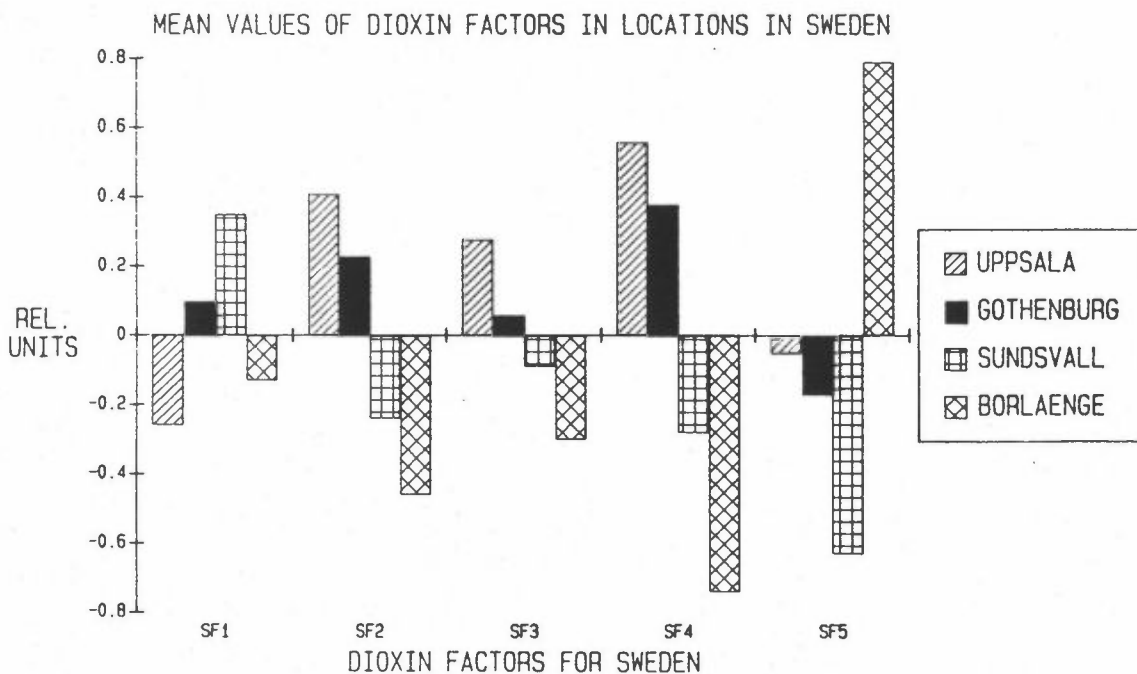
Figure 8: Mean values of the 5 dioxin factors constructed for Sweden in the 4 Swedish locations. The factors are identified by the percent of variability they explain (see Table 21). Units of the factors are relative.

5.2 COMPARISON OF DIOXIN CONCENTRATIONS WITH THE RESULTS REPORTED BY THE WHO

The World Health Organization (WHO) through its European Regional Programme on Chemical Safety has collected data on PCBs, PCDDs and PCDFs in human milk from analytical field studies throughout the world. These data were obtained in different laboratories, by different methods. However, the WHO inter-laboratory study did not reveal important differences between performance of the participating laboratories. When analysed more closely, the results on fat basis vary almost by a factor of 10 (see Table 22) (WHO, 1988).

The results both for individual data and for pooled samples, as given in WHO (1988) and by Lindström (1988) were plotted (see figures 9 and 10). The results are only roughly comparable (see Table 22). The pooling was not always done on volume basis. There are also differences in the number of hexa CDD, hexa CDF and tetra CDF congeners. A

Table 22: 700-800 ml of two samples of pooled human milk collected in Sweden were distributed to 15 laboratories in 10 countries. Result from 11 laboratories were accepted. Mean values and ranges of detected concentrations are presented in this table. Source: WHO, 1988.

Component	Pool 1		Pool 2	
	Mean	Range	Mean	Range
2,3,7,8-tetra CDD	4.5	2.2- 10.6	4.1	2.2- 7.8
1,2,3,7,8-penta CDD	7.5	1.2- 10.2	7.3	1.3- 11
1,2,3,4/6,7,8-hexa CDD	31.5	22.3- 43.2	32.2	18 - 46.8
1,2,3,7,8,9-hexa CDD	6.4	1.5- 9.5	5.4	1.9- 8.6
1,2,3,4,6,7,8 hepta CDD	55	36 - 76	46	28 - 63
Octa CDD	231	58 -449	245	59 -610
2,3,7,8-tetra CDF	4.9	0.9- 13.7	3.5	0.7- 7.5
1,2,3,7,8-penta CDF	0.9	0.3- 2.5	1.1	0.2- 2.4
2,3,4,7,8-penta CDF	21	7.4- 27	20	11.7- 34
1,2,3,4,7,8-hexa CDF	4.3	2.7- 7.0	5.5	<3.0- 8.8
1,2,3,6,7,8-hexa CDF	3.2	<2.0- 5.5	3.8	<2.0- 5.7
2,3,4,6,7,8-hexa CDF	1.5	<0.4- 2.7	1.6	<0.2- 3.7
1,2,3,4,6,7,8-hepta CDF	7.9	3.6- 14.0	7.1	2.1- 15
Octa CDF	1.9	1.3- 5.6	1.4	0.6- 2.2
% of fat	2.4	2.0- 2.8	2.3	1.5- 2.6

missing value covers both the "not analysed" and "not reported" cases. Values for the 1,2,3,4,7,8-hexa CDD and 1,2,3,6,7,8-hexa CDD congeners were summed up, and when the 1,2,3,4,7,8-hexa CDD was not detected, the concentration was considered to be zero. More details on the WHO project are given in WHO, 1988. List of abbreviations used in the figures is given in Table 23. Different graphical patterns in the figures were chosen to distinguish between different areas.
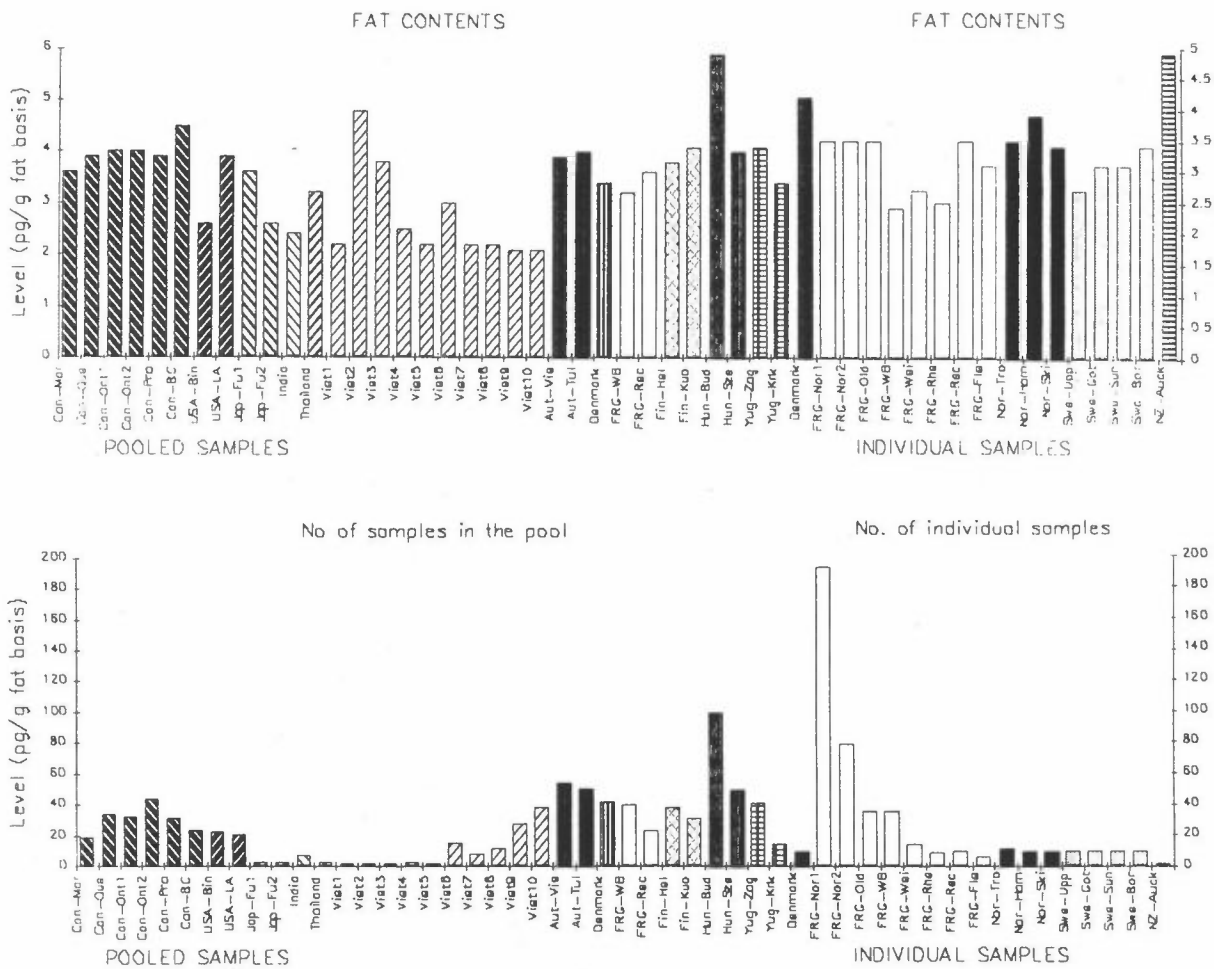
Figure 9: Mean value of fat percentage in milk and number of mothers contributing either to a pooled sample or with an individual sample in various countries as reported by the WHO (1988).
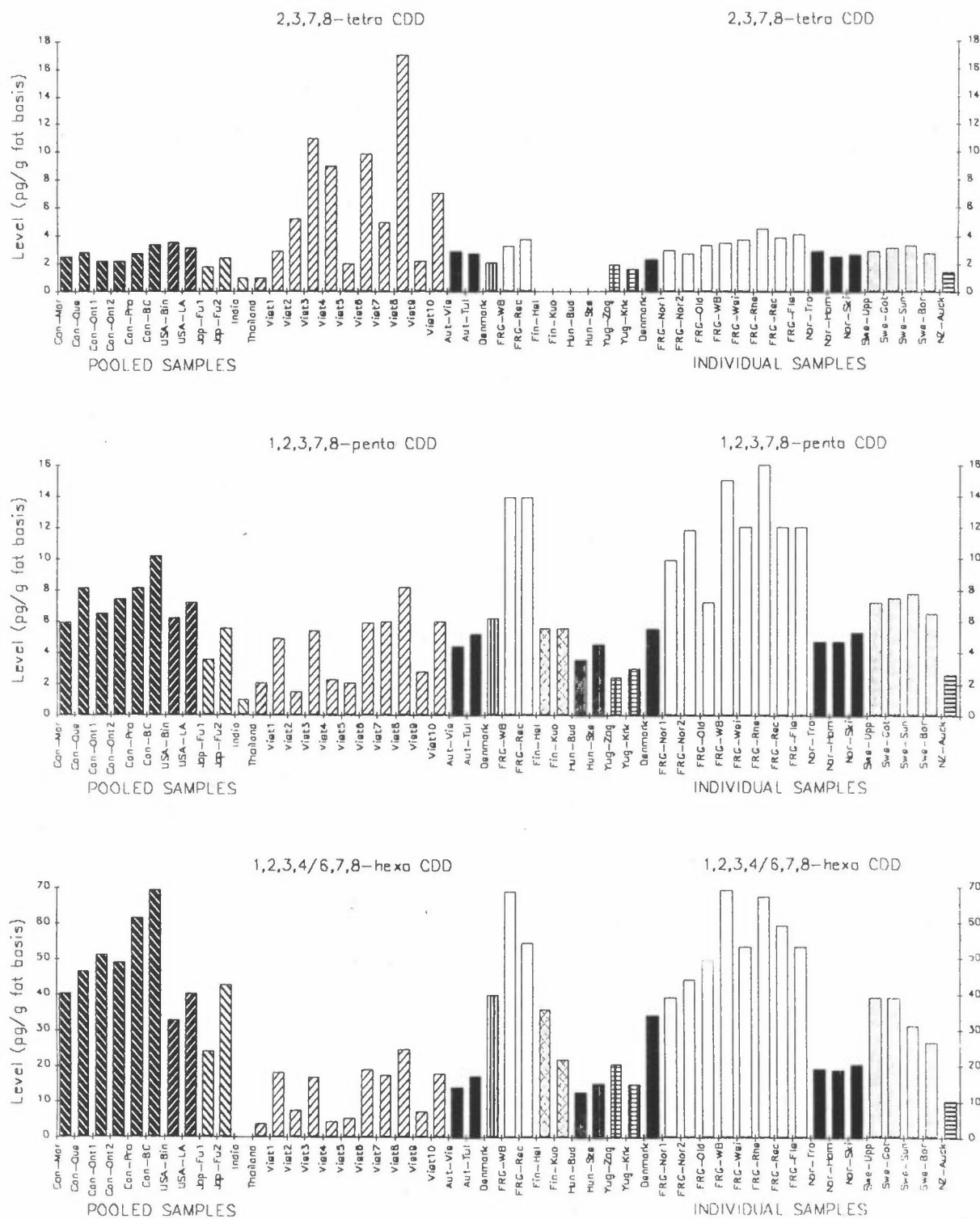
Figure 10: Mean value of dioxin congeners in the countries and locali-
ties as reported by the WHO.
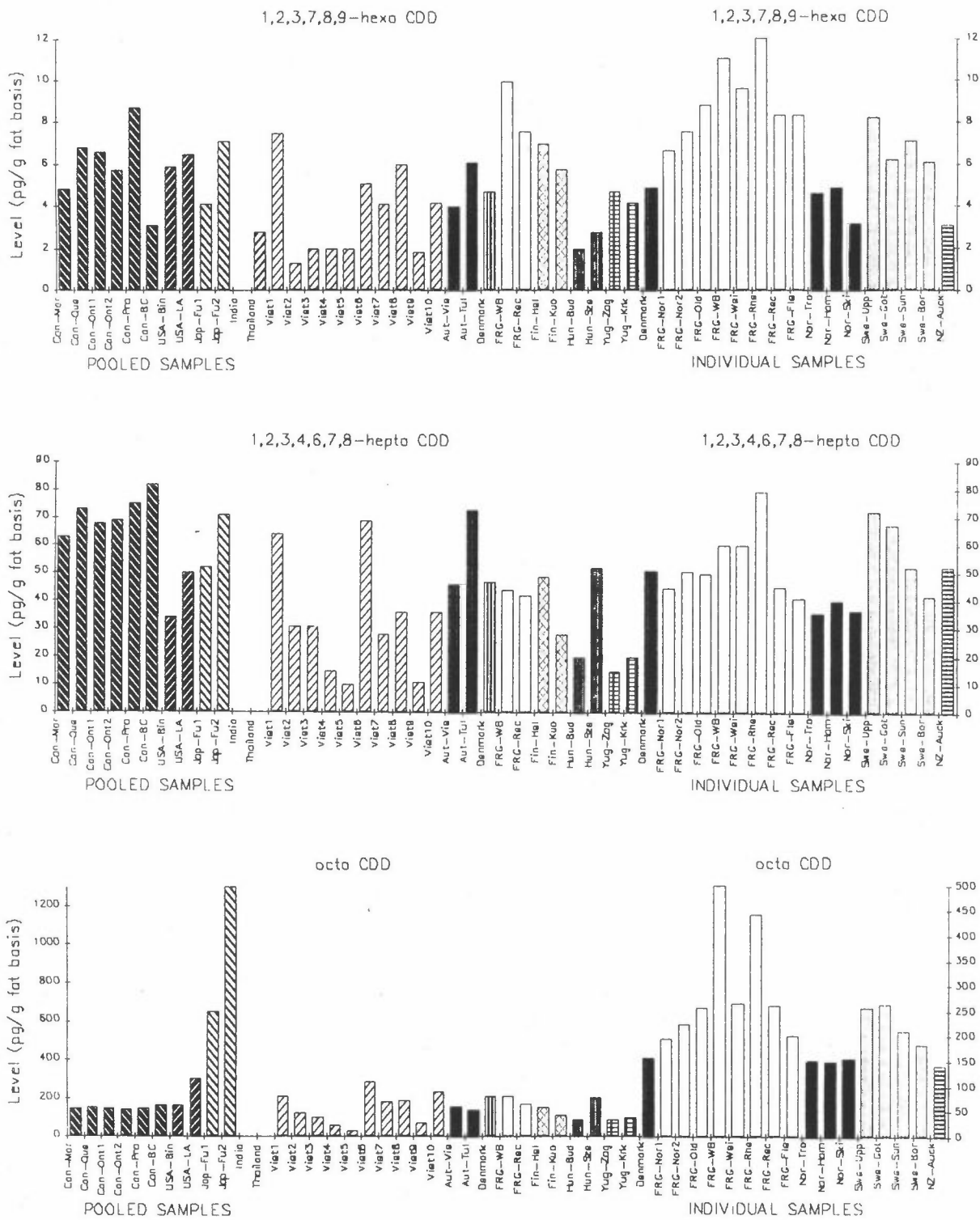
Figure 10: Cont.
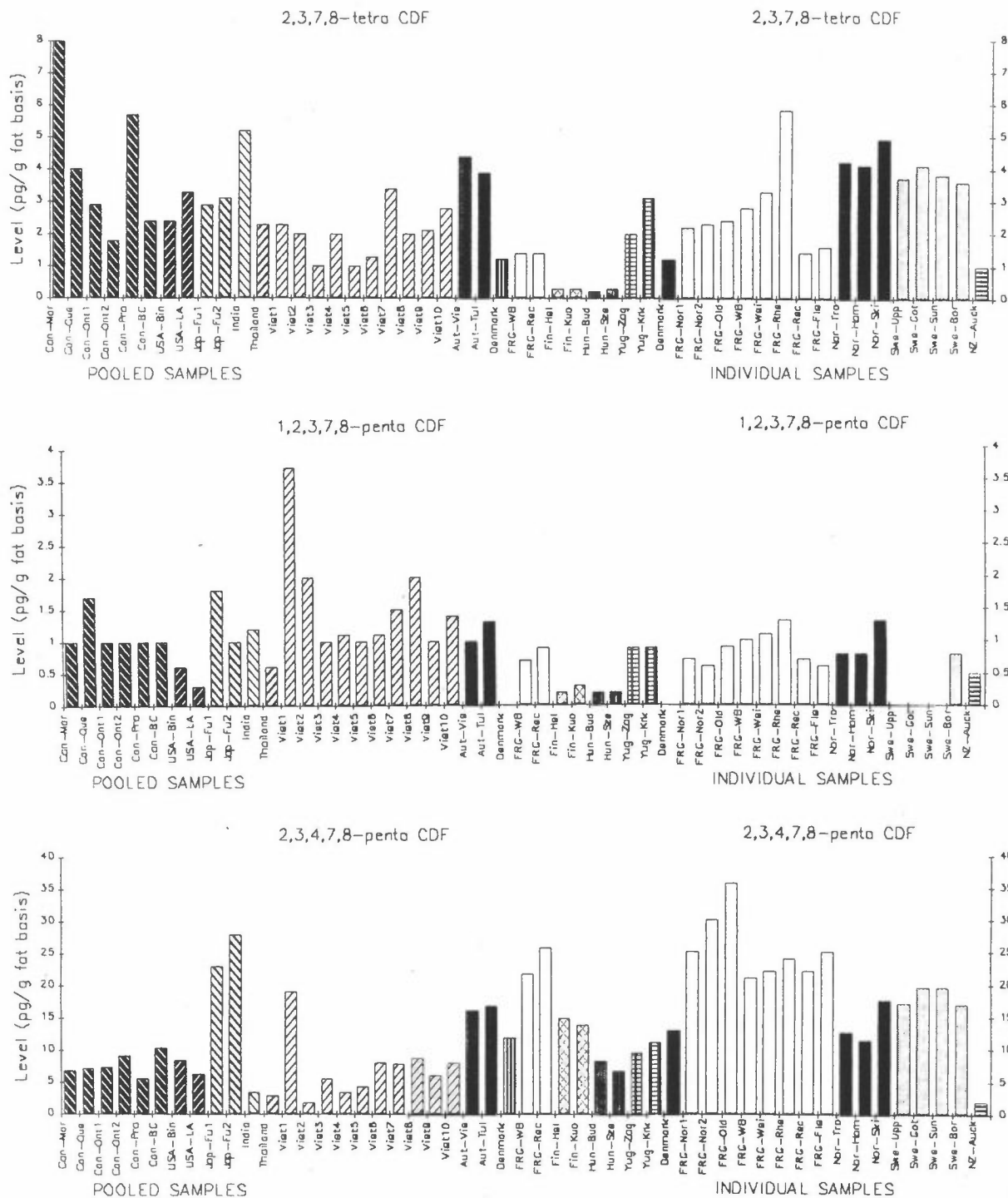
Figure 10: Cont.
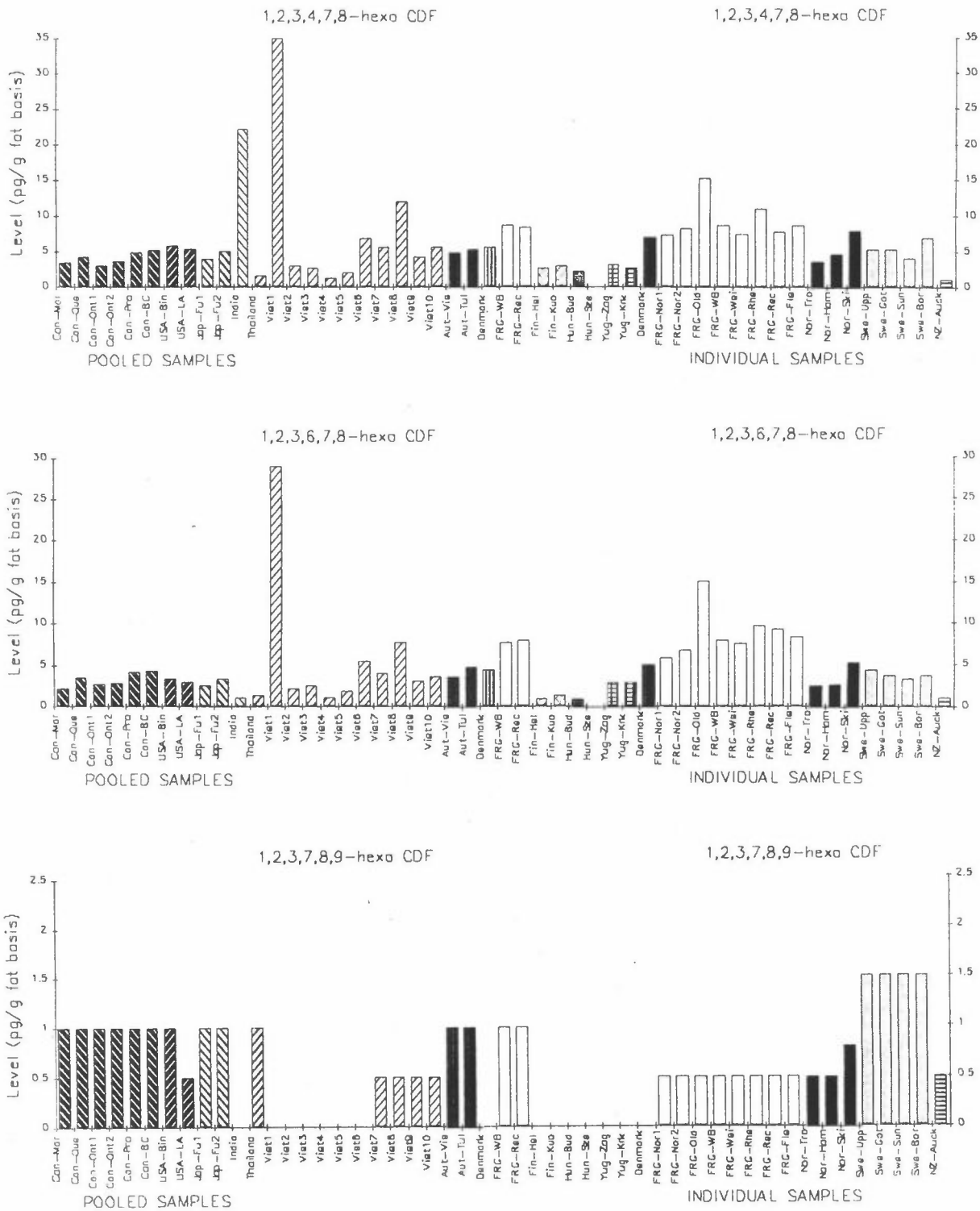
Figure 10: Cont.

Figure 10: Cont.
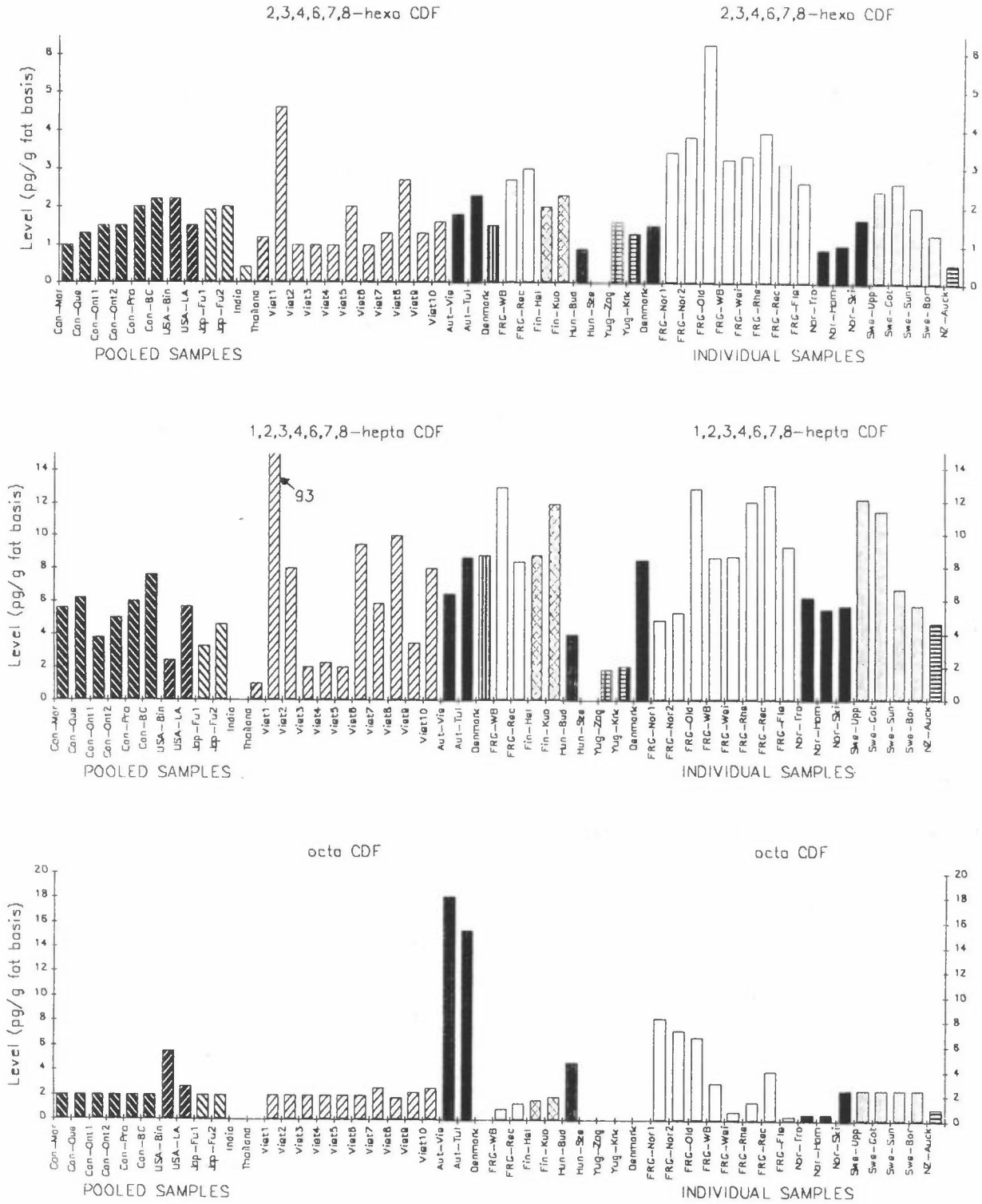
Table 23: List of areas whose donors contributed to the comparative
study co-ordinated by the WHO. Number of donors is indicated
in parentheses.

Pooled samples	
Abbrev.	Location
	North America
Can-Mar	Canada - Maritimes (19)
Can-Que	Canada - Quebec (34)
Can-Ont1	Canada - Ontario N,E (32)
Can-Ont2	Canada - Ontario SW (44)
Can-Pra	Canada - Prairies (31)
Can-BC	Canada - British Columbia (23)
USA-Bin	USA - Binghampton (22)
USA-LA	USA - Los Angeles (21)
	Asia
India	India (7)
Jap-Fu1	Japan - Fukuoka pref.1 (3)
Jap-Fu2	Japan - Fukuoka pref.2 (3)
Thailand	Thailand - Bangkok (3)
Viet1	Vietnam - Hanoi (28)
Viet2	Vietnam - Ho Chi Minh (38)
Viet3	Vietnam - Song Be province (12)
Viet4	Vietnam - Tan Uyen (2)
Viet5	Vietnam - Tan Uyen (2)
Viet6	Vietnam - Tan Uyen (2)
Viet7	Vietnam - Gan Glo (3)
Viet8	Vietnam - Long Xuyen (2)
Viet9	Vietnam - Ho Chi Minh (15)
Viet10	Vietnam - Ho Chi Minh (8)
	Europe
Aut-Vie	Austria - Vienna (54)
Aut-Tul	Austria - Tulln (51)
Denmark	Denmark (42)
Fin-Hel	Finland - Helsinki (38)
Fin-Kuo	Finland - Kuopio (31)
	Fed. Rep. Germany
FRG-WB	- West Berlin (40)
FRG-Rec	- Recklinghausen (23)
Hun-Bud	Hungary - Budapest (100)
Hun-Sze	Hungary - Szentes (50)
Yug-Zag	Yugoslavia - Zagreb (41)
Yug-Krk	Yugoslavia - Krk (14)
Individual samples	
	Europe
Denmark	Denmark
FRG-Nor 1	Fed. Rep. Germany - Northrhine-Westphalia (193)*
FRG-Nor 2	Fed. Rep. Germany - Northrhine-Westphalia (79)
FRG-Old	Fed. Rep. Germany - Oldenburg (35)
FRG-WB	Fed. Rep. Germany - Berlin West (35)
FRG-Wei	Fed. Rep. Germany - Weiden (14)
FRG-Rhe	Fed. Rep. Germany - Rheinfelden (9)
FRG-Rec	Fed. Rep. Germany - Recklinghausen (10)
FRG-Fle	Fed. Rep. Germany - Flensburg (6)
Nor-Tro	Norway - Tromsø (11)
Nor-Ham	Norway - Elverum-Løten-Hamar (10)
Nor-Ski	Norway - Skien-Porsgrunn (10)
Swe-Upp	Sweden - Uppsala (10)
Swe-Got	Sweden - Gøteborg (10)
Swe-Sun	Sweden - Sundsvall (10)
Swe-Bor	Sweden - Borlänge (10)
	Other
NZ-Auck	New Zealand - Auckland (2)

* participating mothers are with all birth parities.

6 DISCUSSION OF RESULTS

The results of this analysis indicate that the three Norwegian locations are quite homogeneous in most compounds of the polychlorinated hydrocarbons in question. Local variations that were revealed in Norway can be attributed to a large source in Porsgrunn. The Porsgrunn source probably also obscured a possible influence of e.g. smoking. Diet related differences were not confirmed, possibly due to a cross-sectional study design. The results indicate higher values of several compound in mothers who lived in Oslo, but a more directly targeted investigation would be needed to confirm this.

Comparison of the Norwegian chemical results with those of Sweden and Denmark indicates that the milk contamination by dioxins in these three countries is a little different, and perhaps a little lower in Norway. Compared to results from other industrialized countries as they were reported to the WHO, the Norwegian samples seem to lie in lower ranges of concentrations.

The data did not show a considerable skewness or kurtosis, therefore we did not consider a normalizing transformation necessary, also because we know from experience that in such small data sets the differences in results are small. Our main strategy was to use a transformation of data into factors, which yields approximately normal variables, but also produces an averaging effect on the data.

7 ACKNOWLEDGEMENTS

This report was prepared while Alena Bartonova was NTNF postdoctorate fellow at NILU. She is permanently of the Institute of Hygiene and Epidemiology, Prague, Czechoslovakia.

We are very thankful to Dr. B. Ottar, who considerably helped us in making the report more comprehensive.

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APPENDIX A

English translation of the questionnaire
used in this study

NORWEGIAN INSTITUTE FOR AIR RESEARCH
P.O. Box 64, 2001 Lillestrøm, Norway
Ref.: JCA/KAS/O-8553/15.9.1986

QUESTIONNAIRE FOR PARTICIPANTS IN THE STUDY OF
DIOXINS AND DIBENZOFURANS

Code number

Quantity (ml) of milk sample............
Milk sample was collected
          between (date)...........
          and   (date)...........

YOUR NAME...

ADDRESS...

TELEPHONE...

A LITTLE INFORMATION ABOUT YOURSELF:

When were you born?...

Do you suffer from any known illness?   ☐ YES   ☐ NO

   If yes, which?...

   Do you take any medication?..................................

Have you ever been near a major fire or explosion? ☐ YES ☐ NO

   In your house?..

   Outside, f.ex. in towns or cities where you have lived?.........

   ....

SMOKING HABITS

At the current time are you: ☐ Smoker?   ☐ Non-smoker

For those who smoke:

   How many cigarettes do you smoke per day?...................

   or how many packs of tobacco do you smoke per week?...........

   How many years have you smoked?.............................

For those of you who do not smoke:

Have you ever smoked? ☐ YES ☐ NO

If yes, how many years ago did you quit?...................years

How many years did you smoke?............................years

How many cigarettes did you smoke on the average per day?......

or how many packs of tobacco did you smoke per week?........

Do any family members smoke, or are you otherwise exposed to passive smoking? We mean by passive smoking that you are in the same room as a smoker every day.

☐ YES ☐ NO

If yes, how many hours per day?............................hrs.

OCCUPATIONS YOU HAVE OR HAVE HAD

Have you ever held a salaried position? ☐ YES ☐ NO

What kind of job have you had and how long have you worked with it?

Kind of job.................... from......... to.........

Kind of job.................... from......... to.........

Kind of job.................... from......... to.........

Kind of job.................... from......... to.........

HOW MANY YEARS HAVE YOU LIVED AT THE FOLLOWING ADDRESS:

1. At your present address?................................years

2. In the same town or city, but different address?..........years

3. Write the name of the places you have lived earlier. Mark each place with the following code: C = city, T = town, S = sparsely populated area.

Name of place	Code	Time period

TRAVEL

Have you traveled abroad in 1985?   ☐ YES ☐ NO

If yes, where did you travel to? Sweden or Denmark? ☐ YES ☐ NO

                              Southern Europe?   ☐ YES ☐ NO

                    If yes, which country and how long?

                    ....

                    Other locality (give name of place
                    or places and how long?

                    ....

Have you often traveled outside of Scandinavia more than 1 week
during the last five years?

....

FOOD AND EATING HABITS

What do you usually eat?   ☐ Mixed average diet (with meat,
                                   fish, etc.)

                                ☐ Primarily vegetarian, but
                                   including milk and/or egg

                                ☐ Only vegetarian

For those with mixed diet:

How often do you eat fish per week?................................

                    or per month?................................

Name the type of fish you eat most of:

                    1)...

                    2)...

                    3)...

                    4)...

                    5)...

                    6)...

Have you changed your eating habits since
the baby was born?   ☐ YES ☐ NO

Have you dieted and lost more than 10 kg in your life? ☐ YES ☐ NO

If yes, how often?...

When did you diet and lost this weight?...........................

A LITTLE ABOUT YOUR HOME

What do you use for heating your house?

☐ Fire-   ☐ Wood-   ☐ Coal   ☐ Paraffin or ☐ Electric
  place   stove   oven   oil stove   heating

PREGNANCY AND BIRTH

How tall are you?...cm

How much did you weigh before pregnancy?......................Kg

How much did you weigh just before giving birth?..............Kg

How much weight did you lose the first week after
the baby was born?..Kg

Where did you give birth?

   Name of clinic..

           hospital...

           other..

What date was the baby born?.................................

Did you have a normal pregnancy?.............................

What problems did you have during the pregnancy?.............

....

....

Was the birth normal?   ☐ YES   ☐ NO

   If no, what was different? (f.ex. Caesarian section)...........

   ....

THANK YOU FOR YOUR HELP

APPENDIX B

List of variables and correlation matrices.

Table B1: List of variables.

Explanatory variables: location		Chemical compounds:
AGE	mother´s age	dioxin 2378-tetra
	mother´s illness (allergy)	dioxin 12378-penta
	observed major fire	dioxins 1234/678-hexa
	current smoker	dioxin 123789-hexa
	- amount of cigarettes	dioxin 1234678-hepta
	- curr. smoker: years	dioxin octa
	previous smoker	furan 2378-tetra
	- years since quit	furan 12378-penta
	- prev. smoker: years	furan 23478-penta
	- prev. smoked cigaretts	furan 123478-hexa
	nonsmoker: passive smoking	furan 123678-hexa
	- passive smoking - hours	furan 123789-hexa
SMH	smoking history	furan 234678-hexa
	years lived in the same area	furan hepta
	years lived in Oslo	furan octa
	years lived in a larger town	percent of fat
	years lived in a village	2nd % of fat
	years lived in a sparsely	PCBs
	populated area	pp-DDE
	exposure to urban environment	HCB
ITEX	index of expos. to urban env.	TCDD-equivalent
OSLO1	index of ever lived in Oslo	sequence of analysis
	travelling in 1985	pooled sample
	- Scandinavia travelling	analysing laboratory
SOUTH	- South travelling	PCDD/PCDF F1
	No. of travels in last 5 yrs	PCDD/PCDF F2
	eating - bottom fish	PCDD/PCDF F3
	- cod type fish	PCDD/PCDF F4
	- surface fish	PCDD/PCDF F5
	- deep water fish	
	- fresh water fish	
COD1	index of eating non-cod fish	
	number of fish meals per month	
	heating by a fireplace	
	heating by a wood stove	
	heating by a coal stove	
	heating by oil	
	electric heating	
OPENF	index of open fire heating	
SLIM	reduction diet history	
	history of a subst. diet change	
	mother´s height	
	weight before pregnancy	
	weight before delivery	
LOSS	weight loss in the 1st week	
	index of wt loss in the 1st wk	
	date of delivery - month	
	delivery complications	
	mean volume of milk	
	value of overweight	
OBES1	index of overweight	
	month of milk collection	
	explanatory F1	
	explanatory F2	
	explanatory F3	
	explanatory F4	
	explanatory F5	

Table B2: Correlations between the explanatory variables (for abbreviations see Table B1).

	AGE	OSLO1	ITEX	SMH	OPENF	COD1	SLIM	LOSS	OBES1	SOUTH
AGE	1.0000	.2871	-.2281	-.0930	-.0218	-.2200	.3177	.2272	.3319	.1195
OSLO1	.2871	1.0000	-.1459	-.3989	-.1908	.1035	.4146	.0079	.1163	.1163
ITEX	-.2281	-.1459	1.0000	-.0989	.4099	.3296	-.0483	.0321	.0948	.0948
SMH	-.0930	-.3989	-.0989	1.0000	.1429	-.1704	-.2928	-.0130	.0639	-.1917
OPENF	-.0218	-.1908	.4099	.1429	1.0000	-.3564	-.2928	.1037	.0639	.3194
COD1	-.2200	.1035	.3296	-.1704	-.3564	1.0000	.1588	.0070	.2425	-.0346
SLIM	.3177	.4146	-.0483	-.2928	-.2928	.1588	1.0000	.1771	.0727	-.2182
LOSS	.2272	.0079	.0321	-.0130	.1037	.0070	.1771	1.0000	.4348	.1449
OBES1	.3319	.1163	.0948	.0639	.0639	.2425	.0727	.4348	1.0000	-.1429
SOUTH	.1195	.1163	.0948	-.1917	.3194	-.0346	-.2182	.1449	-.1429	1.0000

N of cases: 24   2-tailed Signif: * - .01 ** - .001

Table B3: Correlations between the PCBs, pp-DDE and HCB.

	PCBS	pp-DDE	HCB	FAT2
PCBS	1.0000	.4995*	.7774**	-.3711
PPDDE	.4995*	1.0000	.2939	.0191
HCB	.7774**	.2939	1.0000	-.5292*
FAT2	-.3711	.0191	-.5292*	1.0000

N of cases: 26   2-tailed Signif: * - .01   ** - .001

Table B4: Correlations between the dioxin compounds.

	dioxin 2378- tetra	dioxin 12378- penta	dioxins 1234/678- hexa	dioxin 123789- hexa	dioxin 1234678- hepta	dioxin octa	furan 2378- penta
dioxin 2378-tetra	1.0000	.8427**	.5720*	.3753	.6662**	.4975*	.5453*
dioxin 12378-penta	.8427**	1.0000	.8119**	.4668	.7917**	.4320	.4527
dioxins 1234/678-hexa	.5720*	.8119**	1.0000	.7927**	.8202**	.3693	.2043
dioxin 123789-hexa	.3753	.4668	.7927**	1.0000	.6543**	.2996	.0002
dioxin 1234678-hepta	.6662**	.7917**	.8202**	.6543**	1.0000	.5979*	.5366*
dioxin octa	.4975*	.4320	.3693	.2996	.5979*	1.0000	.4937
furan 2378-tetra	.5453*	.4527	.2043	.0002	.5366*	.4937	1.0000
furan 12378-penta							
furan 23478-penta	.7774**	.9072**	.6943**	.2562	.6865**	.3623	.5180*
furan 123478-hexa	.6551**	.7391**	.4606	.0567	.6349**	.5812*	.6710**
furan 123678-hexa	.6206**	.7151**	.4210	.0087	.5838*	.6079**	.6365**
furan 123789-hexa							
furan 234678-hexa	.5345*	.7555**	.5952*	.1824	.6473**	.3889	.4986*
furan hepta	.4283	.3322	.3751	.3687	.5194*	.7040**	.4775
furan octa							
percent of fat							
2nd % of fat	-.4073	-.4544	-.3828	-.1597	-.4584	-.3463	-.5674*

N of cases: 26   2-tailed Signif: * - .01 ** - .001

Table B4, cont.

	furan 23478- penta	furan 123478- hexa	furan 123678- hexa	furan 234678- hexa	furan hepta	2nd % of fat
dioxin 2378-tetra	.7774**	.6551**	.6206**	.5345*	.4283	-.4073
dioxin 12378-penta	.9072**	.7391**	.7151**	.7555**	.3322	-.4544
dioxins 1234/678-hexa	.6943**	.4606	.4210	.5952*	.3751	-.3828
dioxin 123789-hexa	.2562	.0567	.0087	.1824	.3687	-.1597
dioxin 1234678-hepta	.6865**	.6349**	.5838*	.6473**	.5194*	-.4584
dioxin octa	.3623	.5812*	.6079**	.3889	.7040**	-.3463
furan 2378-tetra	.5180*	.6710**	.6365**	.4986*	.4775	-.5674*
furan 12378-penta						
furan 23478-penta	1.0000	.8020**	.7590**	.8134**	.3414	-.5270*
furan 123478-hexa	.8020**	1.0000	.9594**	.7840**	.4431	-.4385
furan 123678-hexa	.7590**	.9594**	1.0000	.7639**	.4254	-.4669
furan 123789-hexa						
furan 234678-hexa	.8134**	.7840**	.7639**	1.0000	.3176	-.3924
furan hepta	.3414	.4431	.4254	.3176	1.0000	-.4772
furan octa						
percent of fat						
2nd % of fat	-.5270*	-.4385	-.4669	-.3924	-.4772	1.0000

N of cases: 26   2-tailed Signif: * - .01 ** - .001

Table B5: Correlations between the PCBs and the dioxin compounds.

	PCBS	PPDDE	HCB	FAT2
dioxin 2378-tetra	.6054*	.4511	.4261	-.4073
dioxin 12378-penta	.7024**	.3184	.5331*	-.4544
dioxins 1234/678-hexa	.5944*	.2479	.4860	-.3828
dioxin 123789-hexa	.2978	.4451	.1758	-.1597
dioxin 1234678-hepta	.4420	.1707	.3398	-.4584
dioxin octa	.1661	.0272	.0998	-.3463
furan 2378-tetra	.1077	-.1341	.1502	-.5674*
furan 12378-penta				
furan 23478-penta	.7101**	.2034	.6464**	-.5270*
furan 123478-hexa	.2901	-.0429	.2808	-.4385
furan 123678-hexa	.2831	-.0747	.3212	-.4669
furan 123789-hexa				
furan 234678-hexa	.3448	-.0248	.3380	-.3924
furan hepta	.0672	.0266	.1244	-.4772
furan octa				
percent of fat				
2nd % of fat	-.3711	.0191	-.5292*	1.0000**

N of cases: 26   2-tailed Signif: * - .01 ** - .001

Table B6: Correlations between the eplanatory variables (for abbreviations see Table B1) and the dioxin compounds.

	AGE	OSLO1	ITEX	SMH	OPENF	COD1	SLIM	LOSS	OBES1	SOUTH
dioxin 2378-tetra	.1997	.4394	-.1142	-.0908	-.2569	.0605	.2393	-.2602	.0329	.0329
dioxin 12378-penta	.3163	.4821	-.2066	-.3622	-.2674	.0279	.2234	-.3137	.0285	.2170
dioxins 1234/678-hexa	.2085	.5276*	-.0065	-.2908	-.0317	.0742	-.0230	-.2719	-.0571	.4208
dioxin 123789-hexa	-.0880	.3059	.3447	-.0629	.1919	.2202	-.1758	-.1864	-.0785	.4767
dioxin 1234678-hepta	.2705	.6035*	.0906	-.4361	-.0100	.1659	.1111	-.0846	.0846	.4665
dioxin octa	-.0821	.1990	.0006	-.0075	.0666	.1560	.0114	-.1696	.0122	.0796
furan 2378-tetra	-.0136	.3040	.0073	-.3810	-.1831	-.0899	.1334	-.1528	-.1533	-.0834
furan 12378-penta										
furan 23478-penta	.3700	.5505*	-.3071	-.3683	-.4280	-.0304	.3641	-.2061	-.0139	.0714
furan 123478-hexa	.2065	.5302*	-.2285	-.4066	-.2465	.0248	.4129	-.2321	-.0559	-.0357
furan 123678-hexa	.1443	.4387	-.2651	-.3339	-.2816	.0635	.2979	-.3593	-.0279	-.0669
furan 123789-hexa										
furan 234678-hexa	.2771	.4983	-.1261	-.4958	-.4597	.0664	.2400	-.2660	.0045	.0404
furan hepta	-.1809	.3240	.2884	-.0505	.0481	.1103	.0716	-.0923	.0799	-.0818
furan octa										
percent of fat										
2nd % of fat	-.0857	-.2494	.2133	.0870	.3138	.1065	-.0853	.2342	.1977	-.2248

N of cases: 24   2-tailed Signif: * - .01 ** - .001

Table B7: Correlations between the environmental variables (for abbre-
viations see Table B1) and the PCBs compounds.

	PCBS	pp-DDE	HCB	FAT2
AGE	.4324	.2149	.2853	-.0857
OSLO1	.2701	.0096	.1837	-.2494
ITEX	-.4610	.0788	-.3098	.2133
SMH	-.1126	.1525	-.1703	.0870
OPENF	-.2526	-.1233	-.4424	.3138
COD1	-.1714	.1598	.1322	.1065
SLIM	.0767	.1150	.2344	-.0853
LOSS	-.1046	-.1583	-.0806	.2342
OBES1	.0197	-.0241	.0356	.1977
SOUTH	.2557	.0359	.0575	-.2248

N of cases: 24   2-tailed Signif: * - .01   ** - .001

NORSK INSTITUTT FOR LUFTFORSKNING (NILU)
NORWEGIAN INSTITUTE FOR AIR RESEARCH
POSTBOKS 64, N-2001 LILLESTRØM

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TITTEL Statistical analysis of PCBs, PCDDs and PCDFs in human milk in Norway	PROSJEKTLEDER J. Clench-Aas
	NILU PROSJEKT NR. O-8553
FORFATTER(E) A. Bartonova and J. Clench-Aas	TILGJENGELIGHET A
	OPPDRAGSGIVERS REF.

OPPDRAGSGIVER (NAVN OG ADRESSE)
Norges teknisk-naturvitenskapelige forskningsråd, Postboks 70 Tåsen, 0801 Oslo 8
Statens forurensningstilsyn, Postboks 8100 Dep, 0032 Oslo 1
Norsk institutt for luftforskning, Postboks 64, 1001 Lillestrøm

3 STIKKORD (à maks. 20 anslag)

Dioxins	Mother´s milk	Statistical analysis

REFERAT (maks. 300 anslag, 7 linjer)

TITLE   Polychlorinated biphenyls, dibenzo-p-dioxins and dibenzofurans in human milk: Statistical analysis of cross-sectional study in Norway. Comparison of concentrations with other published data.

ABSTRACT (max. 300 characters, 7 lines)
Cross-sectional study on concentrations of PCBs, PCDD and PDFs was performed in Norway, Sweden and Denmark (30, 41 and 11 individual samples were collected respectively). Report describes statistical analysis of the Norwegian part. A detailed comparison of chemical results from Scandinavia is given, together with graphical presentation of dioxin data reported to the WHO. Dioxin levels in Norway are found lower than in Sweden and lower than in the industrialized countries.

* Kategorier: Åpen - kan bestilles fra NILU   A
             Må bestilles gjennom oppdragsgiver   B
             Kan ikke utleveres   C