PCB congener pattern in plasma from Swedish women. A multivariate analysis.

Niklas Johansson[1,2] and Annika Hanberg[1]
[1]Institute of Environmental Medicine, Karolinska Institute, P.O. Box 210,
S-171 77 Stockholm, Sweden
[2]Swedish Environmental Protection Agency, S-106 48 Stockholm, Sweden
Anders Seldén
Dep. of Occupational and Environmental Medicine, Örebro Medical Centre Hospital,
S-701 85 Örebro, Sweden

1. Introduction

Based on elevated levels of PCB in moss samples from two communities in Örebro county in central Sweden[1)], a survey was undertaken to study the human levels of PCB in the same areas. In addition, a location showing low levels of PCB in moss was chosen as a reference. One of the locations showing elevated levels of PCB in moss was down-wind (in the predominant direction of the wind) of an incineration plant for hazardous waste (SAKAB) and the other one was near Karlskoga, a small but heavily industrialized town. Since women (or rather their foetuses and infants) constitute the main risk group for PCB exposure, 136 women of child-bearing age residing in the three areas were studied[2)].

2. Materials and methods

Blood samples were collected from the women, and the plasma was separated, frozen and stored until analysis. The PCB congeners IUPAC 28, 52, 101, 118, 138, 153 and 180 were quantified, using gas chromatography - low resolution mass spectrometry, and related to the amount of lipid. The test subjects were asked to fill in a questionnaire regarding age, weight, breast-feeding, smoking habits, profession, hobby activities, type of housing and diet.

In order to interpret a data set of this size (77 variables recorded for 136 individuals) Principal Component Analysis (PCA)[3)] and Partial Least Squares (PLS)[3)] were used. PCA is a multivariate projection method designed to extract systematic variation in a data table. The method is based upon the decomposition of the original matrix into (the product of) two smaller matrices, containing different parts of the systematic variation. PCA makes it possible to combine the variables included to a few underlying dimensions, thus summarizing the systematic information present in the data matrix.

The PLS method is suited for correlation of systematic variation in one data matrix Y (dependent variables) to systematic variation in another data matrix X (independent variables). PLS modelling consists of simultaneous projections of both X and Y spaces on low dimensional hyper planes with the purpose of predicting Y from X. The statistical analysis was performed with Simca-S 5.1 (Umetri AB, Umeå, Sweden).

3. Results and discussion

The plasma concentration of PCB (sum of seven congeners) was similar in the three groups compared (SAKAB: 342±144; Karlskoga: 374±136; reference site: 360±125 ng/g lipid), and in the further statistical analysis the groups were combined (358±135 ng/g lipid, range 64-718 ng/g lipid). The levels of PCB that were found in this study were similar to, or lower than, those reported for Swedish fishermen's wives[4].

The initial analysis of the total data matrix resulted in a complex model containing eleven significant principal components explaining some 50% of the total variation in the data matrix. It also revealed that a great number of variables only gave a minor contribution to the model, whereas a few other variables contained more or less identical information. The variables that gave an insufficient contribution to the model were excluded together with variables that proved to contain identical information. The latter were excluded in order to avoid redundant correlations.

This first reduction resulted in a model based on 30 variables. Four significant principal components were extracted. The first component was mainly based on systematic variation derived from variables such as the levels of some individual PCB congeners and a few life style factors. The second component on the other hand was mainly based on life style variables connected to occupational and hobby activities.

Further analyses were performed with PLS. The result from the final analyses is illustrated in a PLS loading plot (Fig 1). The model is based on the six most important variables from the questionnaire (total time of breast feeding, body weight, number of children, age and consumption of fish and milk fat) treated as independent variables (X block) and the PCB levels recorded in the plasma samples, treated as dependent variables (Y block). This analysis resulted in two significant PLS components that together explained 44% of the total variation in the X block and 27% of the total variation in the Y block.

From the figure it can be seen that the levels of PCBs 28, 52 and 101 were independent of all other variables. It should however be noted that these congeners were related to each other in all analyses. The levels of PCBs 118, 138, 153 and 180, on the other hand, were correlated to age, and less so (negatively) to consumption of milk fat. The latter finding might probably be explained by a possible negative relationship between age and consumption of milk fat.

From the figure, fish consumption seems to be associated with PCBs 118, 138, 153 and 180. On the other hand, as a correlation between age and fish consumption was demonstrated, it is uncertain whether the correlation between the four PCBs and fish consumption is causal or not. When age was excluded from the analysis, no significant relationships between sum of PCBs and milk fat consumption (negative) and sum of PCBs and fish consumption were identified. Thus, it is likely that the association between fish and milk fat consumption on one hand, and levels of PCBs 118, 138, 153 and 180 on the other, are principally explained by age.

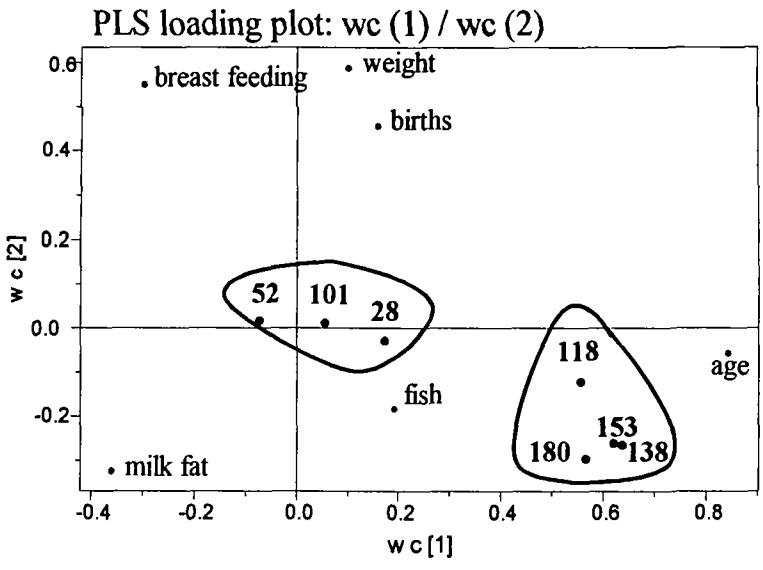

Figure 1 *Loading plot illustrating the relationships between the variables found to be the most important for explaining the variation in levels of the seven individual PCB congeners recorded. PCB congeners given as their IUPAC numbers.*

The observation that the PCBs broke down into two groups in the model, when correlated to age, could be a result of kinetic differences between the two groups. The group that showed no correlation to age could have reached a steady state, whereas the other group had not. Provided that the test subjects' exposure to the different congeners had not undergone substantial changes, this could imply that the rate of metabolism and excretion is different between the two groups in such a way that the highly chlorinated congeners studied were more difficult for the human body to metabolize and excrete compared to the lower chlorinated congeners studied.

Another interesting association that can be seen in Figure 1 is that high levels of PCBs 118, 138, 153 and 180 are negatively related to the total duration of breast feeding. When PCB was excluded from the analysis, a negative relation between age and total breast feeding period was discovered, and when age was excluded, the relation between the highly chlorinated PCBs and duration of breast feeding persisted. Based on these findings there seems to be a true association between low levels of PCBs 118, 138, 153 and 180 and long total breast feeding period.

4. Acknowledgement

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5. References

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