International Journal of Hygiene and Environmental Health 217 (2014) 765–774

Contents lists available at ScienceDirect

International Journal of Hygiene and Environmental Health

journal homepage: www.elsevier.com/locate/ijheh

Original article

Prevalence and incidence rates of mental syndromes after occupational exposure to polychlorinated biphenyls

Petra M. Gaum*, André Esser, Thomas Schettgen, Monika Gube, Thomas Kraus, Jessica Lang

Institute for Occupational Medicine, RWTH Aachen University, Germany

ARTICLE INFO

Article history:
Received 11 November 2013
Received in revised form 1 April 2014
Accepted 7 April 2014

Keywords:
Hazardous substance exposure
PCB
Mental health
Prevalence rate
Incidence rate

ABSTRACT

Mental disorders were often reported following hazardous substance exposure. The present study analyses this association in relation to a work-related exposure to PCBs (polychlorinated biphenyls). Specifically, the aim was to investigate (a) the relationship of inner PCB burden and the severity of mental symptoms and (b) the prevalence and incidence of mental syndromes. This study was initiated as part of the occupational medical surveillance program HELPcB (Health Effects in high level exposure to PCB). A total of 136 individuals were included in the analysis. The plasma PCBs were collected via biomonitoring and the psychological syndromes (i.e., somatoform, depressive, anxiety, panic) with a standardized screening instrument. The relationship of PCB and the severity of mental syndromes were analyzed via linear regression. Prevalence rates, the respective odds ratios (OR) and the incidence rates were calculated with logistic regressions. We thereby compared the higher-PCB burdened individuals with those individuals showing PCB levels comparable to the general population. We found especially a significant relationship between PCB burden and depressivity. Within the higher-PCB-exposed group prevalence rates were descriptively higher than for normal-exposed participants, except for anxiety syndrome. Similarly, the higher exposed group had a higher risk for developing a depressive syndrome. The incidence rates were always descriptively higher in higher-exposed group. To summarize, this study supports a relationship between PCB exposure and mental illness.

Introduction

In the general population there is a background burden to many hazardous substances. Whether these substances may have a negative impact on our health often depends on the dose someone is exposed to. One of the still relevant environmental (and occupational) toxins and hazardous substances are PCBs (polychlorinated biphenyls; see e.g. Fitzgerald et al., 2008; Kraus et al., 2012; Schwenk et al., 2002).

PCBs are synthetic chemicals, which do not naturally occur in the environment. There are various forms of PCBs, which are grouped according to their properties and number of chlorine atoms in lower-chlorinated biphenyls (LPCB), higher-chlorinated biphenyls (HPCB) and dioxin-like polychlorinated biphenyls (dlPCB). Hereby, dlPCBs are similar to the group of HPCBs, but distinct in the fact that they share similar properties to dioxins and furans (Baars et al., 2004). Therefore, dlPCBs are classified as a separate group. PCBs have very advantageous chemical properties such as high durability, heat resistance, or high lipid solubility. Because of these properties, they have been used in many different industrial fields (Stroh, 2006). For example, PCBs were utilized as dielectric in capacitors and transformers and as plasticizer in sealants and paints (e.g. Banerjee et al., 2007; Hopf et al., 2010; Robertson and Ludewig, 2011).

Almost everybody in the world is exposed to PCB via the food chain (Carpenter, 2006). Because of their high lipid solubility, PCBs accumulate in fatty tissues of animals; and so especially HPCB pass into the human body via food intake (Stroh, 2006). Therefore, also the general population shows a background burden with PCB (Becker et al., 2002), which we call a "normal burden". However, there is often a work-related increased exposure, because of the occupational contact with PCBs (e.g. Hopf et al., 2010; Kraus et al., 2012). Moreover, PCB can be inhaled through contaminated air or absorbed in direct skin contact (Faroon et al., 2003). Since

* Corresponding author at: Institute for Occupational Medicine, RWTH Aachen University, Pauwelsstraße 30, D-52074 Aachen, Germany. Tel.: +49 241 80 89040.
E-mail address: pgaum@ukaachen.de (P.M. Gaum).
URL: http://www.arbeitsmedizin.ukaachen.de (P.M. Gaum).

http://dx.doi.org/10.1016/j.ijheh.2014.04.001
1438-4639/

the 1980s PCBs have been banned in Germany, because of their harmful properties to human health (Schettgen et al., 2012). PCBs have been described as leading to chloracne and hyperpigmentation (Longnecker et al., 1997). In addition, Longnecker et al. (1997) report a negative influence of PCB on liver and immune system function. In 2003, the World Health Organization (Faroon et al., 2003) reported that HPCB may be a cause for liver cancer in animals and Robertson and Ludewig (2011) postulated that – in particular – LPCB congeners are carcinogenic. Moreover, in the year 2013 the IARC (International Agency for Research on Cancer) classified PCB generally as carcinogen for humans (Lauby-Secretan et al., 2013). Finally, past research has shown that PCB can also impair hormone functions (e.g., Boas et al., 2006; Persky et al., 2001). Due to the relevance of hormonal reactions for mental health (e.g. Murray, 1991), an impact of PCB on mental well-being cannot be excluded.

Based on this latter finding, not only physical health seems to be influenced by PCB, but also mental well-being may be affected. Specifically, PCB is suspected to be jointly responsible in the development of mental disorders. For example, Fitzgerald et al. (2008) compared fish eaters with non-fish eaters; people at the age of 55–74 years reported more depression if they had a higher PCB concentration in the blood serum. This result is presumably related to HPCB. Seegal et al. (2013) report a weak tendency of plasma-PCB to influence the development of anxiety. Another study found that firemen, who were exposed to PCB during firefighting operations in a transformer room, showed higher values in depression and anger, than a control group without PCB-exposure (Kilburn et al., 1989). However, Santiago-Rivera et al. (2007) did not find an association of PCB with depressivity.

To summarize, past research has shown first hints that besides physical health effects, the exposure with PCB may also impair psychological health; but results are rather inconsistent.

One reason for these inconsistent findings may be that some previous studies examined mental health according to an environmental PCB exposure and others have focused on the work-related PCB exposure. The goal of the present study was to investigate whether a work-related exposure to PCB has an influence on the occurrence of clinical relevant mental syndromes (i.e. somatoform, depressive, anxiety and panic syndrome). To achieve our aim, the present analyses are structured in three parts. First, we compare the prevalence rates of the present study sample with the prevalence rate of the general population and we took relevant confounder into account as control analyses. Thereby a better interpretation of the results is possible. Second, we analyze the association between the inner-PCB burden and the severity of mental health symptoms (i.e., amount of depressive symptoms). Finally, and third we classify the mental symptoms into DSM-IV categories of mental syndromes and compare whether participants, who have an occupationally-related higher PCB exposure also show more mental syndromes than normal burdened participants.

In the first part we conducted controlling analyses. This gave us the opportunity for a better interpretation of the results. Firstly, we compared the prevalence rates of the present sample with the prevalence rates of the German general population. If there are no differences, we are able to interpret the results within the present sample with more reliability. Secondly, we investigated relevant confounding factors regarding to the prevalence rates of mental syndromes. Epidemiologic studies about the prevalence rates of mental health reported that women, unemployed people and persons with poor physical health have a higher risk to develop an affective, somatoform and an anxiety disorder (Jacobi et al., 2004). It is necessary to take these relevant confounding variables into account.

In the second part we tested two hypotheses. Past research often deals with the linear relationship between PCB and mental health. For a better insight in the relationship between the inner PCB burden and the expression of mental symptoms we also investigate the linear relationship.

Hypothesis 1a. There is a positive association between the inner PCB burden and the severity of mental symptoms for each measurement occasion.

Hypothesis 1b. There is a positive influence of the inner PCB burden and the severity of mental symptoms over time.

In the third part, the main focus is the comparison of DSM-IV classified mental syndromes between the higher burdened and the normal burdened participants (i.e. prevalence and incidence rates).

Hypothesis 2a. Individuals with higher PCB exposure have higher prevalence rates in somatoform, depressive, anxiety and panic syndrome than normal exposed participants.

Hypothesis 2b. Higher exposed individuals have a higher risk to develop one or more of the considered mental syndromes than individuals with normal PCB exposure.

Hypothesis 2c. The higher PCB exposed group show higher incidence rates of the respective syndromes than the normal exposed persons.

Method

Sample

The present sample was derived from employees who participated in the medical surveillance program HELPcB (Health Effects in high Level exposure to PcB; for further details on the program see Kraus et al., 2012). The employees had work-related contact to PCB, as well as their relatives and people from surrounding companies. So far, 300 individuals participated in the HELPcB program at least one time. However, only 136 participants (M_{age} = 47.2; SD_{age} = 12.3) completed a psychological screening questionnaire at all three measurement occasions. Thereof, 118 participants were male (86.8%) and 18 were female (13.2%), 31 participants are unemployed (22.8%) and 103 have a job (75.7%), 3 participants have no school graduation (2.2%), 55 a low school graduation (40.4%), 48 a middle school graduation (35.3%) and finally 27 participants have a high school graduation (19.9%). From eight people the level of education respectively job status was unknown. The final sample included for analyses does not relevantly differ from the remaining program participants. The only difference is that the included sample contains more former exposed employees (86%, vs. 73.2%; Chi^2 $(1,289) = 7.201$, $p = .007$) than their relatives. Individuals had to provide informed consent prior to every investigation. The study was approved by the Ethics Committee of the Medical Faculty of the RWTH Aachen University (no. EK 176/11).

Design

We used a 3-year longitudinal within-subjects design with a one year time lag between the different measurement occasions. We used the abbreviation t1, t2 and t3 for the different measurement occasions in the text and in the tables.

Measures

PCB-exposure

To capture the individual internal PCB exposure for all participants, a human biomonitoring was carried out. Therefore, a blood sample of each participant was collected and plasma was analyzed. Before PCBs were extracted with n-hexane, the plasma was deproteinized with formic acid. Then the extracts are cleaned up on