

Serum concentrations and profiles of polychlorinated biphenyls in Taiwan Yu-cheng victims twenty years after the incident

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Total serum PCBs in the Yu-cheng adult victims twenty years after the incident were still higher than that of the general population in Taiwan.

Abstract

In 1979, about 2000 people in central Taiwan were intoxicated via rice oil consumption that was contaminated with polychlorinated biphenyls (PCBs). This “Yu-cheng” incident was one of the two known major human PCB intoxication episodes. Twenty years after the intoxication, serum samples of 435 Yu-cheng victims, 414 adults and 21 children, were collected. Sixteen PCB congeners were analyzed with a gas chromatograph-electron capture detector. We found the median concentration of total PCBs in the adult serum was 1500 ng/g lipid, still substantially higher than that of the general population in Taiwan (3.7-fold) and most seafood consumers in the world. Most of analyzed PCB congeners in children were below or around the detection limits. Congener #138, however, had the highest concentrations, approximately accounting for 55% and 29% in the child and adult groups, respectively. Given that PCBs are persistent organic pollutants and endocrine disruptors, the concentrations and congener-specific profiles regarding the Yu-cheng victims provide valuable information for the investigation of such chemicals in humans.

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1. Introduction

In 1979, about 2000 people in central Taiwan were intoxicated by consumption of rice oil that was contaminated with polychlorinated biphenyls (PCBs). A Japanese-produced PCB mixture (Kanechlor 400, 500) used as the heat-transfer medium in the manufacturing process leaked into the rice oil and resulted in significant PCB contamination (Hsu et al., 1994). This intoxication incident was called the “Yu-cheng” incident and the exposed subjects were referred to as the Yu-cheng cohort. The Yu-cheng cohort and the

Abbreviations: PCBs, polychlorinated biphenyls; POPs, persistent organic pollutants; PCDDs, polychlorinated dibenzo-*p*-dioxins; GC-ECD, gas chromatograph-electron capture detector; IUPAC, International Union of Pure and Applied Chemists; MDLs, method detection limits; TEF, toxic equivalent factor; TEQs, toxic equivalents; TCDD, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin; ICES, International Council for the Exploration of the Seas; PCDFs, polychlorinated dibenzo-furans.

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Japanese Yusho cohort in 1968 were regarded as two unique human populations who were exposed to significant amounts of PCBs and related compounds within a short period of time by direct ingestion. Because PCBs are persistent organic pollutants (POPs) as well as suspected endocrine disruptors (Tmovec et al., 2003), the complete examination of the concentrations and congener profiles in the blood of the Yu-cheng cohort could provide an important information base for the further evaluation of the toxicities, health effects, and mechanisms of PCBs and similar compounds.

As of February 1983, 2022 subjects were enrolled in the governmental Yu-cheng registry. There were similar numbers of females and males, and more than 50% of them were less than 25 years of age. This cohort was thought of as a young cohort of low socioeconomic status (Hsu et al., 1994). An annual health examination sponsored by Taiwan Government was implemented for this cohort to assess potential health effects. It was reported that skin diseases, goiter, anemia, joint/spine diseases and sperm changes occurred more frequently in this cohort than in controls (Guo et al., 1999; Hsu et al., 2003). Increased mortality from all causes and from liver disease was also observed (Hsieh et al., 1996). The female victims experienced higher frequency of menstrual bleeding and stillbirth (Yu et al., 2000). In addition, some of the follow-up epidemiological studies focused on the children born to the exposed mothers, the Yu-cheng children, since they could be exposed to PCBs via breast-feeding or transplacental transfer. Delayed development, lower verbal intelligence quotient, musculoskeletal changes, sperm changes and higher prevalence of growth abnormalities, middle-ear disease, and dental defects of the Yu-cheng children were reported (Chao et al., 1997; Chen et al., 1992; Guo et al., 1994, 1995a,b, 2000; Wang et al., 2003).

It is certainly hoped that this kind of tragedy will not occur again; nevertheless, the omni-presence and persistence of the PCBs and similar compounds in the environment and the intake of the general population of various foodstuffs which might have been contaminated via food chains or other routes (e.g. Belgium food contamination incidence, Van Larebeke et al., 2001) make human beings liable to be exposed to these pollutants. At what exposure levels significant health effects will occur becomes an inevitable concern. The detailed description of this acute intoxication cohort not only provides a better understanding of this cohort, but also enhances our understanding of related POPs and endocrine disruptors. Moreover, specific congeners may be responsible for some specific health outcomes other than those synergic effects exerted by similarly structured pollutants such as polychlorinated dibenzo-*p*-dioxins (PCDDs) (Guo et al., 1996). However, very limited epidemiological studies have been elucidated with regard to the specific congeners. Thus, congener-

specific analysis of the PCB levels in serum of the Yu-cheng adults and children can provide important information filling the knowledge gaps between dose levels of specific congeners and health outcomes.

One year after the incident, PCBs, which ranged from 3 to 1156 ppb in the blood samples, were analyzed as mixtures (Chen et al., 1984; Ko et al., 1981). Later, congener-specific analysis was implemented; however, only levels of total PCBs or 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD)-like congeners such as coplanar PCBs were reported (Chao et al., 1997; Ryan et al., 1994; Wang et al., 2003), except for one study analyzing congeners for 56 Yu-cheng women (Guo et al., 1997). The current work reports PCB congeners in serum samples of 435 Yu-cheng male and female subjects, including both adults and children. The results are by far the most comprehensive PCB congener-specific data in the specimens obtained from the Yu-cheng victims. PCB concentrations and profiles are compared with other studied populations. The relative abundance of the congeners in the serum samples compared to the estimated percentage in the original rice oil contamination is also discussed.

2. Materials and methods

Serum samples were collected from 451 subjects in 1999, 20 years after the incident; subjects were from the Yu-cheng registry including both Yu-cheng adults and children. Sixteen subjects were excluded due to the incomplete information on their age or sex. Since the intoxication incident occurred in 1979, subjects with age younger than or equal to 21 years old presumably were not intoxicated directly from rice oil ingestion, but rather through breast-feeding or transplacental transfer via mothers. Thus, based on their different exposure routes, subjects were divided into two groups, children (up to 21 years) and adults (older than 21 years). The characteristics of these two groups are in Table 1. There were 21 and 414 subjects in the child and adult groups, respectively, with mean ages of 16.3 and 48.6. Table 1 also lists the serum triglycerides and cholesterol levels which were measured by the standard procedure during periodical health examination.

Table 1
Basic information regarding the PCB intoxication subjects in the study

	Children	Adults
Number of subjects	21	414
Male	7	180
Female	14	234
Age (years old)	16.3 ± 4.0	48.6 ± 15.5
Serum (mg/dl)		
Triglycerides	87 ± 42	130 ± 95
Cholesterol	150 ± 21	181 ± 38

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