DIOXIN LEVELS IN HUMAN SPECIMENS FROM TAIZHOU, AN ELECTRONIC-WASTE RECYCLING SITE IN EASTERN CHINA

Chan JKY[1], Xu Y[2], Liang Y[3], Chen LX[4], Wu SC[1], CKC Wong[1], Leung CKM[5], and Wong MH[1*]

[1]Croucher Institute for Environmental Sciences, and Department of Biology, Hong Kong Baptist University, G/F, Block 5, Low-Rise Buildings, 32 Renfrew Road, Kowloon Tong, Hong Kong SAR, PR China; [2]State Key Laboratory of Freshwater Ecology and Biotechnology, Institute of Hydrobiology, Chinese Academy of Sciences, 430072, Wuhan, Hubei Province, PR China; [3]Luqiao Hospital of Traditional Chinese Medicine, 318050, Taizhou Region, Zhejiang Province, PR China; [4]Centre for Disease Control and Prevention of Luqiao District, 318050, Taizhou Region, Zhejiang Province, PR China; [5]*In Vitro* Fertilization Centre, Rm 1701, Prudential Centre, 238 Nathan Road, Jordan, Hong Kong SAR, PR China

*Corresponding author: mhwong@hkbu.edu.hk

Abstract

Human milk samples were collected from an e-waste recycling site (Taizhou, Zhejiang Province) and a reference site (Lin'an city, Zhejiang Province) in China to determine dioxin body burden. The level of dioxin in samples collected from the former site (21.02 ± 13.81 pg WHO-TEQ/g lipid) was 2.5 times higher than those from the latter (9.35 ± 7.39 pg WHO-TEQ/g lipid) and was considered higher when compared with the results of the WHO 3rd Exposure Study on Human Milk Dioxins. The difference between the two studied sites was due to uncontrolled e-waste recycling operations which led to elevated background levels. Moreover, mothers from the e-waste recycling site consumed more foods of animal origin. Our results implicated that uncontrolled e-waste recycling operations led to high levels of dioxins in both environments and humans.

Introduction

Obsolete electronic waste (e-waste) has become a serious problem. The average lifespan of computers in developed countries has dropped from six years in 1997 to two years in 2005[1]. According to the State Environmental Protection Administration of China, 70 % of the worldwide e-waste have been sent to China[2]. Moreover, in China alone, 4 million PCs are discarded annually[3]. The "recycling" is done by primitive methods, which include burning piles of wire to recover metals, melting circuit boards over coal grills to release valuable chips, cooking computer casing to remove combustible plastics and isolate metals, and extracting metals in acid baths[4, 5]. These processes expose workers and local residents to toxic chemicals, and can lead to environmental contamination.

In this paper, we report dioxin levels in human milk from Taizhou region, Zhejiang Province, an intensive e-waste processing site, and from Lin'an city, a control site, in China. The e-waste recycling activities in Taizhou began in the late 70's. Forty thousand people are now working in the e-waste recycling sector.

Materials and Methods

Study population and sample collection

Human milk samples were collected from 5 women who gave birth in 2005 at each of the 2 studied sites. Before the collection of specimens, the donors completed an informed consent. Approximately 100 ml of milk was collected from each donor. The sample was manually expressed and sampled in hexane-rinsed reagent bottles with Teflon-lined caps. The samples were frozen immediately after collection and stored at -20 °C until chemical analyses.

Data collection

Socio-demographic data and food consumption habits of the study population were obtained from face-to-face interviews and semi-quantitative food intake questionnaires, respectively. The response rate was 100%.

Laboratory analysis
Samples were Soxhlet-extracted based on U.S. EPA Method 3540C[6]. Subsequently, a clean-up was carried out according to U.S. EPA Method 3630C[7], Method 3610[8], and Method 3620B[9]. The concentrated samples were analysed by HRGC/HRMS according to Method 1613B[10].

Data analysis
The Statistical Package for Social Sciences (SPSS of Windows, version 11.0; SPSS Inc., Chicago, IL, USA) was used for the quantitative data analysis. The differences among groups were assessed by the Student's t-test or by analysis of variance (ANOVA). The significant level was $p < 0.05$ and two-tailed.

Results and Discussions
The level of dioxins in samples collected from the e-waste recycling site (21.02 ± 13.81 pg WHO-TEQ/g lipid) was 2.5 times higher than those from the control site (9.35 ± 7.39 pg WHO-TEQ/g lipid). Such difference was due to the uncontrolled e-waste recycling operations, such as open burning, which led to relatively high background contamination levels at the e-waste processing site. Moreover, relatively high levels of dioxins were found in human hair and ash samples collected from an e-waste recycling site (Guiyu town, Guangdong Province) (21.0 & 5858.33 pg WHO-TEQ/g, respectively). This further supported that the e-waste processing activities release significant amounts of dioxins[11]. Furthermore, mothers from the e-waste recycling site generally consumed more foods of animal origin which are considered to be the major dietary sources of dioxins[12]. Therefore, the higher intakes of this food class together with higher background levels resulted in greater body loadings in the mothers from Taizhou.

All samples from the e-waste recycling site and 80 % of the samples from the control site exceeded EU's maximum permitted level in milk (3 pg WHO-TEQ/g lipid). The concentrations of the former was high while the latter was moderate when compared with the countries involving in the WHO 3rd Exposure Study on Human Milk Dioxins[13]. For example, the concentrations in human milk from Taizhou would be ranked number 2 after Egypt whereas Lin'an city showed concentrations similar to Ireland and Norway. Moreover, human milk from the e-waste recycling site showed the highest concentrations among the samples collected from other parts of China during 2000 to 2005[13-17].

Although this study is not completed, the results indicated that e-waste processing operations led to high levels of dioxins in both the environment and in humans. The body burdens of dioxins in the local people were at the top of the list of international comparison. The elevated body burden may impose health implications for the next generation. Work should be done on reducing the negative impacts caused by the e-waste recycling activities to the environments and humans. Moreover, further investigations on epidemiological study on the health impacts by e-waste recycling operations should be carried out.

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