Brominated and Chlorinated Organic Contaminants in Human Serum from obese adolescents undergoing weight loss treatment

Govindan Malarvannan[1], Kim Van Hoorenbeeck[2], Ann Deguchtenaere[3], Stijn L Verhulst[2], Philippe G Jorens[4], Eveline Dirinck[5], Luc Van Gaal[5], Adrian Covaci[1]

[1]Toxicological Centre, University of Antwerp, Universiteitsplein 1, Wilrijk, Belgium
[2]Department of Pediatrics, Antwerp University Hospital and University of Antwerp, Edegem, Belgium
[3]Zeepreventorium, De Haan, Belgium
[4]Department of Clinical Pharmacology, Antwerp University Hospital and University of Antwerp, Edegem, Belgium
[5]Departments of Endocrinology, Diabetology and Metabolism, Antwerp University Hospital and University of Antwerp, Edegem, Belgium

Introduction

As the prevalence of obesity in humans is increasing[1], obesity is rapidly becoming a public health problem despite food shortages in many parts of the world. In 2010, the World Health Organization estimated that >700 million people worldwide have obesity and ~2 billion people are overweight[2]. The prevalence of childhood obesity is also increasing and is a strong risk factor for adult obesity[3]. Furthermore, an overwhelming majority of individuals with obesity have multiple comorbidities that result in poor health[2].

Over the last decades, obesity rates have been rising among European children[4]. For school-age children, a first analysis, based on 2007–2008 data from 13 EU countries, finds that 24% of European children aged 6 to 9 are overweight[5]. For adolescents, 14 EU countries had trend data available, though some were based on self-reported measures with small samples[4].

Recent evidence has shown that a variety of environmental endocrine disrupting chemicals (EDCs) can influence adipogenesis and obesity[6]. Due to their persistency, the elimination of persistent organic pollutants (POPs) is a slow process and therefore their kinetics in obese adolescents is possibly different from their lean or adult obese counterparts. The main aim of this study was to obtain an overview of occurrence and levels of POPs in Belgian obese adolescents and to evaluate the dynamics of various POPs in the serum of obese individuals during weight loss treatment.

Materials and Methods

Sample collection

This study was approved by the Ethical Committee of the Antwerp University Hospital and all participants provided their written informed consent. Ninety four (*n*=94) adolescents were prospectively recruited when visiting the Zeepreventorium (ZEEP) between 2010 and 2011. Serum samples were taken before weight loss (*0M*) and after five months (*5M*) from 94 obese adolescents (mixed gender (34 male and 60 female): age range 11-19 years). Participant's age, gender, total lipids and their demographic characteristics were recorded.

Chemical analysis

Analyses of POPs, including flame retardants, in serum samples were performed according to the method described elsewhere[7], with slight modifications. Serum samples (typically 3.0 mL) were analyzed for polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), and organochlorinated pesticides (OCPs). Solid-phase extraction (SPE) on OASIS HLB cartridges was used followed by fractionation on acidified silica (44% H_2SO_4, w/w) and elution with hexane:

dichloromethane (1:1). After, concentration, the extract was re-dissolved in iso-octane. Quantification of PBDEs, PCBs and OCPs were further analyzed by gas chromatography coupled to mass spectrometry operated either in electron capture negative chemical ionization (GC-ECNI-MS) or electron ionization (GC-EI-MS) depending on the analytes' sensitivity. The analytical procedures were validated through the analysis of procedural blanks, sample replicates, by random injection of standards, spiked samples and solvent blanks. The quality control scheme was also assessed through regular participation to inter-laboratory comparison exercises (POPs in serum) organized three times per year by AMAP[8]. Outliers and concentrations below the limit of quantification (LOQ) were assigned a value of DF $\times$ LOQ. The concentrations of PBDEs, PCBs and OCPs are expressed in ng/g lw, unless otherwise specified.

Results and Discussion

POPs were detected in variable quantities in all serum samples in the order of DDTs > PCBs > HCB > HCHs > CHLs > PBDEs. No significant differences in the concentration of POPs between males and females at initiation and during the weight loss treatment. The most important PBDE congeners were BDE 47 (*0M/5M*; median: 0.43/0.50 ng/g lw), 100 (*0M/5M*; median: 0.066/0.066 ng/g lw) and 153 (*0M/5M*; median: 0.0085/0.24 ng/g lw), although total PBDE levels were relatively low (*0M/5M*; median: 0.63/0.88 ng/g lw). Only for these congeners, detection frequencies (DFs) higher than 50% were found. Although slightly increasing trends were evidenced for the total PBDE levels, no statistically significant difference was observed during weight loss. DDTs (*0M/5M*; median: 31/42 ng/g lw) and PCBs (*0M/5M*; median: 17/28 ng/g lw) were the major compounds in all serum samples. Differences in concentrations of DDTs and PCBs are probably due to the differences in contaminant's load of the food items or to the possible present (secondary) sources of exposure. The main contributor (94%) to the total DDT levels was *p,p*'-DDE for all serum samples. PCB 153 was the most dominant congener, followed by PCB 138, PCB 180 and PCB 118. Overall, this data suggest that the serum levels of POPs is decreasing over time (when comparing previous Belgian obese adolescents[9,10] and obese adults[11, 7] studies), but markedly increase during weight loss.

After following the weight loss program, increasing serum levels of POPs (except PBDEs) were statistically significant over time combined with a decrease in the body weight. Due to the weight loss, the lipid soluble contaminants were released from adipose tissue into the blood leading to their redistribution into the body. The increase in the POPs levels during weight loss did not affect the profile, which remained similar over time. However, the PBDE profile was slightly different with a higher contribution of BDE 153 (from 3% in 0M to 26 % in 5M).

The results of the present study indicate that the increase in the levels of POPs released in blood during weight loss might be of concern since literature suggested that they can be associated with endocrine disturbances, such as a decrease in thyroxine levels. Beneficial health effects of weight loss are generally expected, however, the increase in the internal exposure may adversely act on health since metabolism and/or elimination of POPs may be altered.

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