

Chapter 12

Association between Urinary Bisphenol A Concentration and Obesity Prevalence in Children and Adolescents: Bisphenol A and Its Effects on Humans

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ABSTRACT

Bisphenol A is an organic compound that serves as a building block of polycarbonate plastics and epoxy resins. Being the world's highest-volume chemicals in use today in the form of medical devices, water and infant bottles, food cans, kitchen utensils, water supply pipes, compact devices, etc., this compound—after gaining an access to the body of an individual by way of leaching into food and water supplies—acts as an obesogen and disrupts the body weight regulation by either promoting adipogenesis or triggering the differentiation of fibroblasts into adipocytes. The other adverse effects of bisphenol A include insulin resistance, adipocyte differentiation or aromatase-mediated transformation of androgen into estrogen, cardiovascular diseases, liver function abnormalities, alterations in the circulating thyroid hormone levels, association with diabetes and carcinogenic effect. Its other aspects on health individually as well as in combination with other chemicals are worth mentioning.

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INTRODUCTION

The plastic monomer bisphenol A is one of the highest volume chemicals produced worldwide, with over 6 billion pounds produced each year and over 100 tons released into the atmosphere by yearly production. Humans are widely exposed to bisphenol A and animal studies have linked bisphenol A to obesity (Golub, *et al.*, 2010; Newbold, 2010; Rubin, 2011). Emerging evidence linking the worldwide obesity epidemic to increased exposures to environmental endocrine disruptors, collectively called “environmental obesogens” (Heindel, 2003; Wang and Lobstein, 2006; Newbold, 2008; Heindel and Vom, 2009), one such important potential obesogen is bisphenol A. Although it was first recognized in the 1930’s as a potential synthetic estrogen (Dodds and Lawson, 1938), bisphenol A is contained in a variety of consumer products from baby bottles, plastic containers, and the resin lining of cans for food and beverages, to dental sealants (National Toxicology Program USDOHAHS, 2008). Bisphenol A was detected in about 93%–100% of children and adolescents in Northern America, some European nations, Egypt, Australia, and Asian countries (Dodds and Lawson, 1938; Newbold, 2007; National Toxicology Program USDOHAHS, 2008; Heindel and Vom, 2009; Golub *et al.*, 2010; Newbold, 2010; Rubin, 2011). In Thailand Bisphenol A was detected in 52.8% of adults in serum samples (Calafat *et al.*, 2008).

In recent decades, both developing countries such as China as well as developed countries have witnessed an alarming increase in the prevalence of obesity (Chen, 2008; *et al.*, 2008; Shan *et al.*, 2010). The most troubling aspect of this increase is the acceleration in the prevalence of obesity and overweight among children. The prevalence of obesity in U.S. children is close to 20% (Barlow, 2007; Kosti and Panagiotakos, 2006; Wang and Lobstein, 2006). This is especially alarming given the well-known consequences of overweight and obesity which include type 2 diabetes, hyperinsulinemia, insulin resistance, coronary heart disease, hypertension, stroke, and liver and kidney diseases among many other adverse health effects. Bisphenol A could both accelerate girls’ pubertal development and weight gain during this period. The acceleration of growth by Bisphenol A may impact both weight and height, leading to a slightly weaker bisphenol A effect on Body Mass Index measurement. It has been hypothesized that human exposure to Bisphenol A in the early stage of development could also lead to the onset of obesity and other metabolic syndrome (Rubin *et al.*, 2001; Somm *et al.*, 2009).

Research studies have reported an association between urine bisphenol A level and obesity in human populations (Carwile and Michels, 2011; Wang *et al.*, 2012). Urine is an appropriate specimen with which to determine BISPENOL A exposure because BISPENOL A and its metabolites are present in urine for several weeks or months (Volkel *et al.*, 2002; Stahlhut *et al.*, 2009). Bisphenol A is rapidly eliminated from plasma within 24 hours after ingestion (Stahlhut *et al.*, 2009). Urinary bisphenol A levels are reported to be associated with food in plastic containers (Nahar *et al.*, 2012), bottled milk feeding (Rhie *et al.*, 2014), and eating canned food (Casas *et al.*, 2013). One study reported an association between urine bisphenol A level and metabolic diseases including diabetes (Lang *et al.*, 2008). In a recent study, an association between urine bisphenol A and obesity among children and adolescents has been reported (Trasande *et al.*, 2012) using U.S. National Health and Nutrition Examination Survey (NHANES) data. In a U.S. representative sample, bisphenol A was detected in more than 92% of urine samples including those from children (Heffeman *et al.*, 2013; Calafat *et al.*, 2008) and in populations of many other countries (Kim *et al.*, 2003; Matsumoto *et al.*, 2003; Silva *et al.*, 2004; Miyamoto and Kotake, 2006; Li *et al.*, 2011). One of the troubling aspects of bisphenol A exposure is that younger

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