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Mini Review

Phthalate Plasticizers and Safety of Toys - Problems and Perspectives

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Abstract

A number of reports published worldwide create awareness on the harms of global usage of phthalates in various products. The concern towards potential exposure of consumers to phthalates through many sources and different routes of administration is increasing day by day. Evidences of phthalates in toys and phthalate metabolites in the urine of children are becoming common. Children under 3 years are more sensitive as compared to general population towards this problem due to their additional intake of plasticizers by chewing toys. Phthalates are found to cause allergy, asthma and affecting kidney, liver and endocrine system, especially at a young age. As phthalates bear the property to soften the hard plastic material, soft toys possess their higher content in comparison to hard toys. Their usage is restricted in EU, United States and Canada and several other countries mainly in toys suspected to be kept in mouth. Phthalates basically included in the banned for toys category are DEHP, DBP, BBP, DNOP, DIDP and DINP. Usage of less than 0.1% phthalates has been allowed for plastic toys and directives are given to producers to label the age of children who may use the toys and specify its hazards. Parents are suggested to control these labels before buying the phthalate plasticizers based products.

Keywords phtalates, plasticizers, toys

Introduction

Phthalates are large class of chemicals produced by humans in large quantities for various applications.These are added to plasticsfor imparting flexibility and durability and are often marked as plasticizers.Many products contain phthalates like adhesives; plastics in the car industry; detergents; lubricants; some medical devices and medicines; plastic raincoats; solvents; vinyl flooring and personal care products such as soaps, shampoos, deodorants, lotions, flavors, hair sprays and nail polishes.Phthalates are mostly used as additives in PVC plastics (plastic bags, garden hoses, inflatable recreational toys, bags for storage of blood products, intravenous medical tubing, toys and baby care articles). Potential usage of several phthalates in toys, child care articles or cosmetics is the subject of separate risk assessments for human health.

Absorption, distribution, metabolism and toxicity

As phthalates are linked to the polymers in products by weak bonds not covalent bonds, hence are easily exposed to the consumers in several ways including ingestion, inhalation and dermal absorption. They even may enter directly into the bloodstream of patients during medical treatment using plastic equipment. Since these are widely used in everyday life as many products of polyvinyl chloride, paint-varnish coatings, cosmetics and detergents, therefore may be released often in house dust and indoor air (Rudelet al, 2001). Phthalates can be released into the surroundings through exploitation or dumping of the product. They are everywhere as contaminants in food, indoor air, soil and sediments. Although, biologically accumulated in invertebrates, fish and plants, these are not biomagnified in higher organisms due to their efficient metabolism and elimination from the body (Department of Health and Human Services; 2000). The major sources for phthalates production are phthalate anhydride, and phthalate esters.

To date, although, no comprehensive and final toxicological evaluation has been done; however, phthalates are suspected of causing health problems. Phthalates are found to possess low acute toxicity (LD50 1-30 g/kg); however sub-chronic and chronic toxic effects of phthalates and their metabolites are significant. Teratogenic, carcinogenic and endocrine symptoms are required

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to be concentrated in toxicological evaluation. Few such studies have shown promising results in animals and directed towards the possible consequence of phthalates in human health. It is complex to make a common estimation of the dose-response for phthalates because of numerous sources of exposure and routes of management into the organisms. Conclusions from animal based experiments are the main source of our contemporary knowledge regarding the effects of contact to a pariculat phthalate on human body. Phthalates are known to have harmful affects beyond a definite level that are known as critical toxic effects. In 2014, Bagdassarian et al focussed in detail the toxic effects of phthalate esters. Absorption and distribution of phthalates have been studied broadly in humans and laboratory animals (Bagdassarian et al, 2014).

Absorption of phthalates in body, quick hydrolyzation to monoesters and their release through excreta avoid their bioaccumulation in the body. Age and health situation of the body are the major factors affecting the capacity of the body to metabolize phthalates (Koop and Juberg, 1999). In all considered organisms, metabolism is speedy and removal takes place within hours, with the full exclusion within one - two days (Koch and Calafat, 2009; Bagdassarian et al., 2014). Cleavage of diesters to monoesters in gastrointestinal tract is basically liable for the hazardous effects. Monoesters are degraded to orthophosphate subjected to oxidative metabolism prior to removal. Removed metabolites are both in independent and joint form with glucuronic acid (Seckin et al., 2009). On one hand, where Dialkyl phthalates, DEHP and DINP are removed in excretion, other side -DAP-metabolites were detected in biological fluids like urine, bile, faeces, blood, milk and saliva. Oxidative metabolites with higher molecular weight are most general metabolites of phthalates and hence preferred as biomarkers for DINP and DEHP. Cleavage of phthalates to primary and subsequently to secondary metabolites is considered as the basic metabolic reaction (Koch et al., 2005a, 2005b; Yao, 2008; Bagdassarian, 2014). In a report, it has been declared that per day approximately 4.30 µg DEHP/kg is anticipated towards human exposure; however several population groups are facing more disclosure due to the continuous usage of plasticized medical equipments (European Commission, 2007). DEHP exposure has damaging effects on different organ systems including liver, reproductive system in both males and females, circulatory system, respiratory as well as excretory systems and even to the developing embryo.

Phthalates are observed to be lethal even in the prenatal period. It is affecting fertility, pregnancy capacity, disturbed and decreased weight reproductive organs, performance of the germ cells and stem cells (Foster et al., 2000; Kavlock et al, 2002; Swan et al., 2005; Doyle et al., 2013). Kim et al., 2011 suggested that prenatal exposure to phthalate is expected to be inversely related to the Mental and Psychomotor Developmental Indices of infants, particularly males, at 6 months. As per the animal system based research, due to their effects on the male reproductive system, phthalates have been recognized as EDP (endocrine disrupting chemicals) (Foster et al., 2000). Array of impacts identified in males is known as “phthalate syndrome” including infertility, decreased sperm counts, cryptorchidism, hypospadias and other malformations of the reproductive organs. In 2000, National Toxicology Program (NTP) has been initiated to assess the existing experimental facts on the effects of phthalates from the surroundings on reproduction and determining the level of human exposure. It was concluded that there are concerns and serious concerns relating to the potential exposures of most common phthalate DEPH in healthy babies and sick newborns respectively due to their potential migration through medical devices (Kavlock et al., 2002). DEHP is defined as endocrine disrupter in humans, which causes a reduction in motility of spermatozoa and the chromatin damage, induces disorders in the fetus and the germ cells, disrupting the development of the Leydig cells of and the testosterone levels, reduced the anogenital distance (AGD) and has potential to change the development of the androgen-sensitive part of the brain in humans (Swan et al., 2005; Monfort et al., 2010). A study in young girls indicates possible correlation between the early development of breast cancer and early exposure of phthalates (Colon et al., 2000). Study in women associated shortening of pregnancy and exposure to phthalates (Latini et al, 2003). The average gestational age at childbirth was significantly shorter in 65 infants having detectable levels of the main phthalate metabolite - MEHP in serum brain in comparison to 19 infants with negative MEHP content in serum (Latini et al,

2003). In 2005, same working group discussed research and again it was accepted that there is not enough evidence of a relation between exposure to phthalates during pregnancy, in childhood or in adulthood and the negative effects on the human health (Kavlock et al., 2006). In 2005, Swan et al., reported for relationship between phthalates and reduced anogenital distance in baby boys. Mendiola et al., 2011 determined the association of phthalates exposure with reduced sperm in young men. Swan et al., 2005 reported that the babies of mothers exposed to high levels of four phthalate metabolites - MI, MBzP, MEP and MiBP, have lower anogenital index and is more likely to have small genitals and partially no descended testes (Swan et al., 2005). However, statistically significant correlation between the levels of DEHP metabolites and anogenital distance could not be determined.

Conclusions

Several active programs and research reports worldwide are emphasizing on the common usage of phthalates directing towards its harmful effects. Day to day, types and resources of their exposure to human body is amplifying. Children are found to be more prone to these due to their use in manufacturing toys. Hence, to save our present and future generation from their harmful effects is a prerequisite. Although, their overexploitation is banned worldwide, still vigilance is required to control their usage.

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