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PHTHALATES

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What are Phthalates?

Phthalates are a group of man-made chemicals often added to plastics and vinyls to make them more flexible, soft, and durable. They are used in a wide variety of consumer products.¹ Because they are not tightly bound, phthalates can be released into the environment² when the product is exposed to everyday stresses such as sunlight, microwave radiation, or moist heat such as boiling or dishwashing.³ Phthalates can be classified by their molecular weight. High molecular weight (HMW) phthalates are used as plasticizers in vinyl products such as flooring, wall coverings, food containers, and medical devices. Low molecular weight (LMW) phthalates are used in personal care products, lacquers, varnishes and other coatings, including coatings on time-release pharmaceuticals. Phthalates have short biologic half-lives and are quickly excreted from the body, yet they are so ubiquitous that there is virtually constant exposure.

Some Common Phthalates

Low Molecular Weight (LMW)

butyl benzyl phthalate	BBP	Vinyl flooring, adhesives, sealants, industrial solvent ⁴
dibutyl phthalate	DBP	Adhesives, caulk, cosmetics, industrial solvent, medications, carpet backings, paints, lacquers, varnishes, glue, insect repellents, hair spray, nail polish and rocket fuel ⁴
diethyl phthalate	DEP	Shampoo, scents, soap, lotion, cosmetics, industrial solvent, medications, ⁴ toothbrushes, automobile parts, tools, toys and food packaging ⁵

High Molecular Weight (HMW)

(di-2-ethylhexyl) phthalate	DEHP	Soft plastic, including tubing, toys, home products, food containers, food packaging, ⁴ wall coverings, tablecloths, floor tiles, furniture upholstery, shower curtains, garden hoses, swimming pool liners, rainwear, baby pants, dolls shoes, automobile upholstery, sheathing for wire and cable, medical tubing and blood storage bags ⁶
di-isodecyl phthalate	DiDP	Flooring, cladding and roofing, cables and wires, film and sheet, automotive, tubes & hoses, coated fabrics, inks and waxes ⁷
di-isononyl phthalate	DiNP	Automotive, building and construction, cables and wires, floors ⁷
di-n-octyl phthalate	DnOP	Cosmetics, pesticides, medical tubing, blood storage bags, wire and cables, carpetback coating, floor tile and adhesives ⁸

How Are We Exposed to Phthalates?

We are exposed to a variety of phthalates through the products we use and come in contact with every day. Specifically, they can be ingested, inhaled, or dermally-absorbed. Ingesting phthalates can occur through the leaching of these chemicals into our food and water from packaging materials and they can be found in meats, fats, dairy products and processed foods.⁹ Phthalates in cosmetics, colognes, personal care and



cleaning products can be inhaled or absorbed through the skin. Children can be exposed to phthalates when they chew on vinyl objects. Medical tubing and containers may expose patients, especially infants being treated in neonatal intensive care units and those receiving dialysis or blood transfusions.¹

In the built environment, exposure pathways for phthalates include inhalation of dust and other particles, dermal absorption, and ingestion of dust.¹⁰ PVC building materials, furniture, and products that contain fragrances all contribute to indoor air phthalate levels. In the air, phthalates can be absorbed through the skin directly, or can adhere to dust particles that settle on the skin.¹¹ Higher temperatures increase emission rates,¹² and the release of phthalates to indoor air from PVC wall and floor coverings may increase, if the space is new or damp. Concentrations of phthalates in indoor air can be 10 times higher than outdoors.

The exposure levels of young children exceed those of adults due to the fact that children breathe in more air per body weight compared to adults. Children also ingest more dust,¹³ which may be partly due to more skin contact with surfaces and frequently placing fingers, toys, and other objects into their mouths.^{11,14}

Why Are Phthalates a Health Concern?

Research shows that phthalates are endocrine disrupting chemicals, meaning they can disturb the normal functioning of the body's hormonal systems. As such, these chemicals have been found to be associated with a number of adverse health outcomes, including, but not limited to: asthma and allergies, male and female reproductive health, cardiometabolic health, and neurological and behavioral conditions. The EPA has determined that DEHP, one of the most studied phthalate parent compounds, is a probable human carcinogen.^{15,16} More research is being done on other phthalate parent compounds, but evidence of adverse effects of several other compounds has emerged.

Asthma and Allergies

Epidemiologic studies show associations between phthalate exposures from indoor air and allergic sensitization among children with asthma, rhino conjunctivitis or atopic dermatitis.^{17,18} Benzyl butyl phthalate (BBzP) in house dust has been associated with rhinitis and eczema, and DEHP in dust has been associated with asthma in adults.¹⁹ Prenatal exposure to high molecular weight phthalates may also increase the risk of asthma and upper respiratory tract infections in childhood.^{20,21}

Reproductive Health

Puberty. In utero phthalate exposure (DEHP, DEP, DnBP) may impact hormone concentrations, and therefore affect the timing of sexual maturation - in girls typically leading to early maturation.^{22,30} Several studies have also reported links between DEHP and disruption of thyroid function,³¹⁻³³ which can have a wide range of effects at puberty and other stages of development.

Male reproductive health. There is evidence that phthalates disrupt male reproductive systems in early development and continue through infancy, childhood, puberty and adulthood.^{22,24} In utero exposure to higher phthalate levels (DEHP) has been associated with markers of feminization among boys.²³ The metabolites of some phthalates affect sperm quality, reducing sperm concentration and count (MBzP), and decreasing motility (MBP, MEHP).^{24,25}

Female reproductive health and pregnancy. Higher phthalate exposure (DEHP) may put women at risk of infertility-related outcomes including decreased ovarian reserve, fertility rate and live births,²⁶ and increased miscarriage rates.²⁷ Higher phthalate metabolite concentrations are associated with a number of unfavorable pregnancy outcomes including the risk of preterm birth and low birth weight.^{22,26,28} In addition studies have found associations between phthalates (MEP) and excessive weight gain during pregnancy and impaired glucose tolerance, both risk factors of gestational diabetes.²⁹ The parent compound of this particular phthalate metabolite is commonly found in personal care products such as fragrances and cosmetics. In addition, phthalates are also associated with preeclampsia, another common pregnancy complication, and higher risk for fibroids.²⁷

Cardiometabolic Outcomes

A number of studies have found associations between urinary phthalate metabolites and cardiometabolic outcomes. For example, MBP, MBzP, MCP, and DEHP metabolites are associated with obesity and



diabetes in cross-sectional studies. Furthermore, these same chemicals are associated with metabolic syndrome, a strong risk factor for cardiovascular disease.^{34,35} Phthalates are thought to be metabolic disruptors and likely operate through their ability to bind to nuclear receptors thought to affect fat cell development. Interestingly, sex differences exist for many of these cardiometabolic associations.

Neurobehavioral Effects

Prenatal phthalate exposure has been associated with a variety of cognitive and behavioral impairments in children. These include lowered IQ (DBP),³⁶ attention deficit, hyperactivity, and poor social communication.³⁷ Other adverse outcomes include abnormal reflexes,³⁸ higher levels of both internalizing and externalizing behaviors (DnBP), impaired social behaviors,^{39,40} executive function deficits, poor vocabulary test performance³⁷ and alterations in play behavior (DEHP, DnBP, DiBP).⁴¹ Boys may be at somewhat higher risk for these outcomes than girls.⁴²

Regulations

The US Food and Drug Administration (FDA) monitors, but does not regulate, phthalates in cosmetics and personal products. It does, however, require ingredient declaration on retail cosmetic products, but regulations do not require listing of fragrance ingredients, and the law does not apply to products used exclusively by professionals (e.g. in salons).⁴³ The FDA has recently agreed to review thirty ortho-phthalates used in food packaging and handling equipment.⁴³ The U.S. Environmental Protection Agency (EPA) may regulate phthalates that meet certain preference requirements under the Frank R. Lautenberg Chemical Safety for the 21st Century Act ("Lautenberg Act"), formerly known as the Toxic Substances Control Act (TSCA). The US Consumer Product Safety Commission banned (2008) six phthalates from use in children's toys and specific child-care articles. The ban on DEHP, DBP, and BBzP-containing toys is permanent, while the ban on DINP, DIDP and DNOP-containing toys is temporary.⁴⁴ Because of health concerns surrounding phthalates, different plasticizers are being substituted, but even less is known about the health effects of these newer products.



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