



Bisphenol A (BPA)

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Concern regarding the industrial chemical bisphenol A (BPA) and its potential effects has grown significantly over the last two decades. BPA is one of many chemicals identified as an endocrine-disrupting chemical (EDC), which is understood in the chemical and clinical communities as a chemical or mix of chemicals that can affect hormone action.^{1,2} Controversy regarding safe exposure levels makes BPA one of the most widely studied EDCs, and a large number of studies are examining its effects on animals and humans.²

Industrial use and consumer exposure

BPA is used in the manufacturing of polyvinyl chloride, polycarbonate plastics and epoxy resins.^{2,3} Lightweight, inexpensive and resistant to heat and impact, it is one of the most produced and used chemicals in the world.⁴ When BPA's ability to be polymerized into plastics was discovered in the 1950s its use rapidly increased worldwide.⁴

Today, BPA is found in a large variety of products including the lining of cans, plastic bottles and containers, housewares and appliances, eyeglasses and contact lenses, dental fillings, toys, infant incubators, hair dryers, cell phones, compact discs, consumer electronics, automotive parts, construction materials including water supply pipes and laminate flooring, and in thermal paper used in media and the medical field. BPA is also used as an antioxidant in cosmetics and food.^{1,3-9} One report claims 15 billion pounds of BPA were being produced annually in 2013, though other reports place production considerably lower, at about 8 billion pounds per year.^{1,8}

BPA is most often ingested when it leaches from the inside of canned food and beverage containers under high heat, repetitive use and physical manipulation. It can also be absorbed through the skin, as in the case of contact with thermal paper or paper money, or can be inhaled as part of household dust.^{1,4,7} Measureable amounts of BPA or its metabolites can be found in the urine of approximately 93% of Americans. It is also found in breast milk, amniotic fluid, serum, saliva and semen.^{1,5,6,8}

Determining acceptable levels

There remains much controversy surrounding the safety of BPA.⁶ Various national agencies and organizations have noted different acceptable levels of BPA exposure over the past several decades:

- The U.S. Environmental Protection Agency determined in the 1980s that a BPA dose below 50 mg per kg of body weight per day is safe.^{1,6}
- The Food and Drug Administration (FDA) declared BPA safe in 2008.⁶
- The National Toxicology Program (NTP), funded by the U.S. Department of Health and Human Services, concluded in 2008 that exposure to BPA at then acceptable levels could have adverse effects on behavior, the brain, the prostate gland in infants and children, mammary gland development and progression of puberty. The NTP also noted a slight concern regarding BPA exposure and reduced birth weight and growth of infants, fetal mortality, birth defects and reproductive toxicity in men and women.⁶
- The FDA declared in 2010 that it agreed with the NTP's assessment of BPA, and in 2012 banned the use of BPA in plastic children's cups and baby bottles at the request of manufacturers wishing to ease consumer concern.⁶

The controversy over acceptable amounts of BPA is not restricted to the United States. Other countries have also debated its safety:

- The European Food Safety Authority determined there is not adequate evidence to conclude that BPA poses a risk to human health.⁶
- The European Union banned the use of BPA in baby bottles in 2011.⁶
- Canada has banned the use of BPA in plastic baby bottles, and declared it to be harmful to human health.⁶
- Denmark has banned the use of BPA in food containers for young children.⁶
- France banned the use of BPA in any food or beverage packaging in 2015.^{1,4}

Research on health effects

Experts say EDCs like BPA seem to have broader low-dose effects than initially acknowledged.⁶ First synthesized in 1891, BPA's estrogenic activity was only discovered in 1936 when the possibility of using it as a pharmaceutical estrogen was briefly considered. BPA binds with estrogen receptors at low doses, potentially enhancing female traits, like breast development. At high doses, BPA inhibits androgens, potentially decreasing male traits, like sperm production.^{1,6} BPA is currently thought to be associated with human disorders and diseases such as female and male infertility, prostate and breast cancer, polycystic ovarian syndrome (PCOS), diabetes, cardiovascular disease and obesity.^{3,4,6}

Much of the research on the effects of BPA is done in animals, particularly mice and rats. Findings are variable depending on the route and level of exposure. Studies on humans are less frequent, again with multiple variables in design and outcomes. The study conclusions summarized here come from larger literature reviews or meta-analyses, and only represent the very tip of the iceberg when it comes to the more than 4,000 BPA studies listed in the U.S National Library of Medicine and National Institutes of Health PubMed database.

Two review papers, which examined more than 50 studies from 2007 and 2016, note that the research suggests BPA might be linked to the following^{2,8}:

- Altered gene expression and oviduct morphology, which may impair development and movement of the embryo from the oviduct to the uterus²
- Impaired or reduced implantation²
- Compromised uterine function and morphology over several generations²
- Abnormal menstrual cycles²
- Female infertility²
- Impaired sperm motility and quality⁸
- PCOS⁸

A 2018 meta-analysis, which examined nine studies of more than 900 women, noted the following⁹:

- Serum BPA may be positively associated with PCOS.⁹
- BPA might be involved in the hyperandrogenism and insulin resistance found in PCOS.⁹

A 2016 review examined the findings of more than 35 studies and concluded the following¹⁰:

- It is reasonable to believe that BPA is a human carcinogen in the breast regardless of the route of exposure.¹⁰
- Human prostate epithelium exposure to BPA increases susceptibility of neoplasia and cancer with aging.¹⁰
- Elevated urinary BPA levels might be an independent diagnostic marker in prostate cancer patients, and is associated with prostate cancer in humans.¹⁰

Additionally, a 2015 meta-analysis of 33 studies related to cardiometabolic disorders concluded that urine BPA levels are associated with an increased incidence of hypertension, diabetes and general and abdominal obesity.¹¹

Steps for limiting exposure

Almost all study authors agree that additional studies are needed to strengthen their conclusions and determine exact causative mechanisms. Despite the need for further research that might clearly determine the short- and long-term effects of BPA on humans, it seems prudent to mitigate exposure as much as possible.

An American College of Obstetricians and Gynecologists 2013 committee opinion states that clinicians should be prepared to counsel patients regarding avoidance of EDCs such as BPA. As noted in the opinion, "Intervention as early as possible during the preconception period is advised to alert patients regarding avoidance of toxic exposure and to ensure beneficial environmental exposure"¹² Experts have recommended additional actions that might decrease or eliminate daily human exposure to BPA¹²⁻¹⁶:

- Reduce or avoid use of canned foods as well as other dietary sources of BPA.^{12,13,14}
- Avoid plastic containers with recycle codes of 3 or 7 as they might be made with BPA.^{13,14}
- Use porcelain, glass or stainless steel containers whenever possible, especially for liquids or hot food.^{13,14}
- Use BPA-free baby bottles.^{13,14}
- Don't use polycarbonate food containers in the microwave.^{13,14}

- Don't use harsh detergents to wash polycarbonate plastic containers in the dishwasher.¹⁴
- Wash plastics by hand or on the top shelf of the dishwasher.¹⁵
- Avoid using metal water bottles with epoxy-based enamel coatings.¹⁵
- Rinse canned vegetables or fruit.¹⁵
- Use fresh or frozen vegetables and fruit instead of canned varieties.¹⁶
- Use dried beans instead of canned beans.¹⁶
- Purchase food in glass jars instead of cans when possible.¹⁶
- If purchasing plastic toys, choose those that are nontoxic and BPA-free.¹⁶

The attention and concern surrounding BPA has led manufacturers to create and use substitutes for BPA that allow them to label products as “BPA-free.” However, recent studies show that some BPA substitutions, such as bisphenol S and bisphenol F, also have endocrine-disrupting properties and are as hormonally active as BPA.^{17,18} Given this, researchers suggest it might be necessary to consider entire classes of chemical compounds when evaluating their safety for consumer use.¹⁷

While controversy remains regarding the safety of BPA, research suggests BPA exposure is associated with a number of health issues, including reproductive disorders, cancers and cardiometabolic diseases.^{4,3,6} Based on these findings, national organizations and agencies, including the American College of Obstetricians and Gynecologists, the National Institute of Environmental Health Services and the National Toxicology Program have recommended that consumers take steps to limit exposure to BPA, and that clinicians guide patients to do the same.^{6,12-14}

About the author

Sheryl (Sherry) Lipari, LPN, is a clinical education specialist at AllianceRx Walgreens Prime with more than 40 years of experience in nursing and clinical care. After nearly two decades as a clinical director in nephrology and kidney transplantation, Lipari turned her focus to the field of reproductive medicine and fertility preservation. She is a member of the American Society of Reproductive Medicine, the Oncology Nursing Society and the National Association of Female Executives. She writes and presents courses on various topics, most recently Body Image and Cancer, to clinical audiences across the country and is a regular contributor to *Clinical Update*.

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