

Toxic textiles: Potential health risks associated with toxic chemicals in clothing

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7 December 2023

Maria A. Muñoz and Pamela J. Lein from the University of California, Davis, focus on the potential health risks associated with toxic chemicals in clothing

In 2011, approximately 800 of 3,000 Alaska Airlines attendants began reporting various symptoms, including skin rashes, itchy eyes, and coughing. These complaints coincided with the introduction of new uniforms earlier that year and would continue until February 2014, when the clothing was recalled. Laboratory analyses of the attendants' uniforms detected various toxic chemicals, including metals (lead, chromium, and cobalt) and known skin irritants, such as toluene, tributyl phosphate, and dimethyl fumarate, in the cloth used to make the uniforms.

Chemicals used in the textile industry

Chemicals are often used in the textile industry to add desirable properties to products, such as flame-, water-, stain- or pest-resistance. For example, the heavy metals cobalt, copper, chromium, and lead are added because complexes formed between these metals and dyes confer resistance to color fading in wool, silk, and nylon fabrics. Chromium is also used as a pigment mordant to bind dyes onto the fabrics. Dermal exposure to chromium and copper is linked to eczema, itchy skin, and dermatitis.

Chromium is also a known carcinogen. Lead has well-known neurotoxic effects, particularly when it is ingested, but there is limited information that dermal exposure may also have adverse neurological effects. Skin contact with cobalt is linked to skin discoloration, sensitization, and eye irritation. Cobalt is also classified as a possible human carcinogen according to the International Agency for Research on Cancer (IARC).

Flame retardants are added to textiles to prevent or slow fire spread. They include organophosphate flame retardants (OPFRs), tetrabromobisphenol A (TBBPA), and tris(2,3-dibromopropyl) phosphate (tris- BP). OPFRs are newer flame retardants added to textiles used for furniture and clothing. Experimental animal studies suggest that exposure to OPFRs can interfere with development and adversely affect brain function.

Toxic chemicals in clothing

TBBPA is used in synthetic textiles, such as polyester and nylon, and has been linked to cancer. Tris-BP and its synthetic derivative, tris(1,3-dichloro-2-propyl)phosphate (TCDPP), were used in the 1970s as additives to children's pajamas to comply with standards set by the U.S. Flammable Fabrics Act.

However, these chemicals were eventually banned in 1977 after studies conducted by Blum and Ames found that tris-BP metabolites were mutagenic (DNA-damaging) and could cause cancer. Today, children's pajamas no longer contain tris-BP or TCDPP, but they are still required to be flame-resistant, achieved with snug-fitting or polyester-containing clothes.

Per- and polyfluoroalkyl substances

Per- and polyfluoroalkyl substances (PFAS), commonly called "forever chemicals" in the popular press, are widely used in textiles to confer water- or stain resistance. Clothing items typically containing these chemicals include raincoats, hiking pants, and sports bras. One study found that about 70% of tested products labeled as waterproof contained PFAS. This included products from Patagonia, Alpine Design, and North Face.

According to a 2022 study, PFAS have also been detected in children's school uniforms sold in U.S. and Canadian stores. These "forever chemicals" are known to accumulate in the environment and in the body. While there are limited data regarding the effects of dermal exposure to PFAS, various adverse effects, including increased cholesterol, metabolic disorders, reproductive and developmental toxicity, and immune deficits, are associated with exposure to PFAS via other routes of exposure, such as ingestion.

Treatment of clothing for insect resistance

Permethrin, an insecticide belonging to the pyrethroid family, is used to kill or repel ticks, fleas, and mosquitoes. It is the only insect repellent approved by the U.S. Environmental Protection Agency (EPA) for use in the factory treatment of clothing for insect resistance. This chemical was first registered for use in military clothing in 1990, and today, it is available for purchase as an aerosol spray to pretreat clothing or camping gear at home.

In areas with a high risk of malaria and other mosquito-borne diseases, such as Tanzania, permethrins are often used to treat bed nets or clothing to repel mosquitoes. While considered safe at low levels, frequent dermal exposure to permethrin can lead to skin irritation, such as rash, itching, redness, and paresthesia (burning or prickling sensation).

Bisphenol-A for polyester-based clothing

Bisphenol-A (BPA) is presently used in the textile industry for polyester-based clothing to improve the fabric's lifespan, add moisture-wicking or anti-static properties, or fix dyes. BPA is a known endocrine disruptor, meaning it interferes with the body's hormones and has been linked to developmental defects in children.

Most athletic wear is made of spandex and polyester and thus may contain BPA. Indeed, under California's Proposition 65, the maximum allowable dose level for dermal exposure to BPA is 3 µg/day. Recently, BPA levels at 40 times California's legal limit were detected in polyester-spandex clothing like sports bras, leggings, and shorts from eight popular activewear brands, including Nike, Athleta, and Patagonia.

EU chemical legislation

The EU has taken steps through Registration, Evaluation, and Authorization of Chemicals (REACH) legislation to set maximum concentration limits on carcinogenic chemicals that are DNA-damaging or toxic to the human reproductive system. However, to date, the EU does not have restrictions on BPA in textiles, and outside of California, neither does the U.S.

Indeed, the U.S. has lagged significantly behind the EU in setting regulations on the levels of toxic chemicals in textiles. Much of the limited regulation enacted in the U.S. has been at the level of individual states. One significant data gap hindering regulatory progress is the limited information available for many of these chemicals following dermal exposure.

Expand research on chemicals in textiles

Chemicals add desirable features to textiles, ranging from enhanced safety, such as flame- or pest-resistance to aesthetics like color longevity; however, most consumers remain unaware that many of the clothes they wear contain potentially harmful chemicals.

Therefore, we must expand research to understand the risks from prolonged dermal exposure to these chemicals, advocate for limits on the levels of these chemicals in clothing, and make consumers aware of the risks. Such actions can help reduce incidents like that experienced by airline attendants.

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