Artificial Turf and Other Synthetic Surfacing:

Risks for Children's Health and the Environment

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Scope

This document reviews the potential health and environmental risks associated with artificial turf and other synthetic surfacing materials used in environments where children live, learn, and play. Synthetic surfaces include artificial turf systems as well as materials such as rubber mulch, rubber tiles or mats, and poured-in-place rubber. The scientific literature is more extensive for artificial turf systems, particularly in outdoor settings, than for other types of synthetic surfaces. The document describes these materials and the settings in which children may encounter them and summarizes available evidence of human exposure. It then considers potential risks for children and the environment, including those related to toxic chemicals, fire and flammability, heat retention, stormwater runoff and microplastic release, and the loss of ecosystem services and climate impacts. The document also provides context on current rules, restrictions, and policy developments related to managing potential risks, highlighting emerging guidance and regulatory approaches.

Where do children encounter artificial turf and other synthetic surfaces?

The use of synthetic surfacing has increased globally in recent years and is becoming more common across a range of settings, including in Canada; however, recent national data on trends in Canada remain limited.[1–4] The terms "artificial" and "synthetic" are often used interchangeably in the literature. Here, "synthetic surfaces" is used as an umbrella term, while "artificial turf" refers specifically to turf systems. Artificial turf fields, rubber tiles, poured-in-place rubber pads, and rubber mulch are now widely used in schoolyards, child care centers, recreational areas, sports facilities, and residential yards.[4–6] They are also installed indoors in child care playrooms, gymnasiums, and other activity spaces.[7–9] These materials are often selected over natural grass because they provide a consistent, even surface. Artificial turf has been marketed as requiring less maintenance and being suitable for year-round use.[4,7] Other synthetic surfacing materials have gained popularity because they offer impact absorption, reducing the risk of injury from falls.[6,10]

Publicly available data show the scale and continued expansion of artificial turf systems across multiple regions. In North America, more than 6,000 synthetic turf fields had been installed by 2011, with approximately 1,000–1,500 new installations occurring annually.[3] In Europe, there are estimated to be over 13,000 full-size synthetic turf football fields and more than 47,000 mini-pitches, with approximately 1,200–1,400 new fields installed each year.[11] Global market estimates further reflect this expansion, with the artificial turf sector valued at approximately USD 2.7 billion in 2020 and projected to grow substantially in the coming years.[2] Comparable quantitative data for other synthetic surfacing materials, such as rubber flooring and playground surfacing systems, are more limited, although their use across a range of indoor and outdoor applications is well documented. In Canada, publicly available data on the market size and distribution of synthetic surfacing materials are limited, and available information is derived primarily from regional reports and industry sources.

Why do synthetic surfaces matter for children's health?

Children may be particularly vulnerable to adverse effects from chemicals released from artificial turf and other synthetic surfacing materials. This vulnerability reflects both higher potential exposure and greater susceptibility to adverse effects should they be exposed. Children's increased vulnerability for exposure comes from being in close proximity to the ground for extended periods of time, having a higher inhalation rate relative to body weight, frequently placing their hands and objects in their mouths, and having a larger skin surface area relative to body size than adults which can increase dermal absorption.[12,13] In addition, children's bodies are still developing, and their ability to metabolize and eliminate environmental contaminants may be less efficient than that of adults.[14] Periods of growth and development may also represent windows of increased vulnerability to environmental exposures.[15]

What are artificial turf and other synthetic surfaces?

Synthetic surfacing products range from turf systems with infill, to rubber mulch, rubber tiles, and poured in place rubber. Details of materials and common applications are presented in Table 1.

Table 1. Categories of artificial turf and other polymer-based surfaces, their materials, and common applications where children are most likely to encounter them.

Category	Materials	Common Applications
Artificial Turf Systems	Plastic grass-like fibers (polyethylene or polypropylene) stitched into a backing layer with infill (crumb rubber, sand, or organic alternatives) for cushioning and stability [16]	Schoolyards, sports fields, childcare play areas, residential lawns [9,16,17]
Rubber Mulch	Shredded recycled tire rubber, sometimes coated or coloured [18,19]	Playground surfacing, landscaping [17–19]
Rubber Tiles / Mats	Manufactured rubber tiles or mats, sometimes bonded with adhesives [20]	Indoor and outdoor playgrounds, childcare flooring, gyms [17,21]
Poured in Place Rubber	Two-layer system: base layer of shredded rubber for cushioning topped with colored rubber granules bound with polyurethane [22]	Playgrounds, recreational facilities, athletic tracks, sports surfaces [22]

Is there evidence of human exposure?

Most research on human exposure has focused on artificial turf fields with crumb rubber infill. One study was identified for poured-in-place rubber playgrounds (Table 2).[23] To our knowledge, no exposure assessments or biomonitoring studies have been published for rubber mulch or rubber tiles/mats. This leaves a significant knowledge gap regarding children's exposure to chemicals from these materials and routes of exposure. Examples of the available human exposure assessment studies on artificial turf and poured-in-place rubber are summarized in Table 2.

The literature has largely relied on modelled or estimated exposure scenarios, which is standard practice for assessing exposure to complex mixtures with multiple sources.[11,24] Recent studies have also incorporated empirical measurements of environmental concentrations and activity patterns.[25] Based on this information, exposure is presumed to occur through all three pathways of inhalation, dermal transfer and ingestion, with the predominant route likely varying by age and activity level.[26] Younger children's potential exposure pathways include inhalation, dermal transfer, and ingestion (particularly due to handto-mouth behavior),[11,27] whereas older children engaged in sports may have higher potential for inhalation and dermal transfer.[11,28–30] Overall, studies generally report low estimated exposure levels and have not identified a single dominant route. Also, these exposure assessments tend to focus on direct contact during use and do not account for potential indirect or secondary exposures that may arise from broader environmental contamination associated with the production, weathering, or disposal of synthetic surfacing materials. As a result, possible exposures through environmental pathways such as drinking water, recreational waters, dust, or the food chain are not well characterized. An additional source of uncertainty is that most exposure studies have been conducted on outdoor fields with high air exchange, whereas indoor facilities such as domes, which are commonly used in Canada, may have more limited ventilation which could result in higher concentrations of airborne contaminants compared with outdoor settings.

Table 2. Summary of human exposure assessment studies related to artificial turf with crumb rubber infill and poured in place rubber.

Category	Key Contaminants	Biomonitoring Data (Direct Measurement)	Estimated Exposure (Modeled)
Artificial Turf Systems	PAHs	A urinary biomarker of PAHs measured in 7 adult soccer players before and after play. No significant increase observed; levels remained within typical background range, suggesting minimal PAH uptake from crumb rubber.[31]	-
	VOCs (including benzene), PAHs, airborne particles (PM10/PM 2.5)	-	Modeled inhalation, dermal, and ingestion exposures for adults and children using measured air, dust, and granulate concentrations. Exposures for VOCs, PAHs, and dust were below health-based reference values. No elevated cancer risk from PAHs or benzene.[32]
	Benzo[a]pyrene as a representative PAH	-	Worst-case inhalation exposure to benzo[a]pyrene resulted in no meaningful increase in cancer risk.[33]
	Metals (Zn, Pb, Cr, Fe, Al) measured in crumb rubber from fields worldwide	-	Multi-pathway exposure modeling showed non-carcinogenic and carcinogenic risks above acceptable limits for children and young athletes, with lead and chromium as the main contributors. Risks were within acceptable levels for adult bystanders.[34]
Poured in Place Rubber	PAHs		The estimated lifetime cancer risk for children playing on synthetic turf playgrounds was about 10 times higher than for soil playgrounds, mainly due to dermal contact with PAHs. Although this risk falls within regulatory guidelines, it is at the higher end of the acceptable range.[23]

Are there risks for children and the environment?

a) Toxic chemicals

Scientific research has identified substances in synthetic surfacing materials that may pose risks to human health and/or the environment. Table 3 summarizes chemical groups of concern identified in artificial turf and other synthetic surfacing materials and outlines the range of health and environmental effects that have been associated with these chemicals in the scientific literature. These effects relate to the chemicals themselves, not to the materials as a whole, and should be interpreted as dose-dependent potential effects reported for individual chemicals rather than as effects uniformly attributable to all products.

Table 3. Chemical groups identified in artificial turf and other polymer-based surfaces, with examples of potential health and environmental effects reported for associated chemicals [a].

Category	Key Chemicals or Contaminants Identified	Examples of Potential Health Effects Reported for These Chemicals	Examples of Potential Environmental Effects Reported for These Chemicals
Artificial Turf Systems	Polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), rubber additives and antioxidants, UV stabilizers, plasticizers, bisphenol A, per- and polyfluorinated alkyl substances (PFASs), metals (e.g., lead, cadmium, chromium, zinc, and aluminum), microplastics.[11,33–37]	respiratory effects (including asthma), neurodevelopmental and behavioural outcomes, endocrine and metabolic disruption, reproductive and developmental effects, carcinogenicity, cardiovascular effects, and organ-specific toxicity reported for individual chemicals.[13,25,38–41]	**Wildlife**: physical impacts (e.g., reduced feeding in filter-feeding animals), behavioural and reproductive effects, immune and growth impairment, bioaccumulation, endocrine disruption, toxicity and mortality, and population-level changes.[42–48] **Plants:** absorption and bioaccumulation, oxidative stress, reduced growth and germination failure, pigment loss, altered carbohydrate and protein content, increased stress markers, changes in antioxidative enzymes, altered metabolism, and contamination of food crops.[49–53]
Rubber Mulch	Metals (e.g., cadmium, chromium, mercury), highly aromatic oils, PAHs, aromatic nitrogen compounds, VOCs, benzothiazole, microplastics, antioxidants.[54–57]		
Rubber Tiles / Mats	Tire wear microplastics, PAHs, chlorinated paraffin, antioxidants, vulcanizing agents, and UV stabilizers. [57–60]		
Poured in Place Rubber	PFAS, microplastics, metals including lead, PAHs, VOCs, antioxidants, vulcanizing agents, and UV stabilizers.[57,61]		

[a] Chemical group listed were identified in the cited literature. Health and environmental effects shown are examples reported for individual chemicals and should not be interpreted as applying to all materials, products, or exposure scenarios. Effects depend on exposure level, route of exposure, and vary across different stages of childhood and species.

b) Fire and flammability risks

Artificial turf and other synthetic surfacing materials are primarily composed of plastic and rubber polymers which can ignite and burn when exposed to sufficient heat or an open flame, reflecting their inherent combustibility.[62] Artificial turf is classified as an easily flammable material that can be ignited by embers from nearby fires, as well as by heat sources such as cigarettes or barbeques, due to its low melting point.[63,64] The burning of these materials may pose risks to human health, as combustion can release smoke and airborne contaminants that can be inhaled. In addition, the burning of other synthetic surfacing materials, particularly those used in playgrounds, also raises concern for environmental contamination from smoke and runoff of degraded materials.[17] Combustion of artificial turf and other surfacing made from recycled rubber can release fine particles, metals, a range of VOCs, and several SVOCs including PAHs, PFASs, into the surrounding environment.[65–68] Increasing wildfire activity across Canada heightens concern about the flammability of synthetic surfacing materials and the potential release of harmful emissions during fire events. Similar incidents have been reported elsewhere, where discarded artificial turf piles ignited during hot, dry conditions, such as in California and Washington, have released toxic smoke and residues.[67]

c) Heat retention and thermal exposure

Synthetic surfaces can retain heat and reach higher surface temperatures than natural grass under similar weather conditions, contributing to localized heat-island effects.[69] Surface temperatures of artificial turf have been reported to exceed ambient air temperatures by more than 10°C, with maximum surface temperatures reaching approximately 65°C under certain conditions.[25] Elevated surface temperatures may increase heat stress during outdoor activity and can also increase the release of VOCs and SVOCs from synthetic materials.

d) Stormwater runoff and microplastic release

Unlike natural grass, synthetic surfaces reduce rainwater infiltration into soil, increasing stormwater runoff that may carry pollutants into surface and groundwater. Over time, loose granules and smaller breakdown particles can migrate into surrounding soil and water, contributing to microplastic pollution.[4,17] Individuals may be exposed to microplastics primarily through ingestion and inhalation, with dermal contact considered a potential but less well-characterized pathway (this pathway could contribute to exposure to plastic additives that can desorb from the microplastics).[70] While microplastics are considered a potential concern for human health, emerging evidence suggests possible, dose-dependent direct effects such as inflammation and physical irritation, and indirect effects resulting from exposure to plastic additives, although current understanding of these impacts remains limited and evolving.[70]

e) Loss of ecosystem services and climate impacts

Replacing living grass with synthetic surfaces removes natural cooling, infiltration, and carbon storage functions, potentially reducing local climate resilience and ecosystem services.

Together, these factors highlight that synthetic surfacing can affect both human health and surrounding ecosystem, and climate resilience. [4,17]

Are there rules or restrictions on synthetic surfacing?

Regulatory actions targeting synthetic surfacing are limited. In the United States, Maryland requires manufacturers and suppliers of synthetic turf with crumb rubber infill to certify that the material meets state-defined limits for hazardous substances, including PAHs, lead, and other heavy metals.[71] Colorado has prohibited the installation of new fields with tire-derived crumb rubber infill beginning in 2026.[72] The European Union has adopted a restriction on the intentional use of microplastics, including rubber infill granules, with a full phase-out required by 2031 as well as a concentration limit of 20 mg/kg (sum of eight PAHs) for rubber granules and mulch used as infill.[11] These policies primarily address crumb rubber infill and do not set limits or requirements for other synthetic surfacing materials such as rubber tiles, mulch, or poured-in-place systems. In addition to regulatory measures, some public health and academic bodies have issued guidance and position statements highlighting potential risks associated with synthetic surfacing and recommending precautionary approaches, particularly in settings used by children.[4,74,75] Toronto Public Health has issued precautionary guidance recommending the consideration of alternatives to synthetic turf and rubber surfacing, particularly in spaces frequented by children. However, these recommendations are advisory and not legally binding.[4]

[b] The eight PAHs defined under EU REACH Entry 50 are benzo[a]pyrene, benzo[e]pyrene, benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, and dibenzo[a,h]anthracene.

What are the key takeaways?

Although the research is limited, publicly available evidence indicates that artificial turf and other synthetic surfacing materials contain a complex mixture of chemicals, some of which are known to harm human health and the environment. Evidence is strongest for the presence of heavy metals, PAHs, and PFASs within these materials and their potential to migrate into air, dust, or runoff. While most exposure studies suggest low exposures to individual contaminants under typical, outdoor use, significant uncertainties remain. Much of the human exposure literature has focused on crumb rubber infill used in artificial turf, while comparatively little research has examined other synthetic surfacing types such as rubber tiles, poured-in-place systems, or rubber mulch nor conditions where these surfaces are used in closed spaces such as athletic domes. Data are also limited on the intensity and patterns of exposure among younger children who spend more time in close contact with these surfaces and are prone to higher exposures as a result, compared to older children and adults. Moreover, studies have generally not evaluated combined or long-term exposures, including repeated contact through inhalation, ingestion, and skin absorption over months or years, nor potential indirect exposures resulting from environmental contamination of air, soil, water, or the food chain.

Beyond the potential for chemical toxicity, synthetic surfacing materials may contribute to additional physical and environmental harm. Heat retention is a key concern, as synthetic surfaces can reach higher temperatures than natural grass and may increase heat stress during outdoor play. Fire and flammability risks add another dimension of potential harm, particularly as wildfire frequency and intensity continue to increase across Canada. Synthetic surfacing materials may also contribute to broader environmental impacts, including microplastic generation with risks to biota and human health, increased runoff, reduced natural infiltration, and loss of carbon-storage functions associated with replacing living grass and other vegetation.

Given the potential for exposure to chemicals of known concern, the persistence of many of these substances in the environment, and uncertainties with estimates of exposure and toxicity, precautionary approaches are warranted. Reducing the use of synthetic surfacing where safer natural or engineered alternatives are available, improving transparency of available information regarding material composition, and expanding monitoring and research on real-world exposures would help address current knowledge gaps and support better protection of children's health and the environment.

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