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10 Questions

Ten questions concerning fragrance-free policies and indoor environments

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ABSTRACT

Indoor air quality is an international concern, linked with adverse effects on health and productivity. A common source of indoor air pollutants is fragranced consumer products, such as air fresheners, cleaning supplies, and personal care products. Exposure to fragranced products has been associated with health problems, such as breathing difficulties and migraine headaches, as well as lost workdays and loss of access in society. In response, fragrance-free policies have been implemented in workplaces, schools, health care facilities, public buildings, and other indoor environments around the world. In addition, national surveys indicate that more people prefer fragrance-free rather than fragranced environments, and would support fragrance-free policies. Though lacking a standard approach, these policies generally restrict the use of fragranced products indoors. And though prevalent, little systematic study has investigated these policies. Yet building managers, occupants, employers, and employees often seek guidance and scientific information. This paper presents and answers ten questions to explore fragrance-free policies within indoor built environments. Using a set of 60 fragrance-free policies, it analyzes who, what, where, when, why, and how policies are implemented. It then examines potential benefits of fragrance-free policies, such as avoided costs from illness and lost workdays, as well as challenges. The paper concludes with guidance and research directions for the future.

Introduction

The paper will first provide some terms and definitions. A "fragrance" is a scent, typically a complex mixture of numerous volatile chemicals and other ingredients [1]. A fragrance is generally intended to provide an aroma, to mask an odor, or both. A "fragrance-free policy" is a protocol, principle, or plan that is implemented to promote an environment without fragrance.

A "fragranced consumer product" (or "fragranced product") is a product that contains an added fragrance or that is largely comprised of fragrance [2]. Fragranced products can include everyday items such as air fresheners, deodorizers, cleaning supplies, laundry detergents, fabric softeners, essential oils, candles, soaps, personal care products, colognes, and hand sanitizers, to list a few out of hundreds.

"Fragrance sensitivity" is a health condition characterized by adverse effects from exposure to fragranced consumer products [3]. As will be examined herein, concerns associated with fragrance sensitivity and other health conditions (such as asthma, autism, chemical sensitivity, and allergies) are a primary motivation for fragrance-free policies.

Fragrance-free policies can be implemented by and can apply to a range of different groups and individuals, such as government agencies, industries, organizations, institutions, members, and employees (herein referred to collectively as "entities").

Fragrance-free policies can apply to a range of physical environments, such as an individual building, a specific area or floor in a building, a campus with a collection of buildings, or all buildings and facilities of an organization (herein referred to collectively as "venues").

For this paper, to provide a reconnaissance and insights on fragrance-free policies, a set of fragrance-free policies were selected for analysis. To identify these policies, an internet search was conducted with the key phrases "fragrance-free," "fragrance free," "scent-free," "scent free," and related terms. The search produced more than 150 possible examples of policies from around the world, with most from the United States and Canada. From this initial group, 60 policies were selected for detailed analysis, drawing upon these two countries and information available from the internet. These policies were chosen to be illustrative, offering useful examples from different entities and venues, rather than exhaustive.

The selected fragrance-free policies were analyzed according to the following factors: (a) Who is implementing the policy and who is affected by the policy? (b) What is the scope of the policy? (c) Where is the policy implemented? (d) When was the policy implemented?

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(e) Why was the policy implemented? (f) How is the policy implemented and enforced? and (g) What are other notable features of the policy? These factors are explored in the questions that follow.

This analytic framework above, with each of the 60 policies analyzed according to each factor, is provided in a spreadsheet as electronic supplementary material (see ESM Fragrance-Free Policies). Each policy is designated a number (1–60) in the spreadsheet. Within this paper, any material quoted from the policies will be referenced according to the policy number [#].

1. What is the need for fragrance-free policies?

Given the ubiquity of fragrance in society, it is useful to ask: What is the motivation or need for fragrance-free policies? Is there a "fragrance problem"?

A primary motivation is fragrance sensitivity and its impacts. Fragranced products have been associated with a range of adverse human health and societal effects among the general population, and especially among vulnerable sub-populations such as asthmatics. Fragrance sensitivity can also be considered a disabling health condition that is covered under legislation in certain countries.

The prevalence of fragrance sensitivity has been recently assessed [2,4–6]. Nationally representative population studies in four countries—the United States (US), Australia (AU), the United Kingdom (UK), and Sweden (SE)—found that, on average, 32.2% of the general population report adverse health effects when exposed to fragranced products [7] (Table 1).

Among vulnerable sub-populations, the prevalence of fragrance sensitivity is higher. For instance, 57.8% of individuals with asthma/asthma-like conditions, 75.8% with autism/autism spectrum disorders, and 82.0% with chemical sensitivity report adverse effects from fragranced products [8].

Fragranced product exposures associated with health problems, among the general population, include but are not limited to the following: air fresheners and deodorizers (17.4%), fragranced laundry products coming from a dryer vent (7.6%), being in a room recently cleaned with fragranced products (15.7%), being near someone wearing a fragranced product (20.1%), and other types of fragranced consumer products (18.6%) (Table 1). Types of adverse health effects associated with these fragranced product exposures, among the general population, include respiratory problems (16.7%), mucosal symptoms (13.2%), migraine headaches (12.6%), skin problems (9.1%), asthma attacks (7.0%), and neurological problems (5.1%), among others [7] (Table 1).

Among vulnerable sub-populations, the prevalence of health problems from exposure is higher. For example, when exposed to air fresheners or deodorizers, 36.7% of individuals with asthma/asthma-like conditions, 62.9% with autism/ASDs, and 54.8% with chemical sensitivity report health problems, compared with 17.4% of the general population [8–10].

For specific types of adverse effects, the prevalences are also higher. For instance, respiratory problems are reported by 37.7% of individuals with asthma/asthma-like conditions, 44.7% with autism/ASDs, and 50.2% with chemical sensitivity when exposed to fragranced products, compared with 16.7% of the general population [7–10]. Also, migraine headaches are reported by 22.6% of individuals with asthma/asthma-like conditions, 42.9% with autism/ASDs, and 36.9% with chemical sensitivity when exposed to fragranced products, compared with 12.6% of the general population [8–10]. In another study, fragranced products were associated with 3.8% of confirmed work-related asthma cases in California [11].

A second motivation for fragrance-free policies is the pervasiveness of exposure to fragranced products. In each of the four countries (US, AU, UK, SE), at least 98.5% of the general population are exposed to a variety of fragranced products at least once a week from either their own use, others' use, or both [2,4–6].[1] The widespread exposure to fragranced products gives rise to the problem of "secondhand scents," or unintentional or involuntary exposure to fragranced products, in an analogy to "secondhand smoke" from tobacco products.

A third motivation is that fragranced products can be a primary source of indoor air pollutants (e.g., [12–14]), yet indoor air quality is not comprehensively monitored or regulated [15]. In addition, fragranced products have been implicated as major contributors to outdoor air pollution, from products used not only outdoors but also indoors as their emissions migrate outdoors [16].

In analyses of fragranced products, using gas chromatography/mass spectrometry, the most commonly emitted compounds were chiral terpenes (e.g., limonene, alpha-pinene, and beta-pinene). Further, comparing emissions from fragranced and fragrance-free versions of the same products, the main chemical difference is the presence of chiral terpenes in fragranced versions but not in fragrance-free versions [17]. In addition to being primary pollutants, terpenes react with ozone to generate secondary hazardous pollutants such as formaldehyde [18].

A fourth motivation is the lack of information about individual ingredients in a fragranced consumer product. No law in any country requires that any consumer product disclose all ingredients in its fragrance. Instead, a product may list the general term "fragrance" (or another legally approved term, such as "perfume" or "parfum") instead of all individual ingredients [19,20]. However, a "fragrance" in a product typically consists of tens to hundreds of compounds [21], among nearly 4,000 documented fragrance ingredients [1].

Further, no law requires that all consumer products (other than foods, drugs, and cosmetics) disclose all ingredients (not even the general term "fragrance") on the label, safety data sheet, or elsewhere [19,20]. The result is that many fragranced consumer products, such as cleaning supplies, may not disclose that they contain a fragrance.

To illustrate these points, previous studies found that fragranced products emit and generate hundreds of different volatile organic compounds, including hazardous air pollutants, but relatively few ingredients (< 10%) are disclosed on labels or safety data sheets [17,22–24]. Emissions of hazardous air pollutants from fragranced products called "green," "organic," "natural," or with "essential oils" were not significantly different from regular fragranced products [17,22,23]. Moreover, a majority of the fragranced products tested (in the categories of air fresheners, cleaning supplies, and laundry products) did not disclose on the label or safety data sheet that the product contained fragrance [17].

A fifth motivation is that, even if indoor environments were regulated and ingredients were fully disclosed, we lack knowledge about which specific chemicals or mixtures of chemicals in fragrance could be triggering the adverse effects. However, in population-based studies, all types of fragranced products were associated with adverse health effects [2,4–6]. Thus, a general approach, addressing a class of product (i.e., fragranced products) could be useful (similar to smoke-free policies that address tobacco products).

The paper now turns to the set of policies and their analysis for the next four questions.

2. Who and what is addressed by fragrance-free policies?

The 60 policies provide examples from public buildings, organizations, educational facilities, government agencies, health care

[1] Fragranced products surveyed include the following: (a) air fresheners and deodorizers (e.g., sprays, solids, oils, disks); (b) personal care products (e.g., soaps, hand sanitizer, lotions, deodorant, sunscreen, shampoos); (c) cleaning supplies (e.g., all-purpose cleaners, disinfectants, dishwashing soap); (d) laundry products (e.g., detergents, fabric softeners, dryer sheets); (e) household products (e.g., scented candles, restroom paper, trash bags, baby products); (f) fragrance (e.g., perfume, cologne, after-shave, essential oils); and (g) other.

Table 1
Adverse health effects (frequency and type) associated with exposure to fragranced consumer products.

	US	AU	UK	SE	Sum/Average %
General Population (n)	1137	1098	1100	1100	4435
Adverse health effects from fragranced products (fragrance sensitive)	34.7%	33.0%	27.8%	33.1%	32.2%
Health problems from exposure to:					
Air fresheners or deodorizers	20.4%	16.4%	15.5%	17.3%	17.4%
Fragranced laundry products from dryer vent	12.5%	6.1%	6.0%	5.6%	7.6%
Room cleaned with fragranced products	19.7%	15.3%	14.0%	13.8%	15.7%
Someone wearing a fragranced product	23.6%	19.4%	13.7%	23.5%	20.1%
Other type of fragranced product	22.3%	20.3%	13.9%	17.9%	18.6%
Type of health problem:					
* *Migraine headaches*	15.7%	10.0%	8.4%	16.1%	12.6%
* *Asthma attacks*	8.0%	7.6%	6.8%	5.5%	7.0%
* *Neurological problems* (e.g., dizziness, seizures, head pain, fainting, loss of coordination)	7.2%	4.5%	3.7%	5.0%	5.1%
* *Respiratory problems* (e.g., difficulty breathing, coughing, shortness of breath)	18.6%	16.7%	11.6%	20.0%	16.7%
* *Skin problems* (e.g., rashes, hives, red skin, tingling skin, dermatitis)	10.6%	9.5%	9.8%	6.5%	9.1%
* *Cognitive problems* (e.g., difficulties thinking, concentrating, or remembering)	5.8%	4.1%	2.8%	4.5%	4.3%
* *Mucosal symptoms* (e.g., watery or red eyes, nasal congestion, sneezing)	16.2%	14.0%	9.2%	13.5%	13.2%
* *Immune system problems* (e.g., swollen lymph glands, fever, fatigue)	4.0%	3.3%	1.9%	1.5%	2.7%
* *Gastrointestinal problems* (e.g., nausea, bloating, cramping, diarrhea)	5.5%	3.3%	3.0%	3.5%	3.8%
* *Cardiovascular problems* (e.g., fast or irregular heartbeat, jitteriness, chest discomfort)	4.4%	3.0%	3.2%	2.1%	3.2%
* *Musculoskeletal problems* (e.g., muscle or joint pain, cramps, weakness)	3.8%	2.6%	2.0%	1.5%	2.5%
* *Other*	1.7%	1.9%	2.1%	2.2%	2.0%

providers, hospitals, houses of worship, libraries, lodgings, private businesses, and restaurants.

For who is addressed, the policies pertain to diverse entities: employees, members, visitors, participants, occupants, faculty, staff, students, parents, patrons, guests, the public, contractors, cleaning staff, volunteers, patients, and all who enter the building.

For what is addressed, analysis of policies revealed the most common components: (1) fragranced products that are problematic, prevented, or proscribed; (2) adverse health effects associated with fragrance exposure; (3) disability recognition of fragrance sensitivity and related conditions; and (4) compliance and enforcement (also covered in Question 5).

Examples of the components from specific policies include the following:

(1) "Scented products may include, but certainly are not limited to, the following: Perfume, cologne, aftershave lotion; Deodorant; Hair care products including shampoos, conditioners, gels, mousses, hairsprays; Hand and body soap; Hand and body lotions; Makeup; Shaving cream; Sunscreen; Laundry soap and stain removers; Dryer fabric softener sheets; Air fresheners, scented candles." [#3] "Do not wear perfume, cologne, scented aftershave or any other products that contain fragrance. Do not wear hair products, lotions, deodorants or other products with fragrance as one of the ingredients." [#1]
(2) "Please refrain from using fragranced products before entering and while in the building as some of these products can cause adverse health effects to individuals who are sensitive to them, including migraine headaches, difficulty breathing, nausea, chest tightness, coughing, loss of voice, scratchy throat and rhinitis." [#22] "While almost everyone may have some reaction, some of us experience severe reactions including migraines, blurred vision, nausea, muscle and joint pain, trouble breathing, and seizures." [#53] "The chemicals used in scented products can make people sick, especially those with fragrance sensitivities, asthma, allergies and other medical conditions. We kindly ask that you not wear or apply fragrances …" [#35]
(3) "Some individuals in our workplace or within our programs have been identified as having multiple chemical sensitivity (MCS), listed under the American Disabilities Act as a physical disability. Individuals with this diagnosis are sensitive to many products that we wear each day. These products may cause severe medical difficulties … Such difficulties may include migraine headaches, nausea, chest tightness, coughing, loss of voice, scratchy throat and rhinitis. Some of the reactions may be life threatening. Products that may cause these difficulties include perfumes, after shave lotions, hair spray, colognes and body sprays." [#20] "Though this issue may be unfamiliar to you, there are a growing number of people who are sensitive to commonly used items. Upon being exposed to scented personal care products, they suffer severe and debilitating physical symptoms." [#26]
(4) "Scented or fragranced products are prohibited at all times in all interior space owned, rented, or leased by CDC. This includes the use of: Incense, candles, or reed diffusers; Fragrance-emitting devices of any kind; Wall-mounted devices, similar to fragrance-emitting devices, that operate automatically or by pushing a button to dispense deodorizers or disinfectants; Potpourri; Plug-in or spray air fresheners; Urinal or toilet blocks; Other fragranced deodorizer/re-odorizer products. Personal care products (e.g. colognes, perfumes, essential oils, scented skin and hair products) should not be applied at or near actual workstations, restrooms, or anywhere in CDC owned or leased buildings. In addition, CDC encourages employees to be as fragrance-free as possible when they arrive in the workplace." [#27]

In summary, fragrance-free policies offered various approaches yet with a common theme: all requested individuals to avoid or refrain from using fragranced consumer products inside the venue.

3. Where and when are fragrance-free policies implemented?

While fragrance-free policies have been implemented around the

world, most policies identified were from the United States and Canada. The set of 60 policies were taken from these two countries, representing 26 of the 50 states and 7 of the 10 provinces, respectively.

For where the policies are implemented, the location varied from a distinct physical building or portion of the building, to a set of buildings or venues, and more broadly to a general protocol for all activities, facilities, and venues.

As examples of policies for specific buildings: A library applies its policy to its own building [#44], a church to a designated fragrance-free area [#38], and a restaurant to all staff and guests [#59].

For groups of buildings: A library applies its policy to all branches [#43], a university to its entire campus [#15], a city government to any town facilities [#25], a community organization to all its offices and spaces [#4], and a health care provider to all its hospitals, clinics, and health centers [#33].

For a broader protocol: A community organization applies its policy to any activity [#3], a health care provider to all divisions, facilities, and programs that are owned and contracted across the state [#28], a chorus to wherever the group assembles [#1], an organization to all conventions and other state-wide meetings [#5], and a government agency to all employees, contract workers, guest workers, and others across the country, at all facilities both leased and owned, and in all work areas [#27].

For when the policies were implemented, about one-third of the policies (22) provided a specific date. Among those 22 policies, 17 were implemented in the past decade (with 10 of those in the past five years), and 5 were implemented in the past two decades.

4. Why are fragrance-free policies implemented?

The most common reason that fragrance-free policies were implemented was to accommodate those with fragrance sensitivity. “Our goal is to be sensitive to participants, staff, other volunteers, and visitors with perfume and chemical sensitivities.” [#54] “For the workplace, staff is encouraged to use only unscented personal hygiene products (e.g. shampoo and conditioners, deodorants, soaps, lotions, creams) and to avoid wearing perfumes, fragrances, aftershaves or colognes. Also, the use of air fresheners and deodorizers, potpourri, scented oils, incense and candles in the workplace is discouraged. As a general guideline, any scent should not be detectable at more than an arm's length from the source.” [#45] “The [entity's] goal is to be sensitive to members with perfume and chemical sensitivities who, as a result, may suffer potentially serious health consequences.” [#5] “Fragrance is not appropriate for a professional work environment, and the use of some products with fragrance may be detrimental to the health of workers with chemical sensitivities, allergies, asthma, and chronic headaches/migraines.” [#27]

Another common reason was to reduce overall health risks or to promote a healthy environment. “The [entity] supports the concept of a smoke, fragrance and pollution-free environment on its properties and in its programs.” [#10] “In order to provide faculty, staff, students, and visitors a safe, healthy, and productive work environment, all [entity] facilities are scent free.” [#19] “Many of the chemicals used to create these fragrances pose a health risk … Some fragrances linger for several days in the Centre and so continue to affect our faculty and students. Students should not apply products of this nature, including after shave, cologne, perfume, or bath and body lotions. Hand sanitizer may not be placed in student backpacks.” [#14]

Some policies address both reasons, and note that a fragrance-free environment helps not only those who are sensitive but also everyone. “We provide our guests with the healthiest indoor air quality possible … We create buildings that are good for the environment and healthy for humans.” [#47] “By working together we can create healthier environments for all, and accommodate the needs of persons who have environmental disabilities.” [#58]

5. How are fragrance-free policies implemented and enforced?

The policies demonstrated a range of approaches, including voluntary compliance, mandatory compliance, enforcement, and a combination of approaches.

Most policies rely on voluntary compliance. “For those employees who are sensitive to fragrances it will help a great deal if we all voluntarily stop wearing our perfumes, aftershaves, and colognes at work.” [#23] “Please refrain from using fragranced products before entering and while in the building as some of these products can cause adverse health effects …” [#22] “We respectfully request that all patrons that attend any [entity] event, be as fragrance free as possible by not wearing perfume, aftershave, scented lotions, fragranced hair products, and/or similar products.” [#13] “Please do not wear perfume, scented hairspray, cologne, scented deodorant, aftershave, or any other scented products when you come to any of our facilities.” [#33] “We request that parents and transportation helpers refrain from wearing perfumes, colognes, powders, or fragrances in our school when visiting, dropping off and/or picking up your child.” [#14]

Requests for voluntary compliance are often accompanied with requests for consideration: “It may at first seem that asking people to use scent-free personal care products touches on a personal and private matter. But when the scents from these products affect the health and well-being of other people, it then goes beyond just being a matter of private concerns. The goal of this awareness campaign is not to target people personally or to criticize people's preferences. Rather, it's to prevent real harm to real people.” [#16] “No scents, please! In consideration for the health of our Sisters and Brothers who may suffer from environmental disabilities, and with the goal of eliminating a contaminant from the air, the [entity] will request that all participants attending the convention refrain from using scented products. These include scented perfumes, colognes, lotions, hairsprays, deodorants and other products.” [#58]

Some policies prescribe mandatory compliance: “Use of perfume, cologne and other scented personal products (e.g. hair care products, soaps, lotions, deodorants) is prohibited inside the school building. Signs to this effect shall be posted outside the entrance doors. Anyone wearing fragrance products is prohibited from entering the school beyond the front office reception area.” [#7] “Personal fragrance products (fragrances, colognes, lotions, powders and other similar products) that are perceptible to others should not be worn by employees, visitors, volunteers or students. Other fragrant products (scented candles, potpourri and other similar items) are also not permitted in the school.” [#8] “The use of scented personal products by staff, patients, clients, residents, visitors, contractors and volunteers is prohibited.” [#34]

Policies can also prescribe enforcement: “When a staff member is aware of a scent, they will: 1. Tell the person about our policy. 2. Ask them to remove the scent. 3. Tell them that if the scent cannot be removed, they will have to leave and return to the clinic later, without the scent. 4. Remind them not to wear scents in the future.” [#33] “Any occupant who noticeably smells of fragrance, smoke or other chemical odors is to be sent to the front office reception area where appropriate actions(s) will be taken to remedy the situation. In the case of students, parents will be notified and summoned to school if a scented personal product must be removed from a child's body. The student may not return to the classroom or regular education environment until the fragrance or chemical odor has been removed.” [#7] “Visitors who violate this policy may be asked to leave the property … 1. Patients/clients/residents scheduled for surgery must be advised when they are notified of the date their surgery is scheduled that they are prohibited from wearing scented products. 2. Patients, clients and residents will receive a pamphlet upon admission explaining the reasons for and how to comply with the Scent Free Policy. Patients, clients or residents who violate this policy may be subject to the provisions of established protocols for inappropriate behaviour.” [#34]

Some offer a hybrid approach of voluntary/mandatory compliance

with enforcement: “Although the restriction is not mandatory, it is very important that we do not impact the health of other employees by our personal choices. For those employees who are sensitive to fragrances it will help a great deal if we all voluntarily stop wearing our perfumes, aftershaves, and colognes at work … All City managers and supervisors are expected to enforce this rule. An employee who is experiencing health consequences due to another employee's use of scented products should report the problem to their supervisor to ensure appropriate action is taken.” [#23] “[Entity] encourages employees to refrain from wearing or using scented products while on duty … If a scent offends or disturbs an employee, customer, or vendor, management will order the employee to cease using the scent.” [#28] “Please do not bring scented products into the house … As some of our guests cannot tolerate scented personal care products (even organic ones with essential oils), please leave yours at home. If this isn't possible, we'll be happy to store them off-premises for you while you're here.” [#46]

In summary, the compliance and enforcement procedures sought to restrict, remedy, or remove a problematic fragranced source from an environment and thereby prevent or reduce adverse health effects.

The paper now turns to preferences for fragrance-free environments, followed by benefits, challenges, guidance, and research directions for the future.

6. Do people prefer fragranced or fragrance-free environments?

Nationally representative population surveys in the US, AU, UK, and SE [2,4–6] have found that more people, at least twice as many, prefer fragrance-free environments to fragranced environments: workplaces, health care facilities and professionals, hotels, and airplanes (Table 2). Among vulnerable sub-populations, preferences for fragrance-free environments are even higher [8–10,25,26].

For workplaces, among the general population, 47.8% would be supportive of a fragrance-free policy in the workplace (compared to 20.4% that would not). Among vulnerable sub-populations, 56.7% of individuals with asthma/asthma-like conditions would support fragrance-free workplace policies (17.7% would not); 65.5% of individuals with autism/ASDs would support fragrance-free workplace policies (24.0% would not); and 70.2% with chemical sensitivity would support fragrance-free workplace policies (10.9% would not).

For health care, among the general population, 51.4% would prefer that health care facilities and health care professionals be fragrance-free (compared to 22.1% that would not). Among vulnerable populations, 62.3% of individuals with asthma/asthma-like conditions would prefer fragrance-free health care facilities and professionals (18.3% would not); 77.2% of individuals with autism/ASDs would prefer fragrance-free (16.4% would not); and 75.4% with chemical sensitivity would prefer fragrance-free (11.9% would not).

For travel, among the general population, if given a choice between staying in a hotel with or without fragranced air, 60.7% would choose a hotel without fragranced air (compared to 22.1% with fragranced air). Thus, over twice as many guests would choose a hotel without fragranced air than with fragranced air. Similarly, if given a choice between flying on an airplane with or without fragranced air pumped throughout the passenger cabin, 64.8% would choose an airplane without fragranced air (compared to 16.1% with fragranced air). Thus, over four times as many passengers would prefer an airplane without fragranced air than with fragranced air.

In summary, regardless of population or indoor environment, more people prefer fragrance-free to fragranced environments. These findings are significant in light of trends towards scent-branding or putting fragranced air through indoor environments [27].

7. What are benefits of fragrance-free policies?

Fragrance-free policies can produce a range of benefits, such as reduced or avoided costs associated with: adverse health effects, lost workdays and lost jobs, loss of access, disability, risk and litigation, indoor and outdoor air pollutants, and purchases of fragranced products such as air fresheners. A full analysis would consider both monetary and non-monetary impacts as well as both personal and public impacts, for overall net societal benefits.

For instance, reduced frequency of asthma attacks associated with reduced fragranced product exposure could produce benefits for the individual (such as reduced costs of medical care, and reduced pain and suffering), as well as benefits for society (such as reduced costs to the health system, reduced losses of economic productivity, and reduced emissions of air pollutants). This section will look at a few categories of potential benefits stemming from reduced or avoided costs with

Table 2
Societal effects associated with exposure to fragranced consumer products.

	US	AU	UK	SE	Sum/Average %
General Population (n)	1137	1098	1100	1100	4435
Adverse health effects from exposure to fragranced products (fragrance sensitive)	34.7%	33.0%	27.8%	33.1%	32.2%
Lost workdays or lost job in past year due to fragranced product exposure in workplace	15.1%	7.7%	6.3%	6.7%	9.0%
Population affected	$3.02*10^7$	$1.12*10^6$	$2.23*10^6$	$4.01*10^5$	$3.39*10^7$
Personal economic costs in past year due to fragranced product exposure in workplace (2016 USD)	$\$1.32*10^{11}$	$\$2.66*10^9$	$\$1.05*10^{10}$	$\$9.00*10^8$	$\$1.46*10^{11}$
Lost workdays (8-h equivalents) due to fragranced product exposure	$1.87*10^8$	$6.42*10^7$	$1.14*10^7$	$1.79*10^6$	$2.07*10^8$
Prevented from access to some place because of fragranced product exposure	22.7%	15.0%	13.5%	12.6%	16.0%
Disabling health effects from fragranced product exposure	17.2%	5.6%	7.1%	8.0%	9.5%
Supportive of fragrance-free policies for workplaces					
yes	53.1%	42.8%	44.7%	50.7%	47.8%
no	19.7%	22.2%	23.3%	16.4%	20.4%
Prefer fragrance-free health care facilities and fragrance-free health care professionals					
yes	54.8%	43.2%	43.3%	64.1%	51.4%
no	22.4%	25.2%	26.7%	14.0%	22.1%
Prefer hotel without fragranced air					
yes	55.6%	55.6%	53.8%	77.7%	60.7%
no	27.8%	22.7%	28.1%	9.8%	22.1%
Prefer airplane without fragranced air					
yes	59.2%	57.7%	61.9%	80.2%	64.8%
no	23.6%	16.3%	18.4%	6.0%	16.1%

fragrance-free policies.

For adverse health effects, as previously examined, exposure to fragranced consumer products has been associated with health problems in 32.2% of the general population in four countries [2,4–7]. Among vulnerable individuals, the prevalence of adverse effects is over two to three times higher [7–10,25,26]. Thus, a major category benefit of fragrance-free policies would be the reduction or avoidance of adverse health effects.

Lost workdays and lost jobs are associated with exposure to fragranced products. Across the four countries, 9.0% of the general population have lost workdays or lost a job, in the past year, due to illness from fragranced product exposure in the workplace [2,4–7]. This loss represents more than 33 million people in four countries [20,28–31] (Table 2).

Personal costs due to these lost workdays and lost jobs, in the past year, ranged from an estimated $86 billion to $206 billion, with a midrange value of $146 billion (in terms of 2016 US Dollars) [7]. Given the population affected, this represents an average annual cost of $4,300 per person. In terms of 8-h equivalent days, the estimated losses across the four countries are over 200 million worker days per year [7] (Table 2).

Loss of societal access can also result from fragranced environments. Among the general population, 16.0% of individuals have been prevented from going to some place because they would be exposed to a fragranced product that would make them sick [7] (Table 2). Thus, a primary type of benefit from fragrance-free policies would be providing greater access and participation in society. If an individual nonetheless goes to the place, the associated adverse health effects could result in costs not only to the individual, but also to the venue, other entities, and society.

Disabling health problems can result from fragranced product exposures. The severity of health problems associated with fragranced products was investigated, using criteria from each country's disability legislation [32–35]. Across the four countries, for 9.5% of the general population, the health effects from fragranced product exposure are potentially disabling under these criteria [7] (Table 2).

As fragrance sensitivity can be considered a disability with relevant legislation for protection, legal action has been used to provide a remedy from fragranced product exposure. For instance, a case where an employer failed to provide a fragrance-free environment to an employee with fragrance sensitivity resulted in a $100,000 award to the employee [36].

For air quality, using fragrance-free products instead of fragranced products can produce benefits in terms of reduced exposures and emissions. For instance, a study of pollutants from dryer vents found that switching from fragranced to fragrance-free laundry products almost entirely eliminated emissions of limonene [37]. Another study of volatile emissions from dryer vents estimated that acetaldehyde emissions from just one brand of laundry detergent would represent 3% of total acetaldehyde emissions from automobiles in the study area [38].

Finally, by obviating the need to use certain types of fragranced products, such as air fresheners, the associated costs with purchasing products is also reduced. If products are still needed for a function, switching from fragranced to fragrance-free versions can usually be accomplished at comparable costs and functionality.

8. What are challenges?

Fragrance-free policies can produce a range of benefits, and they also can present challenges.

Like smoke-free policies, fragrance-free policies seek to restrict use of certain types of products (i.e., fragranced products) and thus prevent or reduce exposures and associated adverse health effects. Unlike smoke-free policies, however, it is often difficult to assess whether a violation occurs. That is, with smoke-free policies, it is relatively straightforward to determine whether someone is smoking. With fragrance-free policies, it may not be as straightforward to determine if someone is fragranced (or too fragranced), especially if they did not intentionally use fragranced products. For instance, if an employee goes out of the office during their lunch hour, and walks into an environment that contains fragranced consumer products, the fragrance chemicals can adhere to their clothing and be re-emitted upon their return to the office.

In addition, in selecting fragrance-free products, it is not always clear if a product is indeed free of fragrance. As previously noted, consumer products (other than foods, drugs, and cosmetics) are not all required to disclose whether they even contain a fragrance. Further, products called “unscented” may in fact be a fragranced product with the addition of a masking fragrance to cover the scent [20]. While many policies rely on a sensitive individual to note if a product is causing problems, it can be helpful to have designated products that are known to be fragrance-free and deemed acceptable.

Finally, a challenge that is implicit throughout the policies is relying on others to comply with the policy. Since many of the policies rely on voluntary efforts, they also tend to provide rationales and appreciation for compliance.

9. What guidance is available?

Government agencies and non-profit organizations offer guidance on how to design and implement fragrance-free policies. Some examples include the following.

The Job Accommodation Network, supported by the U.S. Department of Labor, Office of Disability Employment Policy, offers resources and articles such as “Accommodation and Compliance: Fragrance Sensitivity” and “Implementing a Workplace Fragrance Policy as an Accommodation” [39].

The Canadian Centre for Occupational Health and Safety provides a detailed document entitled “Scent-Free Policy for the Workplace,” which includes definitions, health problems associated with scented products, steps for implementation, and a sample scent-free policy [40].

The American Lung Association provides sample fragrance-free policies: one for a school, and one for a workplace [41]. The Canadian Lung Association offers guidance for developing a scent-free policy [42]. The U.S. Access Board provides guidance and a policy on fragrance-free environments to ensure access to facilities for people with disabilities [43].

In addition, the 60 entities with fragrance-free policies analyzed for this paper can offer useful examples and precedents.

Finally, in conducting research for this paper, some frequently asked questions emerged. These are presented below, along with possible responses (based on research reported herein) to offer some guidance.

Are “natural” or “organic” fragranced products any different from regular fragranced products? In prior studies, emissions of hazardous air pollutants from fragranced products called "green," "natural," "organic," or with “essential oils” were not significantly different from regular fragranced products. All fragranced products tested, regardless of claims, emitted potentially hazardous compounds. Further, the terms “green,” “natural,” and “organic” have no official regulatory definition for fragrances [17,20,44].

What about essential oils? All fragranced products tested with essential oils emitted potentially hazardous compounds. In addition, chemical analyses of commercially available essential oils, both regular and “natural,” found that all emitted potentially hazardous compounds. Further, no significant difference was found between regular and natural essential oils in their emissions of the most prevalent potentially hazardous compounds. [17,22,23]. Essential oils are often restricted in fragrance-free policies because of adverse health effects reported by sensitive individuals.

Are fragrance-free versions of products also pollutant-free? While fragrance-free products can reduce risks associated with fragrance in products, fragrance-free versions are not necessarily pollutant-free.

With any product, its base formulation may contain problematic chemicals [17]. However, fragrance-free products are generally acceptable for fragrance-free policies. Another consideration is whether a consumer product (which typically contains complex mixtures of ingredients, many undisclosed) is really needed for the function. For instance, for certain types of cleaning, using plain water or steam can provide an effective approach (e.g., [45]).

Are some fragranced products somehow better or worse than others? All fragranced consumer products tested, including products with claims of being green, organic, natural, or with essential oils, emitted chemicals classified as potentially toxic or hazardous. No significant difference was found among products in their emissions of hazardous air pollutants. Further, in population studies, all types of fragranced products surveyed were associated with adverse health effects [2,4–6,17].

The air freshener is associated with health problems, but the safety data sheet lists no hazardous ingredients. How can that be? Air fresheners (and many other types of consumer products) are not required to list all ingredients on the label or safety data sheet. Typically, fewer than 10% of all ingredients are disclosed, including potentially hazardous chemicals. Because hazard depends on many factors, such as individual vulnerability and chemical mixtures, emissions can trigger health problems even at very low levels [17,20,27,46,47].

10. What research is needed?

This topic of fragrance-free policies offers a rich area for research with great potential for practical benefits. Given the paucity of prior research, although much anecdotal information, some research directions include the following:

* Analyzing differences in indoor air quality between fragranced and fragrance-free environments.
* Assessing effects on indoor air quality from implementing a fragrance-free policy in a previously fragranced environment.
* Investigating rates and mechanisms of attenuation of fragrance compounds after removing fragranced products from an environment.
* Evaluating health and productivity impacts before and after switching from fragranced to fragrance-free environments.
* Developing analytic methods to determine if an environment is fragranced, or too fragranced.
* Determining ways to distinguish fragrance molecules from consumer products versus fragrance molecules from fruits or flowers.
* Evaluating what works, what doesn't work, and why, and developing criteria for what it means for a fragrance-free policy to “work.”
* Determining best practices, and effective forms of policy development, content, compliance, and enforcement.
* Analyzing the health, economic, and societal impacts of a fragranced versus fragrance-free environment.
* Conducting systematic evaluations of chemicals in fragranced products to understand associations with reported adverse health effects.
* Developing practical guidance, implementation strategies, and science-based evaluation methods for fragrance-free policies.

Finally, a fundamental and enigmatic question is this: Why does "fragrance" apparently cause problems? Fragrance in products is intended to be pleasing, and fragrance ingredients are tested for safety. However, people are reporting adverse effects from fragrance in products. A primary chemical difference between fragranced and fragrance-free versions of products is the presence of chiral terpenes in fragranced but not fragrance-free versions. Yet chiral terpenes are abundant in nature, and at concentrations similar to those emitted by fragranced products. While terpenes in products can generate hazardous air pollutants, so can their counterparts in nature and at similar concentrations. Also, while fragrance-free policies generally restrict fruit-scented products including essential oils, they generally do not restrict aromatic edible fruits. Thus, research to explore this fundamental question could provide a new lens on understanding links between product emissions and exposures, human health and productivity, and indoor built environments.

Expertise of author

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Appendix A. Supplementary data

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