Fragrances and their effects on public health: A narrative literature review

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EXECUTIVE SUMMARY

The purpose of this narrative review is to describe the effects of fragrances on human health through the available scientific literature. MEDLINE, EMBASE, and Web of Science were the three primary database sources we used for this review. Two researchers independently conducted a database search which was later merged, and duplicates were removed. A total of 27,743 articles were identified from these electronic databases. Finally, 52 articles met our selection criteria for inclusion in this literature review.

Canadian health policy must be designed to address the health issues of individuals who experience a range of symptoms involving multiple organ systems because of exposure to low levels of chemicals. Fragranced products are used by some persons as an accessory to feel or smell better, but as these chemicals readily disperse into the air, they may trigger a series of adverse reactions for others. Public spaces, especially hospitals and other health-care facilities, must cater to the needs of those who suffer from many possible types of chemical sensitivities. These zones need to be environmentally safe, in order to offer free access to the many kinds of treatments that ill persons require, despite the fact that they also suffer from chemical sensitivity.

Frequently identified adverse effects of fragrances or fragranced products among children and adults are migraine headaches, asthma attacks and diverse symptoms involving multiple systems, such as neurological (cognition), respiratory, dermatological, gastrointestinal, cardiovascular and musculoskeletal problems.

INTRODUCTION

Specially selected fragranced chemicals, their dispersants and additives to slow evaporation and prolong the fragrance are frequently used in very diverse types of commercially available consumer products. They include, but are not limited to, perfumes, cosmetics, emollients, cleaning products, deodorants, fabric softeners, drugs, sunscreens, plastics, products to scent the air (air fresheners, scented candles) and other household products. Almost 95% of women and 75% of men are daily in contact with cosmetics [1]. In this review of the available literature, we describe what is meant by the term fragrance, the many fragranced consumer products, their impact on the environment and the associated health risks.

Our skin, nervous and olfactory systems each play a vital role in determining quality of life (QoL), for instance, by absorbing and processing many complex mixtures of volatile organic compounds (VOCs) in the environment, both indoors and outdoors. How our body responds to them depends not only on the number and types of ingredients mixed together, but also on the concentrations of these various chemicals. How the reaction to VOCs by olfactory and trigeminal nervous systems is experienced as a sensory irritant or a smell is still unclear; however, what is clear is that sensory irritation induces sensations like itching, pain, irritation in eyes and edema [2]. For example, fragrance allergy and its effect on quality of life (QoL) has been specifically compared with other allergic eczema reactions in patients. The main finding was that young women recently diagnosed with allergies to fragrances seemed to have inferior QoL compared to other eczema patients [3].

Some countries have agencies with specific authority to regulate fragrances. The US Food and Drug Administration (FDA) monitors fragrances in the USA. Health Canada is the ministry that regulates cosmetic products safety in Canada. In Europe, the European Commission (EC) actively monitors fragrance. The International Fragrance Association (IFRA), created in 1973, ensures the safe use of fragrance ingredients by establishing a self-regulation system for the fragrance industry and Canadian Fragrance Materials Association (CFMA) is part of IFRA. The interpretation of Fragrance, in the *Guidelines for VOCs in Consumer Products*, issued by the National Office of Pollution Prevention in accordance with the Canadian Environmental Protection Act (CEPA, 1999), is:

"(…) a substance or mixture of aroma chemicals, natural essential oils and other functional components that is added to a consumer product to impart an odor or scent, or to counteract a malodor (parfum)."

Under the Canadian Law, *Cosmetic Regulations* (C.R.C., c. 869, *Food and Drugs Act*) Section 24 states [4]:

"(1) The label of a cosmetic that presents an avoidable hazard must include directions for safe use. (2) For the purpose of subsection (1), ***avoidable hazard*** means a threat of injury to the health of the user of a cosmetic that can be: (a) predicted from the cosmetic's composition, the toxicology of its ingredients and the site of its application; (b) reasonably anticipated during normal use; and (c) eliminated by specified limitations on the usage of the cosmetic.**"**

Presently, fragranced consumer products in Canada do not present any cautionary labeling for any avoidable hazards and, for cosmetics, it is not obligatory to list ingredients on the label [5]. The lack of disclosure of all ingredients by fragranced products manufacturers can hinder efforts to understand and reduce associated adverse effects entirely. Health effects data on the majority of industrial and consumer chemicals in fragranced products are therefore inadequate.

The National Research Council of Canada in 1984 conducted health hazard assessment for substances in seven categories and appraisal showed no data or minimal data available for 84 percent of cosmetic ingredients [6]. Most chemical ingredients in cosmetics have not been adequately tested for their effects on human health and the environment. Patients who are chemical sensitive may fill in the gaps long before the toxicologists do.

Fragrances surround us in everyday life and affect our behaviour, mood and well-being [7-9]. Natural fragrances (balsams, essential oils, concentrates/absolutes) are obtained from trees rich in resins, flowers and plants, by well-defined methods such as distillation, extraction, enfleurage, maceration and expression [10]. Fragrance industry relies on over 3,000 chemical substances, which have a characteristic odour (of which almost 10% are of natural origin). This review focuses on artificial fragrances in scented products and excludes purely natural products. Monomolecular fragrance is not generally used because a combination is selected to create a unique perfume; a single perfume may contain up to 300 different molecules, most of them synthetic. Similarly, chemical cosmetics and toiletries usage studies (Table 1) show that these scented consumer goods contain multiple artificial fragrances, and in different ratios. Sensitization can arise after a sufficient exposure or after multiple exposures, and once sensitization has occurred, a much lower quantity of allergen(s) can cause an elicitation response [11]. Similar results about fragrance ingredient labeling in products on sale were seen from a study conducted in the UK [12].

Table 1: Most commonly found fragrances in cosmetics and toiletries

Rank order	Fragrance found in 400 products in the USA	% of products containing fragrance listed	Rank order	Fragrance found in 400 products in the Netherland	% of products containing fragrance listed
1	Linalool	90	1	Linalool	91
2	Phenylethyl alcohol	82	2	Phenylethyl alcohol	79
3	Linalyl acetate	78	3	Benzyl acetate	78
4	Benzyl acetate	74	4	Limonene	71
5	Benzyl salicylate	74	5	Citronellol	71
6	Coumarin	68	6	Linalyl acetate	67
7	Terpineol	66	7	γ – methylionone	63
8	Hedione	56	8	Terpineol	52
9	Hexyl cinnamic aldehyde	51	9	β – pinene	51
10	γ - methylionone	51	10	Geraniol	50
11	Terpinyl acetate	50	11	Hydroxycitronellal	49
12	Lilial	49	12	Benzyl benzoate	49
13	Lyral	46	13	Hexyl cinnamic aldehyde	48
14	Geraniol	43	14	Lilial	48
15	Heliotropin	43	15	Coumarin	44
16	Galaxolide®	41	16	Benzyl salicylate	43
17	Acetyl cedrane (Vertofix®)	41	17	Benzyl alcohol	42
18	Musk ketone	38	18	Eugenol	36
19	Citronellol	38	19	α – pinene	35
20	Amyl salicylate	32	20	Geranyl acetate	35
21	Eugenol	26	21	α - amylcinnamic aldehyde	35

22	Vertenex	25	22	Musk ketone	34
23	Isobornyl acetate	23	23	Caryophyllene	33
24	α - amylcinnamic aldehyde	21	24	Lyral	33
25	Hydroxycitronellal	21	25	Camphor	31

(Source: De Groot & Frosch, 1997)

According to Uter et al. [13], their survey and past data search verified that the most frequently used fragrance substances are limonene and linalool. These two chemicals (limonene and linalool) in their unoxidized forms are comparatively weak sensitizers according to the local lymph node assay (LLNA); however, oxidation intensifies their sensitizing potency from five to ten-fold.

Perfume sensitization must not, therefore, be considered as an interaction of the body with a single molecule, but with a complex mix. Perfumes are mainly heterogeneous mixes of molecules of a range of sizes and reactivity, which can result in many interactions during skin penetration or with antigen-presenting cells. Skin irritation and allergic reaction do occur, and numerous cases are not reported to manufacturers and physicians. Various fragranced products are examined in epidemiological and toxicological studies for their irritation and allergic reactions. Adverse reactions largely depend on the sort of chemical constituents present in the product used and the contact time. There is a recognized correlation between the frequency of cosmetic application and development of allergies [1] [13].

Recognizing a precise sensitizer in perfume is a daunting task. Perfumes may be both sensitizers and photosensitizers or just photosensitizers. Patch tests with perfumes, therefore, must be done not only by the traditional closed patch test method, but also by the open process of exposure to the light [14]. Fragrance Mix I (FM I), introduced in 1977 as a screening tool, contains eight fragrance ingredients: alpha-amyl cinnamic aldehyde, cinnamic alcohol, cinnamic aldehyde, eugenol, geraniol, hydroxycitronellal, isoeugenol, and oakmoss absolute (*Evernia prunastri*), each with a concentration of 1% in petrolatum as a solvent. Fragrance ingredients are continually changing. Hence, Fragrance Mix II (FM II) was introduced in 2005 as a new screening tool, which contains: alpha-hexyl cinnamic aldehyde 5%, citral 1%, citronellol 0.5%, coumarin 2.5%, farnesol 2.5%, and hydroxyisohexyl 3-cyclohexene carboxaldehyde (HICC, "Lyral") 2.5% (also in petrolatum as a solvent).

The purity of allergen preparations is still viewed as a fundamental prerequisite, to eliminate false assumptions about the identified allergen and avoid misleading preventive advice. However, in reality, people are exposed to a 'cocktail' of substances that enhance sensitization, a fact that has been evidenced by recent research [13]. For example, a study conducted by Heisterberg et al. [11] concluded that 15.6% of fragrance allergic patients would have been missed if FM II had not been utilized in detecting the sensitivity to fragrance among patients.

There are many ways of classifying products containing fragrances. One way of categorizing cosmetics is dividing them into two groups: left on the skin (leave-on) and rinsed off the skin (rinse-off). Perfumes, deodorants, lotions, creams and lipsticks are a few examples from the leave-on group, and they are responsible for the majority of chemical hypersensitivity. The rinse-off group includes shampoos, conditioners, shower soaps/gels, detergents and hair colouring products [1]. Leave-on creams are often the most commonly assessed type of product [13].

In a wide, 4-year study conducted by Heisterberg et al. [15], 718 patients (556 women, 162 men) had a positive reaction when exposed to a patch test for leave-on and rinse-off fragranced cosmetic products. All patients observed were patch tested with FM I, FM II, HICC 5% and *Myroxylon pereirae* (balsam of Peru: 25% in petrolatum). In their study, the majority of cosmetic products listed were "leave-on" products (74.3%), and the remaining (25.7%) were "rinse-off" products. The results showed leave-on cosmetic products causing fragrance allergy in 75.9% for women and 69.2% for men; the rinse-off fragrance allergy ratio was 24.1% for women, 30.8% for men.

Table 2: Concentrations of perfumes in various products

Aerosol freshener	0.5% - 2%
Bathroom cleaners	≤ 5 %
Colognes	2% - 5%
Compressed powder	0.5%
Facial make-up	1.0%
Hair pomade	0.5%
Hair spray	0.1 % - 0.3%
Laundry powder	0.1 % - 0.3%
Lipstick	1.0%
Masking perfume	≤ 0.1 %
Perfume	12% - 20%
Shower and bath formulation	0.5% - 4 %
Skin care products (emulsions)	0.3% - 0.5%
Soap	0.5 % - 2 %
Toilet water	5 % - 8% (or higher)

(Source: De Groot & Frosch, 1997)

Among different categories of cosmetic products, the concentration of fragrance also varies. Listed in Table 2 are various products with different concentrations with respect to the other categories, and the range depicts that within each category of cosmetic product the concentration is not fixed.

Heisterberg et al. (2011), in their study, found that frequently identified sources of allergic contact dermatitis were deodorants (25.3%), scented lotions (24.4%), fine fragrances (16.0%), shampoos (13.0%), liquid soaps (10.8%), aftershaves (2.7%), lipsticks (1.9%) and the remaining categories had frequencies of 1% or less.

METHODS

In our review, we use the term fragrance synonymously with scent and perfume.

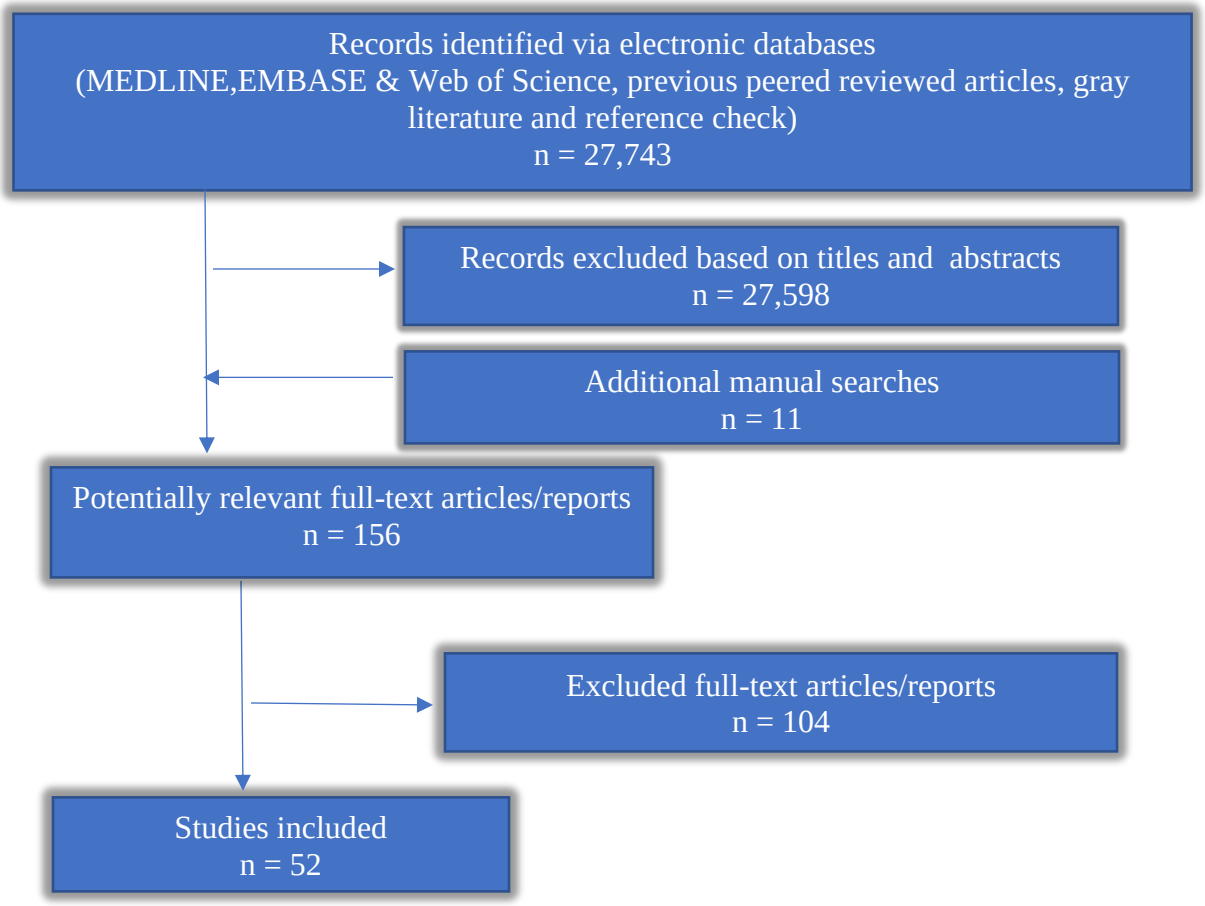
All information used to write this paper are from the sources listed below. In this work, three primary databases were searched. Our exclusion criteria were: any literature related to fragrance effects on animals; fragrance effects on health based on occupational exposure; studies about natural fragrances. The initial search yielded 27,743 articles.

Primary databases used for narrative review:

- MEDLINE search 1966–January 2017. Keywords: Review of the Literature; Authorship; Meta-analysis; Narrative overview.
- EMBASE
- Web of Science

Governmental Web databases and manual searches for references were also performed.

Study selection diagram



RESULTS AND DISCUSSION

We spend a significant portion of our daily time in indoor built environments, where a large percentage of adverse health effects is attributed to indoor air pollutants [16] or inadequate indoor air quality (IAQ). In this regard, the 'European co-ordination action on indoor air quality and health effects' (ENVIE project, 2004-2008) has prioritized diseases caused or aggravated by poor IAQ, as follows: allergic and asthma symptoms, lung cancer, chronic obstructive pulmonary disease, airborne respiratory infections, cardiovascular disease, odour and irritation (SBS – Sick Building Syndrome) [17].

Fragrance and/or fragranced consumer products have been linked to adverse effects on health, including headaches and migraines [18-19] [21], asthma and asthmatic reactions [16] [20] [22], osmophobia [23], mucosal symptoms [24], contact dermatitis [25-27], and photosensitivity (phototoxicity and photoallergy) [28].

A study based on an online survey in the UK, comprising England, Wales, Northern Ireland and Scotland, examined the prevalence and types of fragranced product used, associated health effects, awareness of product emissions, preferences for fragrance-free policies, and indoor environments reported health problems from exposures to fragranced consumer products. The frequency of

adverse effects were respiratory (11.6%) and skin (9.8%) problems, mucosal symptoms (9.2%), migraine headaches (8.4%), asthma attacks (6.8%), neurological (3.7%), cardiovascular (3.2%), gastrointestinal (3.0%), cognitive (2.8%), musculoskeletal (2.0%) and immune system (1.9%) problems [20].

A recent survey of people medically diagnosed with environmental sensitivities / multiple chemical sensitivity (ES/MCS) revealed that 91.5% have fragrance sensitivity and 77.5% are prevented from access to places because of fragranced products [29].

For a realistic exposure assessment, it is useful to understand the usage patterns of fragranced cosmetic products accurately. An adequate safety assessment of fragrance materials begins with a classification of them in terms of chemical structure (Table 3). Chemical structure knowledge aids in the prediction of transdermal absorption, metabolism and functional groups that cause toxicity [28]. In Sweden, a nationally representative, population-based study examined the frequency and categories of fragranced products in use, associated health effects, exposure situations, knowledge of product emissions, preference for fragrance-free policies and indoor environments. In this realistic fragrance exposure assessment across the Swedish nation, 33.1 % reported health problems like respiratory difficulties (20%), migraine headaches (16.1%) and asthma attacks (5.5%) [30]. Parallel to this study, three other national surveys in the USA, UK, and Australia found that 34.7%, 28.7% and 33.0% (respectively) reported one or more adverse health effects from exposure to fragranced consumer products [16] [20] [31].

Table 3: Classification of fragrance ingredients based on chemical structure

Structural group	No. of chemicals	Structural group	No. of chemicals
Esters	707	Pyrans	27
Alcohols	302	Miscellaneous	27
Ketones	259	Schiff's bases	26
Aldehydes	207	Heterocyclic	25
Ethers	100	Epoxides	25
Hydrocarbons	82	Sulfur-containing	24
Acetals	63	Pyrazine	22
Lactones	61	Amines/amides	18
Carboxylic acids	42	Quinolines	14
Phenols	40	Musk	10
Nitriles	39	Coumarins	4
Dioxanes	31	**TOTAL**	**2155**

(Source: Bickers et al., 2003)

Exposure assessments for the solvents or fixatives in scented products are also important as they may further aggravate other health problems. Ethanol and water, alone or in a mix, are most frequently used as solvents (Table 4) in perfumes [9]. Similarly, phthalates esters (PAEs) are commonly used in cosmetics and other personal-care products as solvents or fixatives. A study conducted by Al-Saleh & Elkhatib [32] evaluated the potential genotoxicity of PAEs in 42 brands

of perfumes on TK6 human lymphoblast cell line, and indicated that most of the perfumes induced significant DNA damage. Other adverse effects highlighted were high urinary levels of diethyl phthalate metabolites, low levels of PAEs displaying estrogenic activities that induced the proliferation of human cancer cells, or DNA damage in the sperm.

Table 4: Composition-based classification for perfumes

Type	Concentrate (% v/v)	Ethanol (% v/v)	Water (% v/v)
Extrait or parfum	15-30	74-77	1-3
Eau de parfum	8-15	75-80	9-13
Eau de toilette	4-15	72-81	10-18
Eau de cologne	3-5	58-77	20-40
After shave	2-8	47-67	30-50
Splash cologne	2-3	49-68	30-50

(Source: Teixeira, Rodríguez & Rodrigues, 2010)

ASTHMA

Asthma is described as a chronic inflammatory illness of the respiratory tract, characterized by repeated attacks of breathlessness and wheezing, occurring in people of all ages. The World Health Organization (WHO) evaluates that around 235 million people suffer from asthma, and according to their latest estimates, a total of 338,000 deaths were caused by this condition in 2015 [33]. In 2018, the population of Canada was 37.058 million [34], as for Quebec, it was 8.390 million [35], with 116 health-care facilities offering emergency services to this provincial population [36]. Asthma is the predominant respiratory illness in Canada, and the number of asthmatics increases each year. Close to 2.6 million Canadians were estimated to suffer from asthma in 2018 [37], with almost 600,000 of them living in Québec [38], including over 350,000 children and adolescents [39]. Unfortunately, many patients who have asthma complain that some odours (perfume and cologne in particular) worsen their asthma.

A study by Elberling et al., with 946 responders (all previous participants to the Copenhagen Allergy Study, 1989-1998), found that individuals (age range: 20-82 years) with asthma are more often and more severely troubled by exposure to fragranced products than individuals without asthma. The most recurrent symptoms were associated with nose, followed by the eyes, lungs, and mouth. In this survey, 56% reported symptoms linked to other individuals wearing perfumes, 32% from air-fresheners and 28% related to other individuals wearing newly washed clothes (scented detergents). Also, 67% of non-allergic asthma individuals reported a minimum of one mucosal symptom caused by fragranced products within the last 12 months [24].

Additionally, a study in the USA assessed the percentage of individuals who reported adverse effects from exposure to fragranced consumer products in the general population, in the subpopulation of those with asthma, and also in people who are chemically sensitive. The prevalence of individuals affected by fragrance was 30.5% in the general population, 37.5% in asthmatic patients, and 67% in those who are chemically sensitive – these two last conditions overlap significantly [22].

DERMATITIS

The most common skin reaction identified concerning fragrance is allergic contact dermatitis [40]. Even so, the prevalence is presumed to be underestimated, as many individuals may be aware of the perfumed products they tolerate or not, and they seldom consult a dermatologist about this problem [41]. Allergic Contact Dermatitis (ACD) is a type IV delayed hypersensitivity reaction which needs prior sensitization (characterized by exogenous allergens entering the epidermis) and elicitation (characterized by repeated exposure to the allergens). Admani & Jacob [42] reviewed a decade of literature on pediatric ACD in the USA, Canada and other parts of the world. Table 5 lists studies in which fragrance is mentioned as one of the most common allergens in children.

Table 5: Fragrance as one of the most common allergens in children (studies)

Data studies				
Author/Date	**Country**	**Patients #**	**Patient population tested/ Series tested**	**Findings where fragrance was among the most common allergens**
Lewis, et al., 2004	Wales	191	Children <16 years/ European Standard Series	• PPT rate 41 % • 51.7 % were clinically relevant
Heine, et al., 2004	Germany	2460	Children 6–18 years/ Standard series plus other allergens depending on individual indications	• PPT rate 52.6 % in children age 6-12 and 49.7 % in adolescents 13-18 years of age
Clayton, et al., 2006	England	500	Children 0–16 years/ British Contact Dermatitis Society standard series, plus additional series when indicated	• PPT rate 27 %, 61% relevant
Beattie, et al., 2007	Scotland	114	Children 3–15 years/ European Standard Series or British Contact Dermatitis Group Standard Series	• 54 % PPT, 54 % clinically relevant
Hogeling, et al., 2008	Canada	100	Children 4–18 years/ NACDG standard series, supplementary series if indicated and own products if available	• 70 % PPT, 55.8 % clinically relevant • No gender/age differences • Children with AD were as likely as those w/o AD to have a positive reaction
Zug, et al., 2008	USA	391	Children 0–18 years [9,670 adults (19 and older)]/ NACDG series with supplemental series as needed	• No significant difference in frequency of RPPT reaction in children compared to adults • Children with AD just as likely as those without to have RPPT

Kuljanac, et al., 2011	Croatia	412	Children ≤18 years [440 adults (19 and older)]/ Standard series of allergens manufactured in Croatia	• Top allergens differed between children and adults
Jacob, et al., 2011	USA	102	Children 6–18 years/ T.R.U.E.™ test	• 76.2 % PPT • T.R.U.E.™ test is safe and efficacious in pediatric population
Schena, et al., 2012	Italy	349	Children 0–15 years/ Standard series of allergens of the SIDAPA	• 69.3 % PPT, 69.8 % RPPT •Children with AD 55.3 % PPT (50 % relevant), children without AD 76.9 % PPT (77.5% relevant) • Sensitizers were similar in children with and without AD
Literature reviews				
Author/Date				**Findings where <u>fragrance</u> was among the most common allergens**
Militello, et al., 2006	USA		Review of literature on pediatric ACD	• Rate of ACD in children is increasing, prevalence increases with age • Females have a higher rate of ACD on face
Matiz, et al., 2009	USA		Review of international studies on pediatric ACD	• Contact allergy is not synonymous with ACD • Top 5 global allergens: nickel, cobalt, antibiotics, fragrances, rubber chemicals • In the US, contact dermatitis has an estimated $1.6 billion burden of cost • ROAT can help to determine the clinical relevance
ACD- allergic contact dermatitis; AD- atopic dermatitis; NACDG- North American Contact Dermatitis Group; PPT- positive patch test; RPPT- relevant positive patch test; SIDAPA- Societa Italiana di Dermatologia Allergologica Professionale e Ambientale; T.R.U.E.™TM- Thin-Layer Rapid Use Epicutaneous				

(Source: Admani & Jacob, 2014)

Kintziou, Papaioannou & Rallis [43] conducted a study where 785 Greek patients (273 men, 512 women) with contact dermatitis were patch tested for sensitivity to perfumes (Fragrance Mix I, 8% in white petrolatum). They not only determined the percentage of sensitivity in this subpopulation, but also the frequency of sensitivity according to sex, age, occupation and affected anatomic site. They found that 8.4% of men and 8.0% of women showed a positive reaction to perfume mixture, with the location of dermatitis distributed as 16.2% on face, 6.7% on hands, 5.0% on body and 3.9%

on legs. The highest ratio of sensitivity to perfume was found in the age groups of 45-59 (12.7%) and 60 and/or above (12.8%). Another study also confirms that exposure to airborne and topical fragranced allergens can cause ACD [44].

As early as 1968, Rothenborg & Hjorth [45] studied 1,943 dermatitis patients for two consecutive years, and they found that three quarters of them were sensitive to benzyl salicylate – a common perfume ingredient. Nearly 75% of these patients had dermatitis localized to hands, legs and feet.

Schena et al., in a 7-year study with 349 children, found 26.67% upper limbs/hands, 13.33% lower limbs/feet, 33.33% face, 13.33% trunk and 13.33% widespread (extensive areas) affected by ACD in relation to fragrance. They also observed the highest sensitization rate (76.7%) to allergens in very young children (0 to 5 years old) [46]. Finally, it is noteworthy that for a significant number of ACD patients, their allergy is caused by more than one cosmetic product [15].

MIGRAINE

Numerous primary headache disorders, such as migraine and tension-type headache, impose a burden on sufferers, including substantial suffering, impaired quality of life and financial cost [47]. Migraine is defined as a pulsating headache lasting from a few hours to several days, accompanied by nausea, vomiting, and sensitivity to light, sounds, smells, or other stimuli. While migraine likely has some genetic roots, environmental factors have been shown to play a significant role in how it affects those who suffer from migraine [23] [48].

Around 14% of the world's population, women more likely than men, are estimated to have suffered from a migraine at some stage of their life [48]. In 2010/2011, Statistics Canada[1] estimated that 8.3% of Canadians (2.7 million) had been diagnosed with migraine (Table 6). These results are described as being likely to underestimate migraine prevalence, because some individuals who experience migraine do not reach out for professional help, and therefore, do not get reported, even if this condition affects many aspects of their daily life, including work, education, sleep, and driving [49].

A study was conducted by Silva-Néto, Peres & Valença [19], of 200 migraine patients and 200 tension-type headache patients, to determine fragrances that trigger migraine attacks and the time of onset of a headache after exposure of patients to fragrance. The substances that provoked migraine attacks, ranked by frequency, were: perfumes, paints, gasoline, and bleach. The triggering of headaches by odours occurred in 140/200 migraine patients, but not among tension-type headache patients.

Several environmental and behavioral features are associated with activating or deteriorating further an already existing migraine condition. These trigger factors can be sleep disorders, type of food intake, stress, hormonal factors, and odours. Some of these conditions can be avoided or mitigated by changing the behaviour of the patients or the environment they are likely to face [23].

[1] Data for this study came from the *Neurological Conditions Prevalence File*, which was derived from the 2010 and 2011 Canadian Community Health Survey–Annual Component (CCHS), and the 2011 *Survey of Living with Neurological Conditions in Canada* (SLNCC): https://www150.statcan.gc.ca/n1/pub/82-003-x/2014006/article/14033/data-donnee-eng.htm

Table 6: Sample, estimated population and percentage reporting migraine diagnosis, by selected characteristics, household population, Canada, 2010/2011

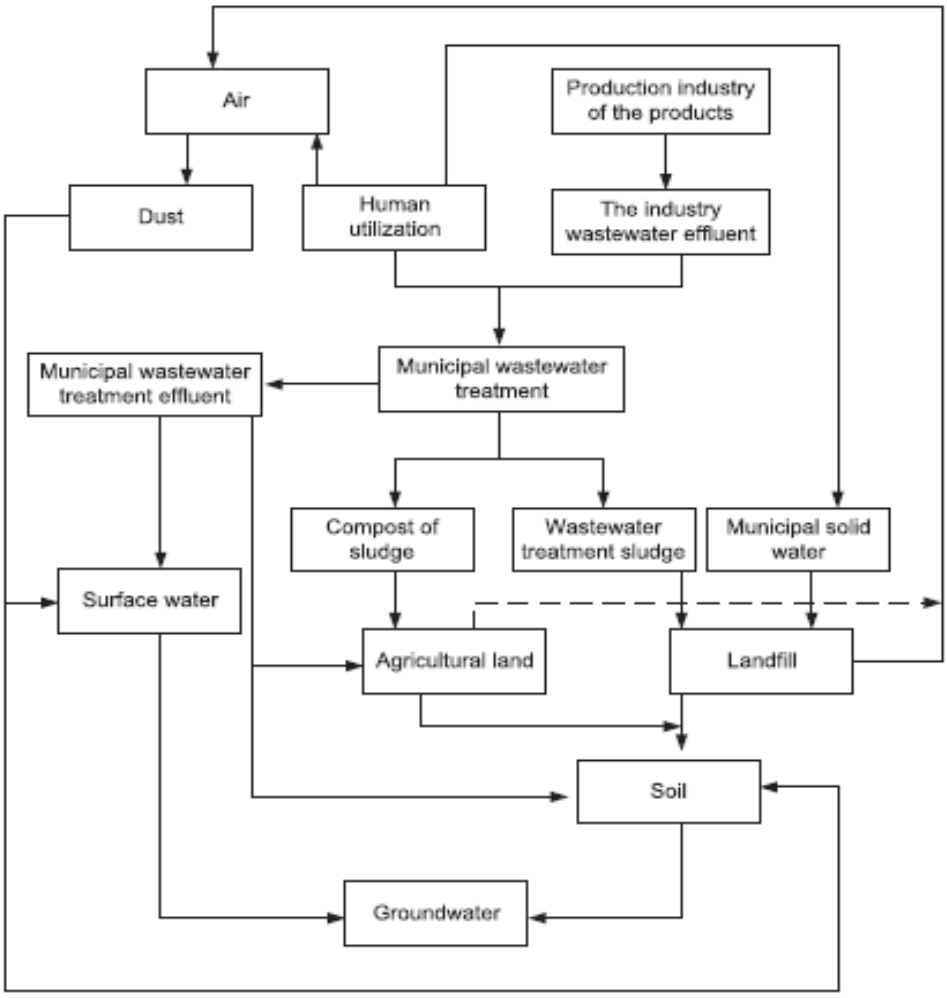
	Sample size	Estimated population '000	Prevalence %
Canada	22,720	2,707.4	8.3
Migraineurs with other selected neurological conditions‡	1,451	170.9	0.5
Migraineurs without other selected neurological conditions	20,886	2,478.6	7.7
Sex			
Female	16,470	1,941.4	11.8*
Male†	6,250	766.0	4.7
Age group			
0 to 11	293	31.6	0.7*
12 to 29	4,550	604.0	8.1*
30 to 49†	9,078	1,177.9	12.1
50 to 64	6,518	664.9	9.9*
65 or older	2,281	229.0	5.1*
Province			
Newfoundland and Labrador	689	43.8	8.8
Prince Edward Island	352	12.2	8.7
Nova Scotia	905	83.1	9.1*
New Brunswick	908	63.7	8.9
Quebec	3,313	518.8	6.8*
Ontario	8,448	1,116.0	8.8*
Manitoba	1,298	108.0	9.5*
Saskatchewan	1,277	81.4	8.4
Alberta	2,258	311.5	8.7
British Columbia	2,686	361.3	8.3
Yukon	221	2.5	7.3
Northwest Territories	219	3.4	8.0
Nunavut	146	1.7	7.6

* significantly different from reference group ($p < 0.05$)
† reference group; Canada is reference group for provincial comparisons
‡ ALS (Lou Gehrig's disease/amyotrophic lateral sclerosis), Alzheimer's disease or any other dementia, brain injury, brain tumour, cerebral palsy, dystonia, effects of a stroke, epilepsy, Huntington's disease, hydrocephalus, multiple sclerosis, muscular dystrophy, Parkinson's disease, spina bifida, spinal cord injury, spinal cord tumour, Tourette's syndrome
Note: Sample, estimated population and prevalence for Canada exceed sum of subcategories because of 383 people who could not be classified (reported migraine but were missing information on other selected neurological conditions).
Source: 2010/2011 Canadian Community Health Survey - Neurological Prevalence File.

FRAGRANCED MATERIAL IN THE ENVIRONMENT

Figure 1 shows how fragranced consumer products such as detergent and shampoo used in the home and sent down the drain, and the discharge of the wastewater from fragranced products manufacture, ultimately become part of surface water, groundwater, wastewater and wastewater sludge [50]. Water treatment facilities, both municipal and industrial, cannot entirely remove fragrance materials. Ultimately, they will go with the effluent of the wastewater treatment and become part of the receiving water body, a river or an ocean [50-51]. Significant levels have been measured in the Great Lakes [52].

Figure 1: Fragrance material transportation in the environment



(Source: Zhang et al., 2013)

ENVIRONMENTAL SENSITIVITIES / MULTIPLE CHEMICAL SENSITIVITY

Environmental sensitivities / multiple chemical sensitivity (ES/MCS) is a condition in which the person experiences a range of symptoms due to exposure to low levels of chemicals that do not affect healthy individuals. Air pollution, outdoor as well as indoor, has a significant effect on the regulatory system of our bodies. Fragranced consumer products such as soaps, perfumes, fabric softeners, detergents, fresh paint, and cleaning products, among many others, are the causative agents. Specific new products, objects or materials – such as new carpet, synthetic materials, clothing, furniture, paint or a freshly painted building – release sharp odours that may cause health issues [53-54].

Chemical sensitive individuals display a wide range of symptoms: for instance, one individual may present more cardiovascular manifestations; another might present more respiratory ones [55-58]. The symptoms commonly associated with fragrances are shortness of breath, palpitation, headache,

dizziness, fatigue, confusion, poor cognition, and disturbed metabolic regulation [59-60]. Thus, it includes respiratory, gastrointestinal, cardiovascular and central nervous systems.

The diagnostic criteria for ES/MCS include [61]:

1- The symptoms are reproducible with each chemical exposure;
2- It is a chronic condition;
3- Low levels of exposure result in the manifestation of symptoms;
4- The symptoms improve or resolve when the incitants are removed;
5- Responses occur to multiple chemically unrelated substances;
6- Symptoms involve multiple organ systems.

ES/MCS is an emerging illness and although non-specific biochemical aberrations are commonly noted, no biological markers have been identified yet to define or identify a patient with ES/MCS [62]. Therefore, more in-depth studies are required to understand this disease fully and ultimately to find a cure. The main treatment strategy, so far, is to avoid any chemical exposures that trigger the symptoms mentioned above.

It is important to highlight that the Environmental Health Clinic at Women's College in Toronto (Ontario) [63], the Integrated Chronic Care Service in Nova Scotia [64], and the British Columbia Women's Hospital and Health Centre in Vancouver [65], all provide assessments and management advice for patients with possible ES/MCS. This is an emerging public health issue [63-65]. In the past decade, the prevalence of physician-diagnosed ES/MCS has increased over 300%, and self-reported chemical sensitivity over 200% [66].

WHY SCENT/FRAGRANCE-FREE POLICY?

A policy is a strategy or an approach, deliberately built to guide decisions and achieve rational outcomes. Fragrances can contribute to poor indoor air quality, which can result in a reduction of productivity and aggravate ES/MCS for individuals in such an environment [67]. The Canadian Human Rights Commission (CHRC) recognizes ES/MCS as a disability and as a result, patients with this diagnosis are entitled to accommodation and protection from discrimination. As stated earlier, avoidance of triggering products is the best pathway to prevent reactions. However, active attention needs clear and workable strategies to diminish or eliminate the presence of such triggers in the environment.

These strategies may include developing and enforcing scent/fragrance-free and chemical avoidance policies, directing informative programs that increase acceptability for such policies and better management of chemicals in use. Such precautionary measures can prevent injuries and illnesses, which ultimately reduce costs that are meant to address health and safety risks [68]. Because patients are more vulnerable, the presence of fragranced products in hospitals should not be an option.

A hospital, by definition, is an institution that provides medical treatment and nursing care for sick and injured people. Administrative authorities in various Canadian hospitals have recognized that certain practices, like the application of artificial scents to our body, are unacceptable inside hospitals [63] [65] [69]. Thus, they have voluntarily established a scent/fragrance-free policy to protect patients from the risks associated with the exposure to scented/fragranced products [63-65].

According to the evidence based on large-scale studies presented earlier in this review, asthma, dermatitis, and migraine sufferers are specifically more vulnerable to artificial fragrances within their surroundings. Also, in a survey, it was concluded that approximately 30% of individuals from the general population had reported some sensitivity to fragrances worn by others [22]. This exposure concern stands true for all hospitals, since these vulnerable patients are involuntarily exposed to artificial fragrances from staff, other patients, and visitors, and affects their medical conditions. Sensitivity to scented/fragranced products can be a significant barrier to access health-care [69].

The state of health of individuals suffering from ES/MCS is mostly dependent on their surroundings and the people surrounding them. Thus, a collective effort is required to understand and make changes as mentioned above. All health-care facilities should be safe places to go to, where the aim and objectives of everyone are to improve the health and quality of life for every individual. Hospital policies should be flexible enough to accommodate the required changes with time. The literature to date is clear that there are potentially harmful effects of scented/fragranced products. Thus, hospitals and all health-care facilities should accommodate the needs of vulnerable people by implementing and enforcing a scent/fragrance-free policy.

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