Exposures and Effects from Fragranced Consumer Products in Sweden

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Abstract

Fragranced consumer products—such as cleaning supplies, perfume, and air fresheners—have been associated with indoor air pollutants and adverse human health effects. Through a nationally representative population-based survey, this study investigates sources and risks associated with exposure to fragranced consumer products in Sweden. It examines the frequency and types of fragranced product use, associated health effects, exposure situations, knowledge of product emissions, and preferences for fragrance-free policies and indoor environments. Data were collected in July 2017 using an online survey of adults (n=1,100), representative of age, gender, and region in Sweden. Across the Swedish population, 33.1% report health problems, such as respiratory difficulties (20.0%), migraine headaches (16.1%), and asthma attacks (5.5%), when exposed to fragranced products. Of these reports, 24.2% could be considered potentially disabling. While 98.5% use fragranced products at least once a week, 70.9% were unaware that fragranced products, even ones called green and organic, can emit potentially hazardous air pollutants. Importantly, 6.7% of the population lost workdays or a job, in the past year, due to exposure to fragranced products in the workplace. Also, 18.1% enter and then leave a business as quickly as possible due to air fresheners or a fragranced product. A strong majority of the population would prefer that workplaces, health care facilities and professionals, airplanes, and hotels were fragrance-free rather than fragranced. Results from this study provide new and important evidence that exposure to fragranced consumer products is pervasive in Sweden, that these exposures are associated with adverse health and societal effects, and that reducing exposures such as through fragrance-free policies can provide benefits to air quality and public health.

Keywords: fragranced consumer product, fragrance, fragrance-free policy, indoor air quality

Introduction

Swedish society is filled with fragranced consumer products. Fragranced consumer products (or fragranced products) are chemically formulated products with the addition of a fragrance, aroma, or scent (Steinemann 2015). Common products include air fresheners, laundry detergents, cleaning supplies, personal care products, household items, soaps, hand sanitizers, baby products, and cosmetics—among hundreds of products that are used by individuals, industries, and institutions every day.

Fragranced consumer products contain and emit complex mixtures of chemicals, such as the volatile organic compounds (VOCs) limonene, alpha-pinene, beta-pinene, ethanol, acetone, and acetaldehyde (Steinemann 2015), which contribute to personal exposure and indoor air pollution. In addition, fragranced product emissions of terpenes (e.g., limonene) react with ozone to generate secondary pollutants such as formaldehyde (e.g., Carslaw 2013; Nazaroff and Weschler 2004).

Previous studies of fragranced product emissions found that relatively few ingredients were disclosed to the public (e.g., Uhde and Schultz 2015; Steinemann et al. 2011; Steinemann 2015). For instance, Steinemann (2015) found over 150 different VOCs emitted from 37 fragranced consumer products in the US, with 42 VOCs classified as toxic or hazardous under US federal laws. Emissions of hazardous air pollutants from so-called green, organic, or natural fragranced products were not significantly different from regular fragranced products. However, fewer than 3% of over 550 collective ingredients were disclosed to the public on the product labels, material safety data sheets, or websites. Further, over two-thirds of the fragranced consumer products, other than cosmetics, did not disclose that the product contained a fragrance. In the European Union, the cosmetics directive requires listing of any of 26 fragrance allergens present above 0.001% in leave-on products and 0.01% in rinse-off

products (EC 2009). However, currently no law in Sweden, or in any other country (to best knowledge), requires complete disclosure of all ingredients in fragranced consumer products (Steinemann 2009; Lunny et al. 2017).

Fragranced consumer products have been associated with a range of adverse health effects including migraine headaches (Steinemann 2016, 2017, 2018; Kelman 2004), asthma and asthmatic reactions (Weinberg et al. 2017; Steinemann 2016, 2017, 2018), breathing difficulties (Caress and Steinemann 2009), mucosal symptoms (Elberling et al. 2005; Millqvist and Löwhagen, 1996), and contact dermatitis (Matura et al. 2005; Johansen 2003; Rastogi et al. 2007). In three other studies parallel to this one, nationally representative surveys in the USA (Steinemann 2016), Australia (Steinemann 2017) and the UK (Steinemann 2018) found that 34.7%, 33.0%, and 28.7% of the population (respectively) reported one or more type of adverse health effects from exposure to fragranced products.

In Sweden, previous regional studies determined the prevalence of intolerance to odours from certain fragranced products. In Skövde, Johansson et al. (2005) found a prevalence of 33.0% self-reported general odour intolerance among adults aged 20 and over (n=1,387), as determined by "Are you bothered by strong odours (e.g., perfume, cleaning agents or flower scents)?" Also in Skövde, using the same criterion, Andersson et al. (2008) found a prevalence of 15.6% self-reported odour intolerance among teenagers aged 13-19 (n=326). In Västerbotten, Palmquist et al. (2014) found a prevalence of 12.2% of odorous/pungent chemical intolerance among respondents aged 18-79 (n=3,406), as determined by "Are you getting symptoms from odorous/pungent chemicals (not limited to certain buildings), such as perfumes and cleaning agents?"

This article reports results from a nationally representative study of Sweden to investigate the sources of emissions and the health and societal effects from fragranced consumer products.

It complements recent national studies in the US, Australia, and the UK, and supports previous regional studies in Sweden, by providing new data on the extent and types of problems, and opportunities for solutions.

Methods

Using a national random sample representative of age, gender, and region (n=1,100; confidence limit=95%, confidence interval=3%), an on-line survey was conducted of the adult population (ages 18-65) in Sweden. The survey instrument was developed and tested over a three-year period, and used in three other national prevalence studies (Steinemann 2016, 2017, 2018).

The survey was run in the official national language of Swedish. The process of survey translation and implementation was performed by Survey Sampling International (SSI), a global survey research company and online panel provider. The survey was translated from English into Swedish by a professional linguist and native speaker based in Sweden, and proofread by another professional linguist and native speaker based in the UK for balance in the translation process. The survey was then piloted with 100 individuals before full implementation in July 2017.

The survey drew upon participants from a large web-based panel in Sweden (approximately 60,000 people), developed and held by SSI, using multi-source samples to achieve a panel blend that reflects the heterogeneity of the study population. [See SSI (2018), and Electronic Supplementary Materials "SSI Methodologies" and "Survey Methodology."] To minimize risk of bias, recruitment followed a three-step randomization process to identify potential participants [See SSI (2018), and Electronic Supplementary Materials "SSI Methodologies"

and "Survey Methodology."] The survey completion rate was 92%, and all responses were anonymous. The research study received ethics approval from the University of Melbourne. Demographic information is provided in Table 1. Survey methods follow procedures reported in Steinemann (2016, 2017, 2018). Details on the survey methodology, including the checklist for reporting results of internet e-surveys (CHERRIES, Eysenbach 2004), are provided as Electronic Supplementary Material ("Survey Methodology").

Survey questions investigated the following areas: use and exposure to fragranced products; health effects related to exposures to fragranced consumer products; specific exposure situations; effects of fragranced product exposure in the workplace and in society; awareness of fragranced product ingredients and labelling; preferences for fragrance-free environments and policies; and demographic information.

Fragranced products were categorized as follows: (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, and dishwashing soap); (d) laundry products (e.g., detergents, fabric softeners, dryer sheets); (e) household products (e.g., scented candles, toilet paper, trash bags, baby products); (f) fragrance (e.g., perfume, cologne, after-shave); and (g) other.

Health effects were categorized as follows: (a) migraine headaches; (b) asthma attacks; (c) neurological problems (e.g., dizziness, seizures, head pain, fainting, loss of coordination); (d) respiratory problems (e.g., difficulty breathing, coughing, shortness of breath); (e) skin problems (e.g., rashes, hives, red skin, tingling skin, dermatitis); (f) cognitive problems (e.g., difficulties thinking, concentrating, or remembering); (g) mucosal symptoms (e.g., watery or red eyes, nasal congestion, sneezing); (h) immune system problems (e.g., swollen lymph glands, fever, fatigue); (i) gastrointestinal problems (e.g., nausea, bloating, cramping,

diarrhea); (j) cardiovascular problems (e.g., fast or irregular heartbeat, jitteriness, chest discomfort); (k) musculoskeletal problems (e.g., muscle or joint pain, cramps, weakness); (j) other.

Specific exposure situations were investigated: air fresheners or deodorizers used in public restrooms and other environments, scented laundry products emitted from a dryer vent, being in a room after it was cleaned with scented cleaning products, being near someone wearing a fragranced product, entering a business with the scent of air freshener or some fragranced product, fragranced soap used in public restrooms, and ability to access environments that used fragranced products.

In addition, questions investigated the loss of workdays or a job in the past year due to fragranced product exposure in the workplace, awareness of fragranced product emissions and ingredient disclosure, and preferences for fragrance-free environments (i.e., workplaces, health care facilities and health care professionals, airplanes, and hotels).

Results

Main findings from the survey are summarized in this section, and complete data on responses to survey questions are provided as Electronic Supplementary Material ("Survey Data").

Fragranced product use:

Among the Swedish population, 98.5% are exposed to fragranced products at least once a week from their own use: 54.4% air fresheners and deodorizers; 90.2% personal care

products; 79.7% cleaning supplies; 76.4% laundry products; 68.0% household products; 63.3% fragrance; 3.1% other.

In addition, 93.3% are exposed to fragranced products at least once a week from others' use: 45.2% air fresheners and deodorizers; 66.0% personal care products; 43.9% cleaning supplies; 45.6% laundry products; 35.3% household products; 76.0% fragrance; 2.5% other.

Collectively, 99.5% are exposed to fragranced products at least once a week from their own use, others' use, or both.

Health effects:

Overall, 33.1% of the population reported one or more types of adverse health effects from exposure to one or more types of fragranced products. The most common types of adverse health effects were as follows: 20.0% respiratory problems; 13.5% mucosal symptoms; 16.1% migraine headaches; 6.5% skin problems; 5.5% asthma attacks; 5.0% neurological problems; 4.5% cognitive problems; 3.5% gastrointestinal problems; 2.1% cardiovascular problems; 1.5% immune system problems; 1.5% musculoskeletal problems; and 2.2% other. (See Table 2.)

Of the 33.1% of the population reporting adverse health effects, 64.0% are female and 36.0% are male. Thus, proportionately more females report adverse health effects than males, relative to the general population (female 49.5%, male 50.5%). Among all gender and age group classifications, proportionately more females aged 45-54 report adverse health effects (16.5%) relative to the general population (12.1%). (See Table 1.)

Exposure situations:

Specific fragranced products and exposure situations that trigger adverse health effects include the following (see Table 3):

Air fresheners and deodorizers: 17.3% reported health problems when exposed to air fresheners or deodorizers. This compares to studies of the USA, Australia, and the UK (Steinemann 2016, 2017, 2018) that found 20.4%, 16.4%, and 15.5% (respectively) reported health problems when exposed to air fresheners or deodorizers ($\chi 2 = (1, N = 4435) = 8.937$, $p=0.0301$).

Scented laundry products: 5.6% reported health problems from the scent of laundry products coming from a dryer vent. This compares to studies of the USA, Australia, and the UK (Steinemann 2016, 2017, 2018) that found 12.5%, 6.1%, and 6.0% (respectively) reported health problems from the scent of laundry products coming from a dryer vent ($\chi 2 = (1, N = 4435) = 48.295$, $p<0.0001$).

Fragranced cleaning products: 13.8% reported health problems from being in a room after it has been cleaned with scented products. This compares to studies of the USA, Australia, and the UK (Steinemann 2016, 2017, 2018) that found 19.7%, 15.3%, and 14.0% (respectively) reported health problems from being in a room after it has been cleaned with scented products. ($\chi 2 = (1, N = 4435) = 16.167$, $p=0.0010$)

Proximity to fragranced person: 23.5% reported health problems from being near someone who is wearing a fragranced product. This compares to studies of the USA, Australia, and the UK (Steinemann 2016, 2017, 2018) that found 23.6%, 19.4%, and 13.7% (respectively)

reported health problems from being near someone who is wearing a fragranced product. ($\chi 2$ = (1, N = 4435) = 35.822, $p < 0.0001$).

Overall, adverse health effects from fragranced product exposures: 33.1% reported one or more types of health problems from being exposed to one or more types of fragranced products. This compares to studies of the USA, Australia, and the UK (Steinemann 2016, 2017, 2018) that found 34.7%, 33.0%, and 27.8% (respectively) reported health problems from exposure to fragranced products ($\chi 2$ = (1, N = 4435) = 9.166, $p=0.0271$). Chi-squared analyses indicate that a significant difference ($p<0.05$) exists among the four countries for each of the four types of fragranced products and exposure situations above, as well as the overall percentages of the national populations adversely affected by fragranced products.

Severity of the health problems resulting from exposure to one or more types of fragranced products was investigated, using language from Swedish Discrimination Act (DA 2008) to determine disability: "Do any of these health problems cause any physical, psychological or intellectual limitations on your functional ability?" Of those adversely affected by fragranced products, 24.2% answered yes, indicating that the severity of effects from fragranced product exposure was potentially disabling.

Ingredient disclosure and product claims:

Across the population, 73.4% were not aware that fragrance chemicals do not need to be fully disclosed on the product label or material safety data sheet. Also, 58.4% were not aware that fragranced products typically emit hazardous air pollutants such as formaldehyde, and 70.9% were not aware that even so-called natural, green, and organic fragranced products typically emit hazardous air pollutants. Yet 50.9% would not still use a fragranced product if they knew it emitted hazardous air pollutants.

Societal and workplace effects:

The use of fragranced products by others can create barriers and adverse consequences in society. Across the population, 12.0% are unable or reluctant to use the restrooms in a public place because of the presence of an air freshener, deodorizer, or scented product. Also, 6.7% are unable or reluctant to wash their hands with soap in a public place because they know or suspect that the soap is fragranced. Further, 18.1% reported that if they enter a business, and smell air fresheners or some fragranced product, they want to leave as quickly as possible. More broadly, 12.6% have been prevented from going to some place because they would be exposed to a fragranced product that would make them sick. Significantly, 6.7% of the population reported that exposure to fragranced products in their work environment, in the past year, has caused them to become sick, lose workdays, or lose a job.

Fragrance-free policies and scent-free indoor environments receive strong support (Table 4). Of the population surveyed, 50.7% would be supportive of a fragrance-free policy in the workplace (compared to 16.4% that would not). Thus, over 3 times as many would support a fragrance-free policy in the workplace than not. Also, 64.1% would prefer that health care facilities and health care professionals be fragrance-free (compared to 14.0% that would not). Thus, over 4 times as many would prefer health care facilities and health care professionals were fragrance-free than not.

Scenting indoor environments may detract rather than attract customers. If given a choice between flying on an airplane that pumped scented air throughout the passenger cabin, or did not pump scented air throughout the passenger cabin, 80.2% would choose an airplane without scented air (compared to 6.0% with scented air). Thus, over 13 times more passengers would prefer an airplane without scented air than with scented air. Similarly, if given a choice between staying in a hotel with fragranced air, or without fragranced air, 77.7% would choose a hotel without fragranced air

(compared to 9.8% with fragranced air). Thus, over 7 times more hotel guests would choose a hotel without fragranced air than with fragranced air.

Strengths of the study include the following: (a) the sample population is statistically representative of age, gender, and region in Sweden (1,100 respondents, 95% confidence level, 3% confidence interval); (b) the 1,100 respondents were randomly recruited from a large web-based panel (approximately 60,000 people in Sweden) developed from multiple sources to reflect characteristics of the study population; (c) the survey questions paralleled three nationally representative studies previously conducted in other countries (Steinemann 2016, 2017, 2018); and (d) the survey was run in the official national language of Swedish.

Limitations include the following: (a) all possible products and health effects were not included, although the low percentages for responses in the "other" category indicates the survey captured the primary products and effects, (b) data were based on self-reports, although a standard method for survey research, it was not possible to measure emissions and effects directly for each respondent, (c) the cross-sectional design of the study, which useful for determining prevalence, is limited in the ability to determine temporal relationships and trends, and (d) the survey was focused on adults ages 18-65, which excludes data on effects of fragranced consumer products on children and the elderly.

Conclusions

Results from this study provide compelling evidence that fragranced consumer products are associated with a range of adverse health and societal effects across the Swedish population. Over one-third of the population in Sweden report one or more types of health problems when exposed to one or more types of common fragranced consumer products. Further, over

one-fourth of those affected individuals report that the health problems can be potentially disabling.

Many problematic exposures are involuntary: 12.0% of the population are unable or reluctant to use restrooms in public places because of air fresheners or deodorizers, 6.7% unable or reluctant to wash their hands with soap in public places because of fragranced soap, 12.6% unable to go someplace because of the presence of a fragranced product, and 18.1% would enter but then leave a business as quickly as possible if they smell fragranced products.

Importantly, 6.7% have lost workdays or a job, in the past year, due to fragranced product exposures in the workplace. A strong majority would prefer fragrance-free rather than fragranced environments, and would support fragrance-free policies in workplaces.

Results from this study, together with results from the US, Australia, and the UK, have the global implication that common fragranced products can be considered a pervasive public health problem. While research continues to investigate which chemicals and mixtures of chemicals are associated with adverse health effects, an important precaution would be to reduce exposure to fragranced consumer products.

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Table 1: Demographic information.

	Respondents with Health Problems from Exposure to Fragranced Products		**Population Sample**	
Age	**Male** (n, %)	**Female** (n, %)	**Male** (n, %)	**Female** (n, %)
18-24	19 21.3%	20 29.4%	89 8.1%	68 6.2%
25-34	25 22.7%	51 44.0%	110 10.0%	116 10.5%
35-44	33 24.6%	48 42.9%	134 12.2%	112 10.2%
45-54	26 23.%	60 45.1%	113 10.3%	133 12.1%
55-65	28 25.5%	54 47.0%	110 10.0%	115 10.5%
Total	131 23.6%	233 42.8%	556 50.5%	544 49.5%

Table 2: Frequency and types of adverse health effects reported from exposure to fragranced consumer products.

Health Problems	**Frequency** (n) (% of general population)
Total	364 **33.1%**
Type of Health Problem	
Migraine headaches	177 16.1%
Asthma attacks	61 5.5%
Neurological problems	55 5.0%
Respiratory problems	220 20.0%
Skin problems	71 6.5%
Cognitive problems	50 4.5%
Mucosal symptoms	149 13.5%
Immune system problems	16 1.5%
Gastrointestinal problems	39 3.5%
Cardiovascular problems	23 2.1%
Musculoskeletal problems	17 1.5%
Other	24 2.2%

Table 3: Frequency and types of health problems from exposure to four types of fragranced consumer products. AF = air fresheners or deodorizers, LP = scent of laundry products coming from a dryer vent, CP = being in a room after it has been cleaned with scented products, FP = being near someone wearing a fragranced product. (% of general population)

	Air Fresheners (AF)	**Laundry Products (LP)**	**Cleaning Products (CP)**	**Fragranced Person (FP)**
Health Problems (n)	190	62	152	259
(% of general population)	17.30%	5.60%	13.80%	23.50%
Type of Health Problem				
Migraines	6.7%	1.6%	6.2%	11.5%
Asthma attacks	3.3%	1.1%	1.9%	3.3%
Neurological	2.9%	0.5%	1.5%	2.5%
Respiratory	9.6%	1.7%	7.4%	14.0%
Cognitive	3.1%	1.8%	1.4%	1.6%
Mucosal	1.9%	0.6%	1.6%	2.6%
Immune system	6.8%	1.5%	5.9%	7.8%
Gastrointestinal	0.6%	0.4%	0.4%	0.4%
Cardiovascular	1.3%	0.3%	1.0%	2.3%
Musculoskeletal	0.9%	0.5%	0.5%	0.7%
Other	0.4%	0.5%	0.3%	0.5%

Table 4: Percentage of individuals who prefer fragrance-free environments

	Yes	No	Neutral/ not sure	Decline to answer
Fragrance-free workplaces	50.7%	16.4%	32.1%	0.8%
Fragrance-free healthcare facilities and healthcare professionals	64.1%	14.0%	21.3%	0.6%
Airplanes without scented air	80.2%	6.0%	13.3%	0.5%
Hotels without scented air	77.7%	9.8%	12.0%	0.5%

Survey Methodology

Following Eysenbach G, 2004, Improving the Quality of Web Surveys: The Checklist for Reporting Results of Internet E-Surveys (CHERRIES), Journal of Medical Internet Research, Jul-Sep; 6(3): e34.

Checklist for Reporting Results of Internet E-Surveys (CHERRIES)		
Item Category	***Checklist Item***	***Explanation***
Design		
	Describe survey design	Target population: national random sample of adults (ages 18-65) in Sweden, representative of age, gender, and region (n=1,100, confidence limit=95%, margin of error=3%). The survey drew upon participants from a large web-based panel (~60,000 participants) held by Survey Sampling International (SSI). Participant recruitment followed a randomized process (Dynamix). All responses were anonymous. Survey completion time was approximately ten minutes.
IRB (Institutional Review Board) approval and informed consent process		
	IRB approval	Ethics approval was obtained by the University of Melbourne, School of Engineering Human Ethics Advisory Group, application 1646894, on May 9, 2016.
	Informed consent	Participants had already provided informed consent as part of the SSI web-based panel. For this survey, participants were given the following introduction: aims of the study; principal researcher name, affiliation, and contact information; human ethics approval; length of survey (less than 15 minutes to complete); assurance that participation is completely voluntary and that all data provided are confidential; assurance that participants can withdraw at any time; outputs of research (findings will be provided through journal articles and website, free of charge); university human ethics contact information; and a specific question to indicate consent: "If you would like to participate in this project, please click the next button to proceed ('Go To Survey')."
	Data protection	Selected survey software and servers were used to ensure data protection. No personal information was linked to the survey results. The dataset (without any identifying information) is kept on password protected computers.

Development and pre-testing		
	Development and testing	The survey instrument was a 35-item questionnaire, developed and tested over a two-year period, including cognitive testing with 10 individuals and piloting with over 100 individuals, before full implementation in July 2017.
Recruitment process and description of the sample having access to the questionnaire		The survey invitation is an open invitation, rather than a direct invite, to the pool of panelists available at the time. The pool is filtered to achieve a representative sample through a set of initial questions for basic demographic characteristics. SSI uses multiple sources to achieve a sample blend that is characteristic of the population, and response quotas for specific variables (e.g., age, gender, and region) ensure proportions that are representative of the population. (See electronic supplementary material: "SSI Survey Methodologies.")
	Open survey versus closed survey	Closed survey (only SSI participants), general population, random sample nationally representative of demographics. SSI uses a three-stage randomization process: first, participants are randomly selected from SSI panels and invited to take a survey; second, participants are combined with others into SSI's Dynamix sampling platform and respond to randomly selected profiling questions; and third, prospective participants are then randomly assigned to a survey they are likely to take. (See electronic supplementary material: "SSI Survey Methodologies.")
	Contact mode	The survey provider, SSI, provided an open invitation to potential participants. The survey targeted the general population rather than a specific cohort.
	Advertising the survey	An open invitation was issued to randomly selected members of the web-based panel. The survey was not advertised.
Survey administration		
	Web/E-mail	The survey was web-based, with multiple choice and open format answers. All responses were anonymous, and collected through the online survey platform and stored on local password protected servers.
	Context	SSI is a survey research company and online panel provider.
	Mandatory/voluntary	Voluntary. Prospective participants were randomly invited to the survey.
	Incentives	Respondents were provided incentives for their participation by the panel provider, SSI, with points that can be redeemed for money or reward programs.
	Time/Date	Data were collected within one week in July 2017.
	Randomization of items or questionnaires	To prevent biases in response, five sets of questions were randomized for their multiple-choice items.
	Adaptive questioning	Eight questions were conditionally displayed based on responses to other items.
	Number of Items	The survey contained 35 questions. Each page contained one question with multiple choice and open format response categories.

	Number of screens (pages)	Overall, 36 to 44 pages were presented (including the introductory page), depending on responses to conditional items.
	Completeness check	All questions were required to be completed. All questions provided non-response options such as "don't know/not sure" and "decline to answer." Only completed surveys were included for analysis.
	Review step	Respondents were allowed one attempt per question, once they click "next" to review the next question; they are not allowed to go back to the previous questions or answers.
Response rates		Survey completion rate: 92%. Number of initial responses: 1,197; number of drop outs: 78; number of screen outs: 19; number of completes: 1,100; Panel size: ~60,000.
	Unique site visitor	Each respondent goes through stringent verification of identity upon signing up on SSI panel (including name, contact details, and IP). Once opt-in process is completed, each respondent is tagged with unique panel ID.
	View rate (Ratio of unique survey visitors/unique site visitors)	not applicable
	Participation rate (Ratio of unique visitors who agreed to participate/unique first survey page visitors)	SSI respondents are invited to survey through general population random selection. Unique clicks or visitors to the first page of the survey can be those who complete survey, drop out, or screen out.
	Completion rate (Ratio of users who finished the survey/users who agreed to participate)	Sweden 92% (1,197 initial; 78 drop outs; 19 screen out; 1,100 completes).
Preventing multiple entries from the same individual		
	Cookies used	not used
	IP check	SSI programming software and sampling tool, Dynamix, controls the traffic and ensures unique entries. Using unique Panel ID and IP, each respondent can attempt the survey only once.
	Log file analysis	not used
	Registration	This is a closed survey for SSI respondents only. Survey invite is mailed specifically to the e-mail address used upon joining survey and verified.
Analysis		
	Handling of incomplete questionnaires	Only completed questionnaires were included in the final dataset for analysis.
	Questionnaires submitted with an atypical timestamp	Minimum survey completion time was 5 minutes; average was 10 minutes. A small number of respondents were omitted for completing the items too quickly.
	Statistical correction	All demographic subgroups obtained statistically valid numbers to ensure a national representativeness.

Table 1

D1. What is your gender?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Male	556
	50.50%
Female	544
	49.50%
Other	-
	-

Table 2

D2. What is your age?

Base: All Respondents

	GenPop
Total	1100
	100.00%
18-24	157
	14.30%
25-34	226
	20.50%
35-44	246
	22.40%
45-54	246
	22.40%
55-65	225
	20.50%

Table 3

D3c. In which region do you live?

Base: All GenPop Respondents

	GenPop
Total	1100
	100.00%
Blekinge län	11
	1.00%
Dalarnas län	35
	3.20%
Gävleborgs län	34
	3.10%
Gotlands län	7
	0.60%
Hallands län	33
	3.00%
Jämtlands län	11
	1.00%
Jönköpings län	34
	3.10%
Kalmar län	11
	1.00%
Kronobergs län	23
	2.10%
Norrbottens län	33
	3.00%
Örebro län	33
	3.00%
Östergötlands län	54
	4.90%
Skåne län	143
	13.00%
Södermanlands län	33
	3.00%
Stockholms län	253
	23.00%
Uppsalas län	44
	4.00%
Värmlands län	33
	3.00%
Västerbottens län	33
	3.00%
Västernorrlands län	22
	2.00%
Västmanlands län	33
	3.00%
Västra Götalands län	187
	17.00%

Table 4

Q1. Which fragranced products are you exposed to, at least once a week, from your own use?

Base: All Respondents

	GenPop
Total	1083
	98.50%
Air fresheners and deodorizers (e.g., sprays,	598
solids, oils, disks)	54.40%
Personal care products (e.g., soaps, hand	992
sanitizer, lotions, deodorant, sunscreen, shampoos)	90.20%
Cleaning supplies (e.g., all-purpose cleaners,	877
disinfectants, and dishwashing soap)	79.70%
Laundry products (e.g., detergents, fabric	840
softeners, dryer sheets)	76.40%
Household products (e.g., scented candles, toilet	748
paper, trash bags, baby products)	68.00%
Fragrance (e.g., perfume, cologne, after-shave)	696
	63.30%
Other	34
	3.10%
None	17
	1.50%

Table 5

Q1a. Which fragranced products are you exposed to, at least once a week, from others' use?

Base: All Respondents

	GenPop
Total	1026
	93.30%
Air fresheners and deodorizers (e.g., sprays,	497
solids, oils, disks)	45.20%
Personal care products (e.g., soaps, hand	726
sanitizer, lotions, deodorant, sunscreen, shampoos)	66.00%
Cleaning supplies (e.g., all-purpose cleaners,	483
disinfectants, and dishwashing soap)	43.90%
Laundry products (e.g., detergents, fabric	502
softeners, dryer sheets)	45.60%
Household products (e.g., scented candles, toilet	388
paper, trash bags, baby products)	35.30%
Fragrance (e.g., perfume, cologne, after-shave)	836
	76.00%
Other	27
	2.50%
None	74
	6.70%

Table 6

Q2. Do you experience any health problems when exposed to air fresheners or deodorizers?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	190
	17.30%
No	780
	70.90%
Don't know/not sure	123
	11.20%
Decline to answer	7
	0.60%

Table 7

BA. Which of the following health problems do you do you experience?

Base: Respondents who experienced below health problems when exposed to air fresheners or deodorizers

	GenPop
Total	170
	100.00%
Migraine headaches	74
	38.90%
Asthma attacks	36
	18.90%
Neurological problems (e.g., dizziness, seizures,	32
head pain, fainting, loss of coordination)	16.80%
Respiratory problems (e.g., difficulty breathing,	105
coughing, shortness of breath)	55.30%
Skin problems (e.g., rashes, hives, red skin,	34
tingling skin, dermatitis)	17.90%
Cognitive problems (e.g., difficulties thinking,	21
concentrating, or remembering)	11.10%
Mucosal symptoms (e.g., watery or red eyes, nasal	75
congestion, sneezing)	39.50%
Immune system problems (e.g., swollen lymph	7
glands, fever, fatigue)	3.70%
Gastrointestinal problems (e.g., nausea, bloating,	14
cramping, diarrhea)	7.40%
Cardiovascular problems (e.g., fast or irregular	10
heartbeat, jitteriness, chest discomfort)	5.30%
Musculoskeletal problems (e.g., muscle or joint	5
pain, cramps, weakness)	2.60%
Other	11
	5.80%
SUM	424
	223.20%

Table 8

Q3. Do you experience any health problems from the scent of laundry products coming from a dryer vent?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	62
	5.60%
No	934
	84.90%
Don't know/not sure	96
	8.70%
Decline to answer	8
	0.70%

Table 9

BA. Which of the following health problems do you do you experience?

Base: Respondents who experienced below health problems from the scent of laundry products coming from a dryer vent

	GenPop
Total	62
	100.00%
Migraine headaches	18
	29.00%
Asthma attacks	12
	19.40%
Neurological problems (e.g., dizziness, seizures,	6
head pain, fainting, loss of coordination)	9.70%
Respiratory problems (e.g., difficulty breathing,	19
coughing, shortness of breath)	30.60%
Skin problems (e.g., rashes, hives, red skin,	20
tingling skin, dermatitis)	32.30%
Cognitive problems (e.g., difficulties thinking,	7
concentrating, or remembering)	11.30%
Mucosal symptoms (e.g., watery or red eyes, nasal	17
congestion, sneezing)	27.40%
Immune system problems (e.g., swollen lymph	4
glands, fever, fatigue)	6.50%
Gastrointestinal problems (e.g., nausea, bloating,	3
cramping, diarrhea)	4.80%
Cardiovascular problems (e.g., fast or irregular	6
heartbeat, jitteriness, chest discomfort)	9.70%
Musculoskeletal problems (e.g., muscle or joint	5
pain, cramps, weakness)	8.10%
Other	5
	8.10%
SUM	122
	196.80%

Table 10

Q4. Do you experience any health problems from being in a room after it has been cleaned with scented products?

	GenPop
Total	1100
	100.00%
Yes	152
	13.80%
No	838
	76.20%
Don't know/not sure	106
	9.60%
Decline to answer	4
	0.40%

Table 11

BA. Which of the following health problems do you do you experience?

Base: Respondents who experienced below health problems from being in a room after it has been cleaned with scented products

	GenPop
Total	152
	100.00%
Migraine headaches	68
	44.70%
Asthma attacks	21
	13.80%
Neurological problems (e.g., dizziness, seizures,	17
head pain, fainting, loss of coordination)	11.20%
Respiratory problems (e.g., difficulty breathing,	81
coughing, shortness of breath)	53.30%
Skin problems (e.g., rashes, hives, red skin,	15
tingling skin, dermatitis)	9.90%
Cognitive problems (e.g., difficulties thinking,	18
concentrating, or remembering)	11.80%
Mucosal symptoms (e.g., watery or red eyes, nasal	65
congestion, sneezing)	42.80%
Immune system problems (e.g., swollen lymph	4
glands, fever, fatigue)	2.60%
Gastrointestinal problems (e.g., nausea, bloating,	11
cramping, diarrhea)	7.20%
Cardiovascular problems (e.g., fast or irregular	5
heartbeat, jitteriness, chest discomfort)	3.30%
Musculoskeletal problems (e.g., muscle or joint	3
pain, cramps, weakness)	2.00%
Other	4
	2.60%
SUM	312
	205.30%

Table 12

Q5. Do you experience any health problems from being near someone who is wearing a fragranced product?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	259
	23.50%
No	723
	65.70%
Don't know/not sure	112
	10.20%
Decline to answer	6
	0.50%

Table 13

BA. Which of the following health problems do you do you experience?
Base: Respondents who experienced below health problems from being near someone who is wearing a fragranced product

	GenPop
Total	259
	100.00%
Migraine headaches	127
	49.00%
Asthma attacks	36
	13.90%
Neurological problems (e.g., dizziness, seizures,	28
head pain, fainting, loss of coordination)	10.80%
Respiratory problems (e.g., difficulty breathing,	154
coughing, shortness of breath)	59.50%
Skin problems (e.g., rashes, hives, red skin,	18
tingling skin, dermatitis)	6.90%
Cognitive problems (e.g., difficulties thinking,	29
concentrating, or remembering)	11.20%
Mucosal symptoms (e.g., watery or red eyes, nasal	86
congestion, sneezing)	33.20%
Immune system problems (e.g., swollen lymph	5
glands, fever, fatigue)	1.90%
Gastrointestinal problems (e.g., nausea, bloating,	25
cramping, diarrhea)	9.70%
Cardiovascular problems (e.g., fast or irregular	8
heartbeat, jitteriness, chest discomfort)	3.10%
Musculoskeletal problems (e.g., muscle or joint	6
pain, cramps, weakness)	2.30%
Other	9
	3.50%
SUM	531
	205.00%

Table 14

Q6. In general, do you experience any health problems from exposure to any type of fragranced product?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	197
	17.90%
No	775
	70.50%
Don't know/not sure	123
	11.20%
Decline to answer	5
	0.50%

Table 15

BA. Which of the following health problems do you do you experience?

Base: Respondents who experienced below health problems from exposure to any type of fragranced product

	GenPop
Total	197
	100.00%
Migraine headaches	81
	41.10%
Asthma attacks	24
	12.20%
Neurological problems (e.g., dizziness, seizures,	23
head pain, fainting, loss of coordination)	11.70%
Respiratory problems (e.g., difficulty breathing,	109
coughing, shortness of breath)	55.30%
Skin problems (e.g., rashes, hives, red skin,	21
tingling skin, dermatitis)	10.70%
Cognitive problems (e.g., difficulties thinking,	16
concentrating, or remembering)	8.10%
Mucosal symptoms (e.g., watery or red eyes, nasal	77
congestion, sneezing)	39.10%
Immune system problems (e.g., swollen lymph	3
glands, fever, fatigue)	1.50%
Gastrointestinal problems (e.g., nausea, bloating,	17
cramping, diarrhea)	8.60%
Cardiovascular problems (e.g., fast or irregular	10
heartbeat, jitteriness, chest discomfort)	5.10%
Musculoskeletal problems (e.g., muscle or joint	4
pain, cramps, weakness)	2.00%
Other	6
	3.00%
SUM	391
	198.50%

Table 16

Do any of these health problems cause any physical, psychological or intellectual limitations on your functional ability?

Orsakar några av dessa hälsoproblem några fysiska, psykiska eller begåvningsmässiga begränsningar av din funktionsförmåga?

	GenPop
Total	306
	100.00%
Yes	88
	24.20%
No	217
	59.60%
Don't know/not sure	58
	15.90%
Decline to answer	1
	0.30%

Table 17

Have you ever been unable or reluctant to use the restrooms in a public place, because of the presence of an air freshener, deodorizer, or scented product?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	132
	12.00%
No	880
	80.00%
Neutral/not sure	79
	7.20%
Decline to answer	9
	0.80%

Table 18

If you enter a business, and you smell air fresheners or some fragranced product, do you want to leave as quickly as possible?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	199
	18.10%
No	751
	68.30%
Neutral/not sure	144
	13.10%
Decline to answer	6
	0.50%

Table 19

Have you ever been unable or reluctant to wash your hands with soap in a public place, because you know or suspect that the soap is fragranced?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	74
	6.70%
No	954
	86.70%
Neutral/not sure	66
	6.00%
Decline to answer	6
	0.50%

Table 20

Are you aware that fragrance chemicals do not need to be fully disclosed on the product label or material safety data sheet?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	165
	15.00%
No	807
	73.40%
Don't know/not sure	122
	11.10%
Decline to answer	6
	0.50%

Table 21

Are you aware that fragranced products typically emit hazardous air pollutants such as formaldehyde?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	315
	28.60%
No	642
	58.40%
Don't know/not sure	137
	12.50%
Decline to answer	6
	0.50%

Table 22

Are you aware that even so-called natural, green, and organic fragranced products typically emit hazardous air pollutants?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	207
	18.80%
No	780
	70.90%
Don't know/not sure	110
	10.00%
Decline to answer	3
	0.30%

Table 23

If you knew that a fragranced product emitted hazardous air pollutants, would you still use it?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	145
	13.20%
No	560
	50.90%
Don't know/not sure	390
	35.50%
Decline to answer	5
	0.50%

Table 24

Have you ever been prevented from going to some place because you would be exposed to a fragrance product that would make you sick?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	139
	12.60%
No	852
	77.50%
Don't know/not sure	103
	9.40%
Decline to answer	6
	0.50%

Table 25

Has any exposure to fragranced products in your work environment caused you to become sick, lose work days, or lose a job?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	74
	6.70%
No	952
	86.50%
Don't know/not sure	68
	6.20%
Decline to answer	6
	0.50%

Table 26

Would you be supportive of a fragrance-free policy in the workplace?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	558
	50.70%
No	180
	16.40%
Neutral/not sure	353
	32.10%
Decline to answer	9
	0.80%

Table 27

Would you prefer that health care facilities and health care professionals be fragrance-free?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes	705
	64.10%
No	154
	14.00%
Neutral/not sure	234
	21.30%
Decline to answer	7
	0.60%

Table 28

Flying On An Airplane That Pumped / Did Not Pump Scented Air Throughout The Passenger Cabin, Which Would You Choose?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Airplane with scented air	66
	6.00%
Airplane without scented air	882
	80.20%
Neutral/not sure	146
	13.30%
Decline to answer	6
	0.50%

Table 29

Staying In A Hotel With / Without Fragranced Air, Which Would You Choose?

Base: All Respondents

	GenPop
Total	1100
	100.00%
Hotel with fragranced air	108
	9.80%
Hotel without fragranced air	855
	77.70%
Neutral/not sure	132
	12.00%
Decline to answer	5
	0.50%

Table 30

People who answer "Yes" to one or more of these options for Q1/Q1A (own use, other's use, or both).

Base: All Respondents

	GenPop
Total	1100
	100.00%
Yes (Net)	1095
	99.50%
Air fresheners and deodorizers (e.g., sprays,	723
solids, oils, disks)	65.70%
Personal care products (e.g., soaps, hand	1018
sanitizer, lotions, deodorant, sunscreen, shampoos)	92.50%
Cleaning supplies (e.g., all-purpose cleaners,	924
disinfectants, and dishwashing soap)	84.00%
Laundry products (e.g., detergents, fabric	910
softeners, dryer sheets)	82.70%
Household products (e.g., scented candles,	782
toilet paper, trash bags, baby products)	71.10%
Fragrance (e.g., perfume, cologne, after-shave)	931
	84.60%
Other	50
	4.50%
None	86
	7.80%

Table 31

People who answer "Yes" to one or more of these questions: Q2/Q3/Q4/Q5/Q6 (fragrance sensitive group).

	FragSens
Total	1100
	100.00%
Yes	364
	33.10%

Table 32

People who answer "Yes" to each type of health problem under BA for each of these questions:
Q2/Q3/Q4/Q5/Q6 (fragrance sensitive group)
Base: All Respondents

	FragSens
Total	1100
	100.00%
Migraine headaches	177
	16.10%
Asthma attacks	61
	5.50%
Neurological problems (e.g., dizziness, seizures,	55
head pain, fainting, loss of coordination)	5.00%
Respiratory problems (e.g., difficulty breathing,	220
coughing, shortness of breath)	20.00%
Skin problems (e.g., rashes, hives, red skin,	71
tingling skin, dermatitis)	6.50%
Cognitive problems (e.g., difficulties thinking,	50
concentrating, or remembering)	4.50%
Mucosal symptoms (e.g., watery or red eyes, nasal	149
congestion, sneezing)	13.50%
Immune system problems (e.g., swollen lymph	16
glands, fever, fatigue)	1.50%
Gastrointestinal problems (e.g., nausea, bloating,	39
cramping, diarrhea)	3.50%
Cardiovascular problems (e.g., fast or irregular	23
heartbeat, jitteriness, chest discomfort)	2.10%
Musculoskeletal problems (e.g., muscle or joint	17
pain, cramps, weakness)	1.50%
Other	24
	2.20%

Table 33

Demographics by Age and Gender

Base: All Respondents

	GenPop
Total	1100
	100.00%
Male/Female	
All Males	556
	50.50%
All Females	544
	49.50%
Gender vs Age	
Male 18-24	89
	8.10%
Male 25-34	110
	10.00%
Male 35-44	134
	12.20%
Male 45-54	113
	10.30%
Male 55-65	110
	10.00%
Female 18-24	68
	6.20%
Female 25-34	116
	10.50%
Female 35-44	112
	10.20%
Female 45-54	133
	12.10%
Female 55-65	115
	10.50%

Table 34

Demographics by Age and Gender

People who answer "Yes" to each type of health problem under BA for each of these questions

Base: Q2/Q3/Q4/Q5/Q6 (fragrance sensitive group)

	FragSens
Total	364
	100.00%
Male/Female	
All Males	131
	36.00%
All Females	233
	64.00%
Gender vs Age	
Male 18-24	19
	5.20%
Male 25-34	25
	6.90%
Male 35-44	33
	9.10%
Male 45-54	26
	7.10%
Male 55-65	28
	7.70%
Female 18-24	20
	5.50%
Female 25-34	51
	14.00%
Female 35-44	48
	13.20%
Female 45-54	60
	16.50%
Female 55-65	54
	14.80%