

Prevalence of Fragrance Sensitivity in the American Population

Stanley M. Caress, Ph.D.
Anne C. Steinemann, Ph.D.

Abstract

This study determined the percentages of individuals who report adverse effects from exposure to fragranced products in the U.S. population and in subpopulations of those with asthma or chemical sensitivity. Data were collected through telephone interviews from two geographically weighted, random samples of the continental U.S. in two surveys during 2002-2003 and 2005-2006 (1,057 and 1,058 cases, respectively). Respondents were asked if they find being next to someone wearing a scented product irritating or appealing; if they have headaches, breathing difficulties, or other problems when exposed to air fresheners or deodorizers; and if they are irritated by the scent from laundry products, fabric softeners, or dryer sheets that are vented outside. Results aggregated from both surveys found that 30.5% of the general population reported scented products on others irritating, 19% reported adverse health effects from air fresheners, and 10.9% reported irritation by scented laundry products vented outside. This study reveals that a considerable percentage of the U.S. population reports adverse health effects or irritation from fragranced products, with higher percentages among those with asthma and chemical sensitivity.

Introduction

Fragranced products—such as air fresheners, laundry supplies, personal care products, and cleaners—are ubiquitous in modern society. Recent studies suggest that fragranced products can elicit adverse health effects, especially in susceptible individuals such as asthmatics (Rumchev, Spickett, Bulsara, Phillips, & Stick, 2004; Zock et al., 2007). Further, fragranced products can generate potentially substantial levels of indoor air pollutants, including volatile organic compounds (VOCs) and ultrafine particles (Singer et al., 2006). Despite growing evidence about links between fragranced products and health, the prevalence of adverse reactions to fragranced products in the general public and in subpopulations has not been determined or systematically examined. This study addresses this need.

Fragranced Products and Potential Health Effects

Fragranced consumer products have been associated with a range of health effects that include headaches (Farrow, Taylor, Northstone, & Golding, 2003; Kelman, 2004), chest tightness and wheezing (Kumar et al., 1995), infant diarrhea and vomiting (Farrow, Taylor, Northstone, & Golding, 2003), mucosal irritation (Elberling et al., 2004), reduced pulmonary function (Elliott, Longnecker, Kissling, & London, 2006; Shim & Williams, 1986), asthma and asthmatic exacerbations (Kumar et al., 1995; Medina-Ramón et al., 2006; Rumchev, Spickett, Bulsara, Phillips, & Stick, 2004; Shim & Williams, 1986), rhinitis and airway irritation (Larsson, Frisk, Hallstrom, Kiviloog, & Lundback, 2001), sense organ irritation

(Millqvist, Bengtsson, & Löwhagen, 1999), and epidermal effects such as contact dermatitis (de Groot & Frosch, 1997; Rastogi, Heydorn, Johansen, & Basketter, 2001). While the emphasis of prior work has been on epidermal exposure effects, consistent with intentional use of products (Cadby, Troy, & Vey, 2002), other exposure routes such as inhalation can be of concern for unintentional and public exposures to fragranced products.

Chemical formulations of fragranced products are largely undisclosed to consumers, due to trade secrets and other regulatory protections (Steinemann, 2009). Furthermore, relatively few studies have analyzed the chemicals emitted from fragranced products. In perhaps the largest and most relevant studies, Wallace and co-authors (1991) and Cooper and co-authors (1992) analyzed 31 fragranced products such as perfumes, deodorants, soaps, fabric softeners, and air fresheners, and identified approximately 150 unique VOCs. The most common VOCs, emitted from at least half of the products, were ethanol, limonene, linalool, β -phenethyl alcohol, and β -myrcene. Steinemann (2009) analyzed six top-selling fragranced products (air fresheners and laundry supplies), and identified more than 50 unique VOCs. The most common VOCs, emitted from at least half of the products, were ethanol, limonene, α -pinene, β -pinene, carene isomer, 2,4-dimethyl-3-cyclohexene-1-carboxaldehyde (Triplal 1), acetaldehyde, benzyl acetate, 3-hexen-1-ol, and linalool. Also emitted from 5/6 of the products were one or more “Hazardous Air Pollutants” (U.S. Environmental Protection Agency [U.S. EPA], 2002), including acetaldehyde, chloromethane, and 1,4-dioxane. In addition to

TABLE 1**Percentages of Respondents Who Find Scented Products on Others Irritating**

Respondents	1st Survey	2nd Survey	Average
General population	31.1	29.9	30.5
Asthmatics	37.2	37.9	37.5
Chemically sensitive	74.4	60.2	67.3
MCS	69.2	48.7	59.0

TABLE 2**Percentages of Respondents Who Report Health Problems from Air Fresheners or Deodorizers**

Respondents	1st Survey	2nd Survey	Average
General population	17.5	20.5	19.0
Asthmatics	29.7	37.2	33.5
Chemically sensitive	55.6	60.2	57.9
MCS	57.7	53.7	55.7

TABLE 3**Percentages of Respondents Who Report Irritation from Scented Laundry Products Vented Outside***

Respondents	1st Survey	2nd Survey
General population	n/a	10.9
Asthmatics	n/a	21.2
Chemically sensitive	n/a	39.8
MCS	n/a	26.8

* Data available only in second national survey.

primary pollutants, fragrance VOCs (e.g., limonene) can react readily with ozone to produce secondary pollutants such as formaldehyde, organic aerosols, ultrafine particles, and the hydroxyl radical (Nazaroff & Weschler, 2004; Sarwar, Olson, Corsi, & Weschler, 2004; Singer et al., 2006).

Few studies have previously attempted to determine the prevalence of adverse reactions to fragranced products in the general population or in subpopulations. In an epidemiological study of 1,027 households in eastern North Carolina (Meggs, Dunn, Bloch, Goodman, &

Davidoff, 1996), 10.5% of the sample reported that one or more individuals in the household had adverse reactions to perfume. Other population surveys of chemical sensitivity, which included perfume sensitivity, found a prevalence of 15.9% in California (Kreutzer, Neutra, & Lashuay, 1999), and 12.6% in metropolitan Atlanta (Caress & Steinemann, 2004a, 2004b).

Objectives of Study

This study investigates the extent to which the general public reacts adversely to common fragranced products. In addition, it in-

vestigates these reactions among individuals with certain medical conditions—asthma and chemical sensitivity—that may make them more vulnerable to fragranced exposures.

Asthma is normally characterized by occurrences of bronchial hyper-responsiveness that obstructs breathing (Bel, 2004). This condition could be exacerbated by certain fragrances that irritate the bronchial lining and overstimulate the respiratory system (Institute of Medicine, 2000). Asthmatics, therefore, constitute a separate subpopulation in this study that is examined and contrasted with the general population.

Chemical sensitivity, which may be medically diagnosed as multiple chemical sensitivity (MCS), is characterized by adverse reactions to common chemical substances, such as those in pesticides, new carpets, fresh paint, synthetic building materials, cleaning supplies, and fragranced products (Ashford & Miller, 1998). Individuals with chemical sensitivity may not be medically diagnosed with MCS but still characterize the condition when surveyed (Caress & Steinemann, 2004a, 2004b). This study, therefore, investigates adverse reactions to fragrances reported by individuals with either characteristics of chemical sensitivity or a medical diagnosis of MCS.

Methodology

Two geographically weighted, random national telephone surveys of the continental United States were conducted in 2002–2003 and 2005–2006. The first sample contained 1,057 cases and the second sample had 1,058 cases. These sample sizes have a confidence interval of $\pm 3.0\%$ and a confidence level of 95%. Each sample was composed of four separate seasonal cohorts.

The research implement was a questionnaire that asked respondents if they found being next to someone wearing a scented product, such as perfume or aftershave lotion, irritating or appealing; if they have headaches, breathing difficulties, or other problems when exposed to air fresheners or deodorizers; and if they are irritated by the scent from laundry products, fabric softeners, or dryer sheets that are vented outside (this question was asked in the second survey only). Additional questions asked respondents if they had been medically diagnosed with asthma, if they had been medically diagnosed with MCS, and if they are “unusually sensitive to everyday chemicals like those in household cleaning

products, paints, perfumes, detergents, insect spray and things like that,” consistent within previous prevalence studies of chemical sensitivity (Caress & Steinemann, 2004a, 2004b; Kreutzer, Neutra, & Lashuay, 1999). Demographic data on age, gender, and race/ethnicity were also collected. Frequencies of responses were recorded and used for cross-tabulation.

Results

The percentages of individuals reporting reactions to fragrances from both the first and second surveys, respectively, are provided below with aggregated percentages given in the tables.

Reactivity in General Population

Among the general population, 31.1% and 29.9% found scented products on others to be irritating (Table 1). Air fresheners caused headaches, breathing difficulties, or other problems for 17.5% and 20.5% (Table 2). Scented laundry products vented outside caused irritation for 10.9% (asked in second survey only) (Table 3).

Reactivity of Individuals with Asthma

Among those with asthma, 37.2% and 37.9% found scented products on others to be irritating (Table 1). Air fresheners caused headaches, breathing difficulties, or other problems for 29.7% and 37.2% (Table 2). Scented laundry products vented outside caused irritation for 21.2% (asked in second survey only) (Table 3).

Reactivity of Individuals with Chemical Sensitivity

Among those with chemical sensitivity, 74.4% and 60.2% found scented products on others to be irritating (Table 1). Air fresheners caused headaches, breathing difficulties, or other problems for 55.6% and 60.2% (Table 2). Scented laundry products vented outside caused irritation for 39.8% (asked in second survey only) (Table 3).

Reactivity of Individuals with MCS Diagnosis

Among those diagnosed with MCS, 69.2% and 48.7% found scented products on others to be irritating (Table 1). Air fresheners caused headaches, breathing difficulties, or other problems for 57.7% and 53.7% (Table 2). Scented laundry products vented outside caused irritation for 26.8% (asked in second survey only) (Table 3).

TABLE 4

Prevalence of Subpopulations in Two National Samples (in Percentages)

Subpopulations	1st Survey	2nd Survey	Average
Asthma	14.0	12.9	13.4
Chemical sensitivity	11.1	11.6	11.4
MCS	2.5	3.9	3.2
Asthma (also with chemical sensitivity)	27.0	31.4	29.2
Asthma (also with MCS)	7.4	11.7	9.6
Chemical sensitivity (also with asthma)	34.2	34.9	34.6
MCS (also with asthma)	42.3	39.0	40.7

Prevalence of Subpopulations

Among all respondents, 14% and 12.9% had been medically diagnosed with asthma, 11.1% and 11.6% reported sensitivity to common chemical products, and 2.5% and 3.9% had been medically diagnosed with MCS (Table 4). Among those diagnosed with asthma, 27.0% and 31.4% also reported chemical sensitivity, and 7.4% and 11.7% had also been diagnosed with MCS. Among those with chemical sensitivity, 34.2% and 34.9% had also been diagnosed with asthma. Among those diagnosed with MCS, 42.3% and 39.0% had also been diagnosed with asthma.

Reactivity in Demographic Groups

The demographic characteristics (gender and ethnicity/race) of the entire sample for both national surveys are provided in Table 5. The percentage of the respondents in each gender and ethnicity/race group who gave a positive response to questions on irritation from scented products, breathing problems from air fresheners, and irritation from vented laundry products are given in Table 6.

Among gender groups, a higher percentage of females, in both surveys, reported reactions to scented products on others (36.0% and 31.6%), to air fresheners (21.1% and 22.0%), and to scented laundry products (12.2%; second survey only). Among ethnicity/race groups, Asians had the highest percentages of reactivity in the first study to scented products on others (38.1%) and to air fresheners (23.8%). In the second study, Hispanics had the highest reactivity to scented products on others (44.3%), Asians had the highest reactivity to air fresheners (26.3%), and Caucasians had the highest reactivity to scented laundry products (11.0%).

Discussion and Conclusion

Results from both surveys indicate that a considerable segment of the American population has adverse reactions to fragranced products, with 30.5% reporting that scented products on others are irritating, 19% experiencing headaches, breathing difficulties, and other problems from air fresheners or deodorizers, and 10.9% being irritated by the scent of laundry products, fabric softeners, or dryer sheets that are vented outside. Individuals with asthma and chemical sensitivity report adverse effects to scented products, air fresheners, and scented laundry products in higher proportions than the general public, as do females relative to males, but these reactions extend beyond these subpopulations. Limitations of this study are that it relied on self-reported data from individuals, it did not specify and medically confirm the types of irritation or other problems experienced by individuals, and it did not investigate factors such as exposure routes and chemical formulations. Nevertheless, the magnitude and consistency of the results from both surveys suggest that sensitivity to fragrances is a widespread condition, and underscores the need for additional research and attention. 🐾

Acknowledgements: We thank Daniel Ribeiro of the University of Washington for his valuable assistance with the article.

Corresponding Author: Stanley M. Caress, Professor, University of West Georgia, Pafford Bldg. #128, Carrollton, GA 30118. E-mail: scaress@westga.edu.

TABLE 5**Demographic Percentages of Positive Respondents in Two National Samples***

Samples	Male	Female	Other/Not Reported	Asian	Hispanic	African-American	Caucasian	Other/Not Reported
1st Study								
Survey sample	38.8	61.2	0	2.1	5.7	11.2	76.3	4.7
Scented products on others irritating	27.7	69.6	2.7	2.4	3.7	11.9	75.3	6.7
Air fresheners cause health problems	25.9	72.4	1.7	2.7	4.3	11.4	77.3	4.3
Scented laundry products irritating	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2nd Study								
Survey sample	35.4	63.3	1.3	3.6	7.5	14.2	69.5	5.3
Scented products on others irritating	31.9	67.1	1.0	2.8	6.7	11.1	74.4	5.1
Air fresheners cause health problems	30.4	67.7	1.9	4.6	7.4	14.3	68.7	5.1
Scented laundry products irritating	26.0	71.4	2.6	3.5	7.0	13.0	70.4	6.1

* Rounding causes some totals to equal more than 100%.

TABLE 6**Percentages of Positive Respondents in Each Demographic Group**

Samples	Groups					
1st Study	Male	Female	Asian	Hispanic	African-American	Caucasian
Scented products on others irritating	22.5	36.0	38.1	20.7	33.9	31.8
Air fresheners cause problems	11.4	21.1	23.8	13.8	18.3	18.3
Scented laundry products irritating	n/a	n/a	n/a	n/a	n/a	n/a
2nd Study						
Scented products on others irritating	27.0	31.6	23.7	44.3	23.3	31.9
Air fresheners cause problems	17.7	22.0	26.3	20.3	20.7	20.3
Scented laundry products irritating	8.0	12.2	10.5	10.1	10.0	11.0

REFERENCES

Ashford, N.A., & Miller, C.S. (1998). *Chemical exposures: Low levels and high stakes*. New York: Van Nostrand Reinhold.

Bel, E.H. (2004). Clinical phenotypes of asthma. *Current Opinion in Pulmonary Medicine*, 10(1), 44–50.

Cadby, P.A., Troy, W.R., & Vey, M.G.H. (2002). Consumer exposure to fragrance ingredients: Providing estimates for safety evaluation. *Regulatory Toxicology and Pharmacology*, 36(3), 246–252.

Caress, S.M., & Steinemann, A.C. (2004a). A national population study of the prevalence of multiple chemical sensitivity. *Archives of Environmental Health*, 59(6), 300–305.

Caress, S.M., & Steinemann, A.C. (2004b). The prevalence of multiple chemical sensitivities in a population based study. *American Journal of Public Health*, 94, 746–747.

continued on page 50

REFERENCES continued from page 49

- Cooper, S.D., Raymer, J.H., Pellizzari, E.D., Thomas, K.W., Castillo, N.P., & Maewall, S. (1992). *Polar organic compounds in fragrances of consumer products* (Final Report, Contract # 68-02-4544). Research Triangle Park, NC: U.S. EPA.
- de Groot, A.C., & Frosch, P.J. (1997). Adverse reactions to fragrances: A clinical review. *Contact Dermatitis*, 36(2), 57–86.
- Elberling, J., Linneberg, A., Mosbech, H., Dirksen, A., Frolund, L., Madsen, F., Nielsen, N.H., & Johansen, J.D. (2004). A link between skin and airways regarding sensitivity to fragrance products. *British Journal of Dermatology*, 151, 1197–1203.
- Elliott, L., Longnecker, M.P., Kissling, G.E., & London, S.J. (2006). Volatile organic compounds and pulmonary function in the Third National Health and Nutrition Examination Survey, 1988–1994. *Environmental Health Perspectives*, 114(8), 1210–1214.
- Farrow, A., Taylor, H., Northstone, K., & Golding, J. (2003). Symptoms of mothers and infants related to total volatile organic compounds in household products. *Archives of Environmental Health*, 58(10), 633–641.
- Institute of Medicine, Committee on the Assessment of Asthma and Indoor Air. (2000). *Clearing the air: Asthma and indoor air exposures*. Washington, DC: National Academy Press.
- Kelman, L. (2004). Osmophobia and taste abnormality in migraineurs: A tertiary care study. *Headache*, 44(10), 1019–1023.
- Kreutzer, R., Neutra, R.R., & Lashuay, N. (1999). Prevalence of people reporting sensitivities to chemicals in a population-based survey. *American Journal of Epidemiology*, 150(1), 1–12.
- Kumar, P., Caradonna-Graham, V.M., Gupta, S., Cai, X., Rao, P.N., & Thompson, J. (1995). Inhalation challenge effects of perfume scent strips in patients with asthma. *Annals Allergy Asthma Immunology*, 75(5), 429–433.
- Larsson, M.L., Frisk, M., Hallstrom, J., Kiviloog, J., & Lundback, B. (2001). Environmental tobacco smoke exposure during childhood is associated with increased prevalence of asthma in adults. *Chest*, 120(3), 711–717.
- Medina-Ramón, M., Zock, J.P., Kogevinas, M., Sunyer, J., Basagaña, X., Schwartz, J., Burge, P.S., Moore, V., & Antó, J.M. (2006). Short-term respiratory effects of cleaning exposures in female domestic cleaners. *European Respiratory Journal*, 27(6), 1196–1203.
- Meggs, W.J., Dunn, K.A., Bloch, R.M., Goodman, P.E., & Davidoff, A.L. (1996). Prevalence and nature of allergy and chemical sensitivity in a general population. *Archives Environmental Health*, 51(4), 275–282.
- Millqvist, E., Bengtsson, U., & Löwhagen, O. (1999). Provocations with perfume in the eyes induce airway symptoms in patients with sensory hyperreactivity. *Allergy*, 54(5), 495–499.
- Nazaroff, W.W., & Weschler, C.J. (2004). Cleaning products and air fresheners: Exposure to primary and secondary air pollutants. *Atmospheric Environment*, 38, 2841–2865.
- Rastogi, S.C., Heydorn, S., Johansen, J.D., & Basketter, D.A. (2001). Fragrance chemicals in domestic and occupational products. *Contact Dermatitis*, 45(4), 221–225.
- Rumchev, K., Spickett, J., Bulsara, M., Phillips, M., & Stick, S. (2004). Association of domestic exposure to volatile organic compounds with asthma in young children. *Thorax*, 59, 746–751.
- Sarwar, G., Olson, D., Corsi, R.L., & Weschler, C.J. (2004). Indoor fine particles: The role of terpene emissions from consumer products. *Journal of the Air & Waste Management Association*, 54(3), 367–377.
- Shim, C., & Williams, M.H., Jr. (1986). Effect of odors in asthma. *American Journal of Medicine*, 80(1), 18–22.
- Singer, B.C., Coleman, B.K., Destailats, H., Hodgson, A.T., Lunden, M.M., Weschler, C.J., & Nazaroff, W.W. (2006). Indoor secondary pollutants from cleaning product and air freshener use in the presence of ozone. *Atmospheric Environment*, 40, 6696–6710.
- Steinemann, A.C. (2009). Fragranced consumer products and undisclosed ingredients. *Environmental Impact Assessment Review*, 29, 32–38.
- U.S. Environmental Protection Agency. (2002). *The Clean Air Act Amendments of 1990 list of hazardous air pollutants*. Retrieved November 17, 2008, from <http://www.epa.gov/ttn/atw/orig189.html>
- Wallace, L.A., Nelson, W.C., Pellizzari, E., Raymer, J.H., & Thomas, K.W. (1991, June). *Identification of polar volatile organic compounds in consumer products and common microenvironments*. Paper presented at the 84th Annual Meeting of the Air and Waste Management Association, Vancouver, British Columbia, Canada.
- Zock, J.P., Plana, E., Jarvis, D., Antó, J.M., Kromhout, H., Kennedy, S.M., Künzli, N., Villani, S., Olivieri, M., Torén, K., Radon, K., Sunyer, J., Dahlman-Hoglund, A., Norbäck, D., & Kogevinas, M. (2007). The use of household cleaning sprays and adult asthma: An international longitudinal study. *American Journal of Respiratory and Critical Care Medicine*, 176, 735–741.



Address changes take approximately two months to become effective. To ensure that you don't miss a single issue of the *Journal*, please notify us as soon as possible of your new address.

Thanks!

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.