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(This category highlights potential health issues from fragrance chemicals and fragranced products.)

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Go Fragrance Free: Healthier Air Has Never Been Easier

Many hospitals, businesses, and employees are not aware that fragranced products can create access barriers to their facilities and can adversely affect the health of those working there. Fragranced products include fragranced cleaning products, hand sanitizers, lotions, laundry products, deodorant, air fresheners or any other scented items.

HOUSEHOLD SUPPLIES

Scented Candles / Scented Dishwashing Liquid and Detergent / Scented Garbage Bags

1. Emissions of air pollutants from scented candles burning in a test chamber

Derudi M, Gelosa S, Sliepcevich A, Cattaneo A, Rota R, Cavallo D, Nano G. Emissions of air pollutants from scented candles burning in a test chamber, Atmospheric Environment, Volume 55,2012, Pages 257-262, ISSN 1352-2310, <https://doi.org/10.1016/j.atmosenv.2012.03.027>.

Article Link: <https://www.sciencedirect.com/science/article/abs/pii/S1352231012002683?via%3Dihub>

“Burning of candles in indoor environments can release a large number of toxic chemicals, including acetaldehyde, formaldehyde, acrolein, and polycyclic aromatic hydrocarbons.... It is believed that regular burning of several candles in indoor environments can expose people to harmful amounts of organic chemicals (USEPA, 2001).”

“It has been found that the BTEX and PAHs emission factors show large differences in similar candles without any clear correlations. On the other hand, **aldehydes** emission factors are quite similar for all the candles, leading to the conclusion that such **emissions are mainly related to the presence of a fragrance** rather than to the other candle parameters. This has been confirmed by the **experiments carried out using candles made by pure paraffin, where almost no emissions of aldehydes have been found.**”

2. Characterization of hazardous and odorous volatiles emitted from scented candles before lighting and when lit

Ahn JH, Kim KH, Kim YH, Kim BW. Characterization of hazardous and odorous volatiles emitted from scented candles before lighting and when lit. J Hazard Mater. 2015 Apr 9;286:242-51. doi: 10.1016/j.jhazmat.2014.12.040. Epub 2014 Dec 31. PMID: 25588193.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/25588193/>

“Scented candles are known to release various volatile organic compounds (VOCs) including both pleasant aromas and toxic components both before lighting (off) and when lit (on).”

“When lit, **formaldehyde** was found to have the highest emission concentration of 2098 ppb (SB), 1022 ppb (CT), and 925 ppb (PL). ... As such, the results suggest that certain scented candle products should act as potent sources of VOC emission in indoor environment, regardless of conditions – whether being lit or not.”

[Note: Fragrance is considered the new ‘second hand smoke’, **[“The parallels between second-hand smoke and synthetic fragrance use are many. At its core, both are battles over indoor air quality](#)** “ - quote and link from De Vader, Christy L. & Barker, Paxson.

Chemicals that cigarettes/cigarette smoke and fragranced products can have in common are: Acetone, Formaldehyde, Benzene, acetaldehyde, terpenoids and phenols.]

3. Household air pollution and its effects on health

Apte K, Salvi S. Household air pollution and its effects on health. F1000Res. 2016 Oct 28;5:F1000 Faculty Rev-2593. doi: 10.12688/f1000research.7552.1. PMID: 27853506; PMCID: PMC508913

Article Link: <https://pubmed.ncbi.nlm.nih.gov/27853506/> - [PDF](#)

“Cigarette smoke contains 7,357 different chemical compounds such as **benzene**, CO, PAHs, heterocyclic amines, cyanide, **formaldehyde**, **terpenoids**, **phenols**, nicotine, and heavy metals.”

“Various studies have reported that toxic levels of air pollutants are emitted when these **fragrances** are burnt. ... Among the Chinese, 76.9% currently burn incense at home every day and over 90% of the population has been using these for over 20 years. **Burning of these fragrances emits high levels of PAHs, benzene, nitrous oxide, and CO.** ... Household air pollution begins to affect a human even during **fetal life. Increased household air pollution increases oxidative stress**, which has been implicated in **decreased fertility** or, in some cases, even **infertility**. Increased oxidative stress leads to **decreased sperm motility and poor zygote quality**. It also plays an important role in **increasing insulin resistance**, which is associated with **polycystic ovarian disease**, a major cause of infertility.”

“...a study of 10 **newborn infants** in New York by the Environmental Work Group revealed that these infants, born to mothers exposed to pollutants, had as many as **232 pollutants circulating in the cord blood collected at birth**....Similarly, another study reported that increased exposure to polycyclic aromatic hydrocarbons and heavy metals (especially lead and mercury) in the second trimester of pregnancy resulted in decreased length of the baby at birth.... They also have lower heights, which do not recover later in life.... The effect of perinatal exposure to PAHs has also been studied, revealing compromised lung function in otherwise-healthy children... Household air pollutants are also implicated in cognitive and judgmental skills”

4. Scented Candles as an Unrecognized Factor that Increases the Risk of Bladder Cancer; Is There Enough Evidence to Raise a Red Flag?

Adamowicz J, Juszczak K, Poletajew S, Van Breda SV, Pokrywczynska M, Drewa T. Scented Candles as an Unrecognized Factor that Increases the Risk of Bladder Cancer; Is There Enough Evidence to Raise a Red Flag? Cancer Prev Res (Phila). 2019 Oct;12(10):645-652. doi: 10.1158/1940-6207.CAPR-19-0093. Epub 2019 Aug 9. PMID: 31399420.

Article: <https://pubmed.ncbi.nlm.nih.gov/31399420/> - [PDF](#)

“Manufacturers of scented products, including candles or plug-in air freshener are not required to disclose all ingredients in the United States and European Union.”

“**Scented candles** are a heterogenic group of products which are the **source of indoor pollution**. In this situation, public awareness of the potential relationship between substances emitted by scented candles and **bladder cancer** is an essential step for better prevention.”

5. Hazard assessment of chemical air contaminants measured in residences

Logue JM, McKone TE, Sherman MH, Singer BC. Hazard assessment of chemical air contaminants measured in residences. Indoor Air. 2011 Apr;21(2):92-109. doi: 10.1111/j.1600-0668.2010.00683.x. PMID: 21392118.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/21392118/>

“Fifteen pollutants appear to exceed chronic health standards in a large fraction of homes. Nine other pollutants are identified as potential chronic health hazards in a substantial minority of homes, and an additional nine are identified as potential hazards in a very small percentage of homes. Nine pollutants are identified as priority hazards based on the robustness of measured concentration data and the fraction of residences that appear to be impacted: **acetaldehyde**; acrolein; **benzene**; 1,3-butadiene; 1,4-dichlorobenzene; **formaldehyde**; naphthalene; nitrogen dioxide; and PM2.5. Activity-based emissions are shown to pose potential acute health hazards for PM(2.5), **formaldehyde**, CO, chloroform, and NO(2).”

[Note: [Endocrine Disrupting Chemicals](#) (EDC's) are [commonly used in perfumes and fragranced products](#) as preservatives or fragrance. [What are EDC's and how can they affect us?](#)]

[Note: [Acetaldehyde](#) is on the [IFRA](#) list. It is on the [Carcinogens and Reproductive Toxicants List](#). *“Acetaldehyde at a low concentration synergistically exacerbates allergic airway inflammation as an endocrine-disrupting chemical and as a volatile organic compound”*]

[Note: [Benzene](#) is a reported fragrance ingredient in the [CSCP Product Database](#).]

6. **Fragranced consumer products: effects on asthmatics**

Steinemann A. Fragranced consumer products: effects on asthmatics. Air Qual Atmos Health. 2018;11(1):3-9. doi: 10.1007/s11869-017-0536-2. Epub 2017 Dec 11. PMID: 29391919; PMCID: PMC5773620

Article Link: <https://pubmed.ncbi.nlm.nih.gov/29391919/> - [PDF](#)

“Fragranced consumer products, such as **cleaning supplies**, air fresheners, and personal care products, can emit a range of air pollutants and trigger adverse health effects...”

“...41.0% of asthmatics report **health problems** from air fresheners or deodorizers, 28.9% from scented laundry products coming from a dryer vent, **42.3% from being in a room cleaned with scented products**, and 46.2% from being near someone wearing a fragranced product.”

“Fragranced consumer products pervade society and emit numerous volatile organic compounds, such as **limonene, alpha-pinene, beta-pinene, acetaldehyde, and formaldehyde**...”

“Fragranced products have been associated with a range of adverse health effects including work-related asthma (Weinberg et al. 2017), asthmatic exacerbations (Kumar et al. 1995; Millqvist and Löwhagen 1996), **respiratory difficulties** (Caress 2009), **mucosal symptoms** (Elberling et al. 2005), **migraine headaches** (Kelman 2004), and **contact dermatitis** (Rastogi et al. 2007; Johansen 2003), as well as **neurological, cardiovascular, cognitive, musculoskeletal, and immune system problems** (Steinemann 2016).”

“Results indicate that 64.3% of asthmatics report one or more types of adverse health effects from fragranced products, including **respiratory problems** (43.3%), **migraine headaches** (28.2%), and **asthma attacks** (27.9%)...”

7. **Fragranced consumer products: exposures and effects from emissions**

Steinemann A. Fragranced consumer products: exposures and effects from emissions. Air Qual Atmos Health. 2016;9(8):861-866. doi: 10.1007/s11869-016-0442-z. Epub 2016 Oct 20. PMID: 27867426; PMCID: PMC5093181.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/27867426/> - [PDF](#)

“Fragranced consumer products, such as cleaning supplies, **air fresheners**, and personal care products, **are a primary source of indoor air pollutants** and personal exposure.... The study investigated the prevalence and types of fragranced product exposures, associated health effects, awareness of product emissions, and preferences for fragrance-free policies and environments.”

“**Secondhand scents** (as termed in this article) **refers to indirect or involuntary exposure to fragranced products (in an analogy to secondhand smoke)**. ... Individuals report **health problems when exposed to fragranced products in society**, other than through intentional use of products.”

“**Fragranced products (even ones called green or organic) emit a range of volatile organic compounds**, including hazardous air pollutants, but relatively few are disclosed to the public (Steinemann 2015).... Further, 67.3 % were not aware that **fragranced products typically emit hazardous air pollutants such as formaldehyde**, and 72.6 % were not aware that even so-called natural, green, and organic fragranced products typically emit hazardous air pollutants.”

8. Acetaldehyde at a low concentration synergistically exacerbates allergic airway inflammation as an endocrine-disrupting chemical and as a volatile organic compound

Kawano T, Matsuse H, Fukahori S, Tsuchida T, Nishino T, Fukushima C, Kohno S. Acetaldehyde at a low concentration synergistically exacerbates allergic airway inflammation as an endocrine-disrupting chemical and as a volatile organic compound. *Respiration*. 2012;84(2):135-41. doi: 10.1159/000337112. Epub 2012 Apr 25. PMID: 22538484.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/22538484/>

“Acetaldehyde is an endocrine-disrupting chemical (EDC) and a volatile organic compound (VOC). It is also a **carcinogen** and teratogen that causes **bronchoconstriction** in a subset of **asthmatics**. However, the mechanism through which acetaldehyde acts as an EDC/VOC causing **allergic airway inflammation** remains unknown.”

“Conclusions: **Exposure to acetaldehyde can enhance allergic airway inflammation in asthma.**”

[**Note:** [Acetaldehyde](#) is on the [IFRA](#) list. It is on the [Carcinogens and Reproductive Toxicants List](#). “[Acetaldehyde at a low concentration synergistically exacerbates allergic airway inflammation as an endocrine-disrupting chemical and as a volatile organic compound](#)”]

[**Note:** [Endocrine Disrupting Chemicals](#) (EDC’s) are [commonly used in perfumes and fragranced products](#) as preservatives or fragrance. [What are EDC’s and how can they affect us?](#)]

9. Characterization of emissions composition for selected household products available in Korea

Kwon KD, Jo WK, Lim HJ, Jeong WS. Characterization of emissions composition for selected household products available in Korea. *J Hazard Mater*. 2007 Sep 5;148(1-2):192-8. doi: 10.1016/j.jhazmat.2007.02.025. Epub 2007 Feb 15. PMID: 17376591.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/17376591/>

“Several studies have implicated these consumer products as sources of indoor air pollutants.... **These compounds have been shown to cause symptoms similar to those characterized as Sick Building Syndrome**; this is a group of symptoms that includes **sleepiness, irritation, inability to concentrate**, and

other health hazards... A major cause of health-related problems for building occupants is the inhalation of consumer-product constituents.”

“Furthermore, **secondary toxic pollutants** are formed by the reaction of unsaturated organic constituents with oxidants such as ozone, hydroxyl radicals, and nitrogen oxides.... For example, **terpene**, a major constituent of household products such as cleaning products and **air fresheners**..., **reacts with ozone thus leading to the formation of formaldehyde**...”

“Of the 59 household products analyzed, 58 emitted one or more of the 72 compounds at chromatographic peak areas above 10(4). There were 11 analytes which occurred with a frequency of more than 10%: **limonene** (44.2%), **ethanol** (30.5%), **acetone** (18.6%), **alpha-pinene** (18.6%), **o,m,p-xylenes** (18.6%), **decane** (17.0%), **toluene** (17.0%), **beta-myrcene** (11.9%), ammonia (10.2%), **ethylbenzene** (10.2%), and hexane (10.2%).”

[Note: Bolded chemicals are chemicals found in fragrance/air fresheners/perfume/fragranced products]

[Note: [Formaldehyde](#) is a [secondary pollutant](#) from fragrance and fragranced products.

Also, a 2012 study, 21 out of 30 perfume samples were shown to [release formaldehyde](#) when tested but formaldehyde was not listed on any of the labels. Formaldehyde is a [sensitizer](#) and [known allergen](#).]

[Note: [Limonene](#) is a common skin sensitizer and [known allergen](#) in fragrance and [fragranced products](#). Limonene (natural or [synthetic](#)) is a terpene. Terpenes can create [formaldehyde and particulate matter](#) in air as [secondary pollutants](#). Limonene is on the [IFRA](#) list as a fragrance ingredient.]

[Note: [Toluene](#) (often a nail polish thinner) is used as a solvent or fragrance in perfume and bath products on the [CSPC Product Database](#). [Toluene](#) is on the [IFRA](#) list and on the EPA's [Priority Pollutant List](#).]

10. Overview of air pollution and endocrine disorders

Darbre PD. Overview of air pollution and endocrine disorders. Int J Gen Med. 2018 May 23;11:191-207. doi: 10.2147/IJGM.S102230. PMID: 29872334; PMCID: PMC5973437.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/29872334/> - [PDF](#)

“Abstract: Over recent years, **many environmental pollutant chemicals have been shown to possess the ability to interfere in the functioning of the endocrine system and have been termed endocrine disrupting chemicals (EDCs)**. These compounds exist in air as volatile or semi-volatile compounds in the gas phase or attached to particulate matter. They include components of plastics (**phthalates**, bisphenol A), components of consumer goods (parabens, triclosan, **alkylphenols**, **fragrance compounds**,... This review summarizes current knowledge concerning the sources of EDCs in air, measurements of levels of EDCs in air, and the potential for adverse effects of EDCs in air on human endocrine health.”

“**Whilst much has been written over the past two decades of the actions of EDCs from oral and dermal exposure, research is increasingly documenting their presence in air which opens a debate on the potential for adverse consequences from inhalation of EDCs.**”

“Since estrogens and androgens regulate reproductive functions, many of the reported effects of the exposure to EDCs have been on adverse consequences for **reproductive health**. However, physiological consequences have been demonstrated as resulting from disruption to **thyroid function** and alterations to **thyroid hormone levels**. More widely, adverse effects have also been reported as resulting from alterations to adrenocortical

function, impairment of the immune system, and the loss of control on energy metabolism including development of **obesity, diabetes, and cardiovascular disease.**”

“**Prior to and just after birth** are especially **vulnerable times for exposure to EDCs** because disruption of hormonal activity in the developing embryo/fetus or young baby can have **consequences for health in adult life** most notably on **reproductive abilities, brain function, immunity, and metabolic programming.**”

“**Man-made EDCs** are contained within many agricultural, industrial, and **consumer products**, which due to their widespread use, have become ubiquitous environmental pollutants. This includes components of pesticides and herbicides used both in an agricultural setting and in urban environments.... EDCs are also widely used in **personal care products (PCPs)** for purposes of preservation, deodorant, antiperspirant, conditioning, and **fragrance.**”

“**EDCs** are contained in domestic pesticide sprays, **air fresheners, laundry detergents, household cleaners,** paints, adhesives, and plastics, all of which may be used routinely indoors.... As a result, **many EDCs are now measurable in indoor air and in indoor dust, often at higher levels than in outdoor air**10...”

11. Indoor Exposure to Selected Air Pollutants in the Home Environment: A Systematic Review

Vardoulakis S, Giagloglou E, Steinle S, Davis A, Smeuwenhoek A, Galea KS, Dixon K, Crawford JO. Indoor Exposure to Selected Air Pollutants in the Home Environment: A Systematic Review. *Int J Environ Res Public Health*. 2020 Dec 2;17(23):8972. doi: 10.3390/ijerph17238972. PMID: 33276576; PMCID: PMC7729884.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/33276576/> - [PDF](#)

“There is increasing awareness that the quality of the **indoor environment** affects our health and well-being.... Identified indoor **PM_{2.5}** sources include smoking, cooking, heating, use of **incense, candles,** and **insecticides,** while **cleaning,** housework, presence of pets and movement of people were the main sources of coarse particles....Household characteristics and occupant activities play a large role in indoor exposure, particularly cigarette smoking for PM_{2.5}, gas appliances for NO₂, and **household products** for **VOCs** and PAHs.”

“Typical **VOCs** found in the indoor environment include **benzene, toluene, ethylbenzene** and **xylenes (BTEX)** from fuel combustion and evaporation, and house renovations; benzene and **styrene** from cigarette smoking; alkanes from natural gas; 1,4-dichlorobenzene from moth repellents; **a-pinene** from wood-based building materials; and **limonene** from **fragranced household cleaning and laundry products**... Reported **VOC concentrations were generally higher indoors than outdoors,** including for **benzene,** particularly in colder seasons due to reduced ventilation and the use of oil and gas heaters.”

“Indoor sources were dominant for most **VOCs** and particularly for **limonene, a-pinene, hexanal, pentanal, o-xylene,** and **n-dodecane.** Use of **artificial air freshener** was **significantly associated with total VOC (TVOC), benzene, toluene** and **ethylbenzene.**”

“Indoor air quality (IAQ) in particular has an impact on multiple health outcomes, including **respiratory and cardiovascular illness, allergic symptoms, cancers,** and **premature mortality.**”

[Note: A synonym for pentanal is valeraldehyde. Valeraldehyde is on the [IFRA list](#) of disclosed fragrance ingredients.]

12. Impact of room fragrance products on indoor air quality

Uhde E, Schulz N. Impact of room fragrance products on indoor air quality. Atmospheric Environment, Volume 106, 2015, Pages 492-502, ISSN 1352-2310, <https://doi.org/10.1016/j.atmosenv.2014.11.020>.

Article Link: <https://www.sciencedirect.com/science/article/abs/pii/S1352231014008796>

“Following a defined test protocol, the release of volatile organic compounds, ultrafine particles and NO_x was monitored for each product. The potential for forming secondary organic aerosols under the influence of ozone was studied, and for a selection of products the long-term emission behavior was assessed. **Terpenoid** substances, **aldehydes** and lactones are common substances in scenting products, and a majority of the compounds used are reactive enough to be susceptible to indoor chemistry (Nazaroff and Weschler, 2004, Singer et al., 2006, Uhde and Salthammer, 2007).”

“Unlike fragranced detergents, cleaning products or cosmetics (Huang et al., 2011, Jo et al., 2008, Nazaroff and Weschler, 2004), the **air fresheners** have no other (primary) function; their **sole purpose is to odorize air** in a building. Their use therefore represents an **intended release of a – mostly unknown – substance mix in an indoor environment** (VITO, 2008).”

“The presented results show the great variety of substances that are released from room fragrance products. It also became evident during the study that these products can be substantial sources of air pollutants: Besides releasing scent substances in high concentrations, even higher concentrations could be found for some solvents. Considering the possible exposure time, which can reach weeks for the high volume diffusers, the use of such products in homes may impair indoor air quality notably.”

13. Effects of indoor environment and lifestyle on respiratory health of children in Chongqing, China

Li W, Liu Q, Chen Y, Yang B, Huang X, Li Y, Zhang JJ. Effects of indoor environment and lifestyle on respiratory health of children in Chongqing, China. J Thorac Dis. 2020 Oct;12(10):6327-6341. doi: 10.21037/jtd.2020.03.102. PMID: 33209472; PMCID: PMC7656398.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/33209472/> - [PDF](#)

“Frequent use of **air fresheners is associated with reduced lung function in children.**”

“According to an WHO report, 100 thousand people die of **asthma** every year due to indoor air pollution around the world, of which 35% are children.”

“Our study also found that frequent use of **hygienic incense** and mosquito coils increased the risk of developing **asthma and bronchitis in children**. Studies have revealed the smoke characteristics of mosquito coils or incense, which including fine and ultrafine **particles**, PAHs, **VOCs** and **aldehydes**, with **high irritation** and **suspected carcinogenic effects**. Burning one mosquito coil would release PM_{2.5} with the same mass as burning 75–137 cigarettes and release formaldehyde with the same concentration as burning 51 cigarettes.”

“A study conducted in American adults found that 1,4-dichlorobenzene (1,4-DCB) was associated with reduced pulmonary function after adjusting for smoking. 1,4-DCB was commonly found in **air fresheners**, toilet bowl deodorants, and mothballs (35). Air fresheners have also been found to increase lung irritation and toxic effects on mice in acute toxicity experiments on mice (36). There are numerous types of air fresheners, which traditionally consist of diethyl ether and aromatic flavor ingredients. Besides, propane, butane, dimethyl ether

and other ingredients are added to high-pressure canned products and these ingredients could impair children's lung function. The use of air fresheners does not improve indoor air quality. Instead, it could exacerbate indoor pollution."

14. Physical and psychological stress along with candle fumes induced - cardiopulmonary injury mimicking restaurant kitchen workers

Chandrasekaran VRM, Periasamy S, Chien SP, Tseng CH, Tsai PJ, Liu MY. Physical and psychological stress along with candle fumes induced-cardiopulmonary injury mimicking restaurant kitchen workers. *Curr Res Toxicol*. 2021 Jul 12;2:246-253. doi: 10.1016/j.crttox.2021.07.001. PMID: 34345867; PMCID: PMC8320639.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/34345867/> - [PDF](#)

"Social disruption stress (SDR) mice were exposed to scented candle fumes (4.5 h/d, 5 d/wk) in an exposure chamber for 8 weeks. Exposure to **burning scented candles failed to reduce serum corticosterone level and increased proinflammatory cytokines levels and NF- κ B activity in the lung**. In the present study, we evaluated the role of SDR in combination with exposure to scented candles as generally accepted to reduce stress. However, the **combined SDR and scented candle exposure were found to escalate the stress level**. This stress escalation might be due to the **cardiopulmonary inflammatory response** of the stress and candle fumes, which could be directly related to restaurant workers."

15. Pediatric allergic contact dermatitis. Part I: Clinical features and common contact allergens in children

Neale H, Garza-Mayers AC, Tam I, Yu J. Pediatric allergic contact dermatitis. Part I: Clinical features and common contact allergens in children. *J Am Acad Dermatol*. 2021 Feb;84(2):235-244. doi: 10.1016/j.jaad.2020.11.002. Epub 2020 Nov 17. PMID: 33217510.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/33217510/> - [PDF](#)

"Children can develop ACD (Allergic Contact Dermatitis) at any age.... Therefore, all children should be asked about the use of personal care products such as **shampoos, soaps, lotions, detergents, and topical medications**....systemic contact dermatitis can occur through oral ingestion of contact allergens in food, such as carmine in red velvet cupcakes, nickel in oatmeal and cocoa, and **balsam of Peru (BoP)** in ketchup....Nickel, **fragrance mix (FM) I, BoP, propylene glycol, CAPB, bacitracin, neomycin, cobalt, formaldehyde (and its releasers)**, methylisothiazolinone (MI), and **lanolin** are top relevant allergens in the United States."

"Fragrances are ubiquitous environmental allergens, and although **there are potentially thousands of allergenic fragrance chemicals**, fragrance markers such as BoP, FM I, and FM II are most frequently used in patch testing.... Fragrances are often used in household products like candles and cleaning supplies. **Children may also be exposed to fragrances used by their care takers, such as perfumes, leading to cases of connubial ACD.**"

"**Formaldehyde** is found in cosmetic and personal care products (including baby products), cleaning supplies, adhesives, sporting equipment, and paints. **One study showed that more than 25% of those with PPTs (positive patch test) to formaldehyde were also sensitized to its releasers** such as quaternium-15, dimethyloldimethyl hydantoin, bronopol, diazolidinyl urea, and imidazolidinyl urea.

“Often, products such as **baby wipes may contain formaldehyde releasers** even though they may not be listed among the ingredients. **Formaldehyde (and releasers) contact allergy is more frequent in the United States compared to Europe, likely reflecting stricter regulation of product concentration and labeling in Europe.**”

[Note: **Balsam of Peru** is used in [fragrance](#) and is a [known allergen](#). Like with all fragrance allergies, [avoidance is suggested](#).]

[Note: **Formaldehyde** is a [secondary pollutant](#) from fragrance and fragranced products.

Also, a 2012 study, 21 out of 30 perfume samples were shown to [release formaldehyde](#) when tested but formaldehyde was not listed on any of the labels. Formaldehyde is a [sensitizer](#) and [known allergen](#).]

16. Symptoms of mothers and infants related to total volatile organic compounds in household products

Farrow A, Taylor H, Northstone K, Golding J. Symptoms of mothers and infants related to total volatile organic compounds in household products. Arch Environ Health. 2003 Oct;58(10):633-41. doi: 10.3200/AEOH.58.10.633-641. PMID: 15562635.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/15562635/>

“Higher TVOC levels were associated with air freshener and aerosol use. **Infant diarrhea** and **earache** were statistically significantly associated with air freshener use, and **diarrhea** and **vomiting** were significantly associated with aerosol use. **Headache** experienced by mothers 8 mo after birth was significantly associated with the use of **air fresheners** and aerosols; **maternal depression** was significantly associated with the use of air fresheners. The results of the study suggest a **link between the use of products that raise indoor levels of TVOCs and an increased risk of certain symptoms among infants and their mothers.**”

[Note: [Fragranced products](#) emit [VOC's](#) that can contribute to higher [particulate matter \(PM\)](#) indoors and out.]

17. Endocrine-Disrupting Chemicals & Reproductive Health

Zlatnik MG. Endocrine-Disrupting Chemicals and Reproductive Health. J Midwifery Womens Health. 2016 Jul;61(4):442-55. doi: 10.1111/jmwh.12500. Epub 2016 Jul 8. PMID: 27391253; PMCID: PMC6701840.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/27391253/> - [PDF](#)

“**Phthalates** are another class of chemicals that have been implicated as **endocrine disrupters**. **Phthalates** are used in multiple consumer applications, including **personal care products** such as **lotion** or **shampoo**, often as “**fragrance**”, and as plasticizers to change the physical characteristics of base plastics, including products made with polyvinyl chloride, such as flooring, shower curtains, packaging, and some medical equipment.”

“Human cohort and experimental animal studies have demonstrated possible **adverse effects on reproduction**, including associations with **poor semen quality** and **miscarriage**.”

“**Prenatal phthalate exposure**, as measured by phthalate metabolite levels in maternal urine, has been associated with **abnormal male genital development in the fetus**. In animal models, anogenital distance is a sensitive index of demasculinization of the male reproductive tract. Multiple epidemiologic studies, including prospective cohort studies, have shown a **shortened anogenital distance** (suggesting anti-androgenic influence) **in boys whose mothers had higher urinary phthalate levels during pregnancy**. Some cohort

studies have shown an association with **smaller penile size** as well. These findings are reproducible in experimental studies with rodents.”

“**Prenatal phthalate exposure has also been associated with reduced “masculine play” in boys**, as indicated in a follow-up study of a cohort of couples who had given blood and urine samples during pregnancy. At age 5, the boys’ (n=74) play activities were assessed with a validated inventory of play styles (Pre-School Activities Inventory). **An association was seen between prenatal exposure to anti-androgenic phthalates and less male-typical play behavior in boys.**”

“A recent systematic review of 11 human **studies suggests that higher levels of prenatal exposure to phthalate metabolites**, measured as urinary concentrations, are associated with **poorer cognitive and behavioral outcomes in children, especially boys.**”

[Note: This article suggests you purchase fragrance free personal care products and avoid air fresheners and scented candles.]

18. Adverse Impact of Environmental Chemicals on Developmental Origins of Kidney Disease and Hypertension

Hsu C-N and Tain Y-L (2021) Adverse Impact of Environmental Chemicals on Developmental Origins of Kidney Disease and Hypertension. *Front. Endocrinol.* 12:745716. doi: 10.3389/fendo.2021.745716

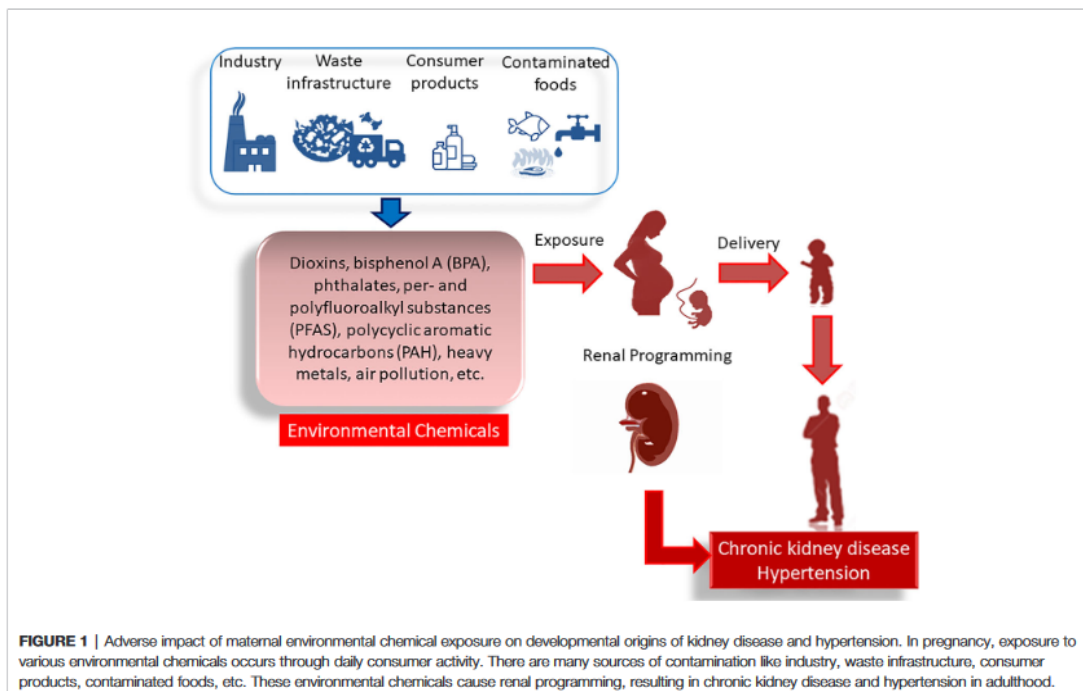
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“Here, we focus on environmental chemicals that pregnant mothers are likely to be exposed, including dioxins, bisphenol A (BPA), **phthalates**, per- and polyfluoroalkyl substances (PFAS), polycyclic aromatic hydrocarbons (PAH), heavy metals, and **air pollution.**”

(note: Graphic is from preceding article)

Hsu and Tain

Environmental Chemical, DOHaD, and Kidney Disease



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“In pregnancy, exposure to various environmental chemicals occurs through daily consumer activity. There are many sources of contamination like industry, waste infrastructure, **consumer products**, contaminated foods, etc. These **environmental chemicals cause renal programming**, resulting in **chronic kidney disease and hypertension** in adulthood.”

“Phthalates can be delivered to the human body through diet, **inhalation, and skin contact**.

Di-2-ethylhexylphthalate (**DEHP**) and di-n-butyl phthalate (DBP) are the primary phthalate ester pollutants in the environment. The metabolites of phthalates can **cross the placenta and be transferred to the fetus**. Epidemiological studies demonstrated that high urinary DEHP levels are **associated with high BP, low eGFR and albuminuria**. As phthalates have estrogenic or antiandrogenic properties, emerging evidence suggests the associations between prenatal phthalate exposure and adverse offspring outcomes. Following these findings, steps should be taken to explore the effect of phthalate exposure during pregnancy on offspring kidneys.”

[Note: Phthalates are [synthetic](#) odorless plasticizers used as solvents, binders or fixatives [in many fragrances](#). Why are phthalates [in the news](#)? [Phthalates](#) are considered Endocrine Disrupting Chemicals. On the [California Safe Cosmetics Program Product Database](#): [DEP](#), [DIDP](#), and [DBP](#) are reported as fragrance while [DEHP](#) and DBP are perfume solvents. [IFRA](#) lists DEP and DMP, as “reported fragrance ingredients”.]

19. Health risks of chemicals in consumer products: A review

Li D, Suh S. Health risks of chemicals in consumer products: A review. Environ Int. 2019 Feb;123:580-587. doi: 10.1016/j.envint.2018.12.033. Epub 2019 Jan 7. PMID: 30622082.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/30622082/> - [Full Text](#)

“It should also be noted that some chemicals have multiple functional uses, while we chose the most dominant functional use for each chemical. An example is the grouping of **phthalates**. Despite categorized as plasticizer together in this review, several phthalates such as **diethyl phthalate** and **dimethyl phthalate** are used as solvents in personal care products and cosmetics as **carriers of fragrance** (Schettler, 2006).”

“...we found that the volume of the peer-reviewed literature that addresses human health risks of the chemicals in consumer products did grow over the last two decades, while its growth could by no means match the speed of increasing volume and diversity of the chemicals produced and used in consumer products by the society. This **growing gap between increasing reliance on chemicals in consumer products and our knowledge on their human health risks raises a potential public health concern**, given the pervasive nature of today's mass production and consumption practice.”

“As a result, peer-reviewed journal publications largely failed to serve as an early warning or a preventive mechanism. The **humidifier disinfectant incident** in South Korea is a stark example that shows the potential vulnerability in chemical exposure through consumer products and its consequences, as well as the limited role for peer-reviewed journal publications to prevent them. It also **highlights the needs for understanding the risks of chemicals before putting them into consumer products**, while the rapidly growing diversity of synthetic chemicals often makes the generation of necessary data cost-prohibitive. As a result, we observed

that scientific literature tends to appear only after the outbreak of major exposure incidents, or they tend to be concentrated in the chemicals or chemical groups of which human health risks have been previously reported. This is a structural problem that is poised to grow under the current practice.”

“We believe that there is an urgent need for creating the framework conditions that encourage more exploratory and speculative risk assessments and their publications in peer-reviewed journal space in the absence of known human health risks. Reducing the costs and time needed for toxicity and exposure assessments is a key, to which the developments in predictive toxicity and risk assessment techniques for screening-level assessment, as well as **the use of systematic prioritization for high-risk exposure pathways and chemicals in consumer products would be crucial.**”

20. Emission characteristics of VOCs emitted from consumer and commercial products and their ozone formation potential

Dinh TV, Kim SY, Son YS, Choi IY, Park SR, Sunwoo Y, Kim JC. Emission characteristics of VOCs emitted from consumer and commercial products and their ozone formation potential. *Environ Sci Pollut Res Int.* 2015 Jun;22(12):9345-55. doi: 10.1007/s11356-015-4092-8. Epub 2015 Jan 21. PMID: 25601614.

Article Link: <https://pubmed.ncbi.nlm.nih.gov/25601614/>

“The characteristics of volatile organic compounds (VOCs) emitted from several consumer and commercial products (**body wash**, dishwashing detergent, air freshener, windshield washer fluid, lubricant, hair spray, and insecticide) were studied and compared.”

“In the spray products, 21.6–96.4 % of the VOCs were propane, iso-butane, and n-butane, which are the components of liquefied petroleum gas. **Monoterpene** (C₁₀H₁₆) was the dominant component of the VOCs in the non-spray products (e.g., body wash, 53–88 %).”

“Besides comprising **hazardous VOCs**, VOCs from consumer products were also **ozone precursors.**”

“The TVOCs from spray products (insecticide, **hair spray**, and lubricant) were higher than those from the liquid products such as the windshield washer fluid, dishwashing detergent, **body wash**, and air freshener.”

“**Limonene** and 1-propanol were the components of one dishwashing detergent. In contrast, another dishwashing detergent comprised **1,3-dioxane, ethanol, ethyl acetate, limonene, β-myrcene, 3-pentanol, and α-pinene** (Kwon et al. 2007, 2008).”

“**Benzene, n-hexane, and ethylbenzene** were observed in the **body washes** and the **air fresheners**. Benzene was classified as Group A of the US EPA lists of **known human carcinogen** (WHO 2010). The unit cancer risk of 1 µg/m³ of benzene is 2.2–7.8 in a million (WHO 2010). The unit risk of **leukemia** per 1 µg/m³ air concentration is 6 in a million. Therefore, **long-term exposure to a considerable amount of benzene in those products might cause health risk**, which should be investigated in future researchers.”

“A **longterm exposure of n-hexane may damage the nervous system**. Exposure to 650 ppm **n-hexane** for 2–4 months causes numbness of the arms and legs (Pohanish 2012). **Ethylbenzene** irritates the eyes, skin, and respiratory tract. A **long-term exposure of ethylbenzene may cause kidney and liver disease...**”

“**Toluene and styrene were detected in body washes**, dishwashing detergents, and windshield washer fluids. It was reported that inhalation of 200–500 ppm **toluene may cause headache, nausea, and loss of**

appetite (Pohanish 2012).”

“**Styrene** is considered as a possible carcinogenic to humans. Inhalation of above 100 ppm **styrene may cause headache, inflammation of the lung, kidney and liver damage, and death** (Pohanish 2012). Since **body washes** are used popularly and frequently, **longterm exposure to the above compounds may cause health damage.**”

[Note: [Limonene](#) is a common skin sensitizer and [known allergen](#) in fragrance and [fragranced products](#). Limonene (natural or [synthetic](#)) is a terpene. Terpenes can create [formaldehyde and particulate matter](#) in air as [secondary pollutants](#). Limonene is on the [IFRA](#) list as a fragrance ingredient.]

[Note: [Benzene](#) is a reported fragrance ingredient in the [CSCP Product Database](#).]

[Note: [N-Hexane](#) is used to extract fragrances and was [on the IFRA list until 2015](#).]

[Note: [Toluene](#) (often a nail polish thinner) is used as a solvent or fragrance in perfume and bath products on the [CSPC Product Database](#). [Toluene](#) is on the [IFRA](#) list and on the EPA's [Priority Pollutant List](#).]

[Note: [Styrene](#) is “[primarily a synthetic chemical](#)” used in fragrance. It is on the [CSPC](#) list as ‘parfum/fragrance’ and also on the [IFRA](#) list.]

[Note: [Ethyl benzene](#) is listed for purchase as a perfuming agent.]

21. Developmental Exposure to Endocrine Disrupting Chemicals and Its Impact on Cardio-Metabolic-Renal Health

Singh RD, Koshta K, Tiwari R, Khan H, Sharma V, Srivastava V. Developmental Exposure to Endocrine Disrupting Chemicals and Its Impact on Cardio-Metabolic-Renal Health. *Front Toxicol*. 2021 Jul 5;3:663372. doi: 10.3389/ftox.2021.663372. PMID: 35295127; PMCID: PMC8915840.

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“**Endocrine disrupting chemicals (EDCs)** include **phenols, phthalates, parabens, flame retardants, heavy metals, pesticides, perfluorinated chemicals, UV filter components, triclosan, and organochlorines.**”

“**Cumulative exposure to mixtures of EDCs can lead to adverse effects on the health of the exposed individuals** (Crews et al., 2003). Multiple studies, including the studies of the National Health and Nutrition Examination Survey (NHANES), have shown that **about 75–97% of US and Asian adults have detectable levels of phthalates and phenols [bisphenol A (BPA) and polyfluoroalkyl chemicals] in their urine** (Silva et al., 2004; Calafat et al., 2007, 2008; Vandenberg et al., 2010; Zhang et al., 2011; Husøy et al., 2019).”

“Epidemiological and experimental studies have also linked **adult exposure to EDCs** with **abnormal male and female reproductive health, diabetes, obesity, cardiovascular and metabolic disorders, thyroid function, and hormone sensitive cancers** (Howard and Lee, 2012; Bodin et al., 2015; Heindel et al., 2015, 2017).”

“**Children are also vulnerable to EDCs** (Calafat et al., 2017; Hendryx and Luo, 2018), **making EDC exposure a major health concern for all age groups.**”

“**Chronic kidney disease** is a growing health problem among children and adults. The incidence and the prevalence of chronic kidney disease (CKD) **among children have been steadily increasing since the 1980s....** A number of traditional risk factors associated with CKD in children include hypertension, obesity,

diabetes, and aberrant divalent mineral metabolism.... There is growing evidence that **links exposure to EDCs with early progression to end-stage renal disease (ESRD)** (Kataria et al., 2015)....”

“Early-life exposure to EDCs was associated with elevated levels of kidney toxicity markers such as albumin-to-creatinine ratio (ACR), estimated glomerular filtration rate (eGFR), and urinary protein-to-creatinine ratio (UPCR) in some human population studies (Li et al., 2012; Trasande et al., 2013a, 2014; Malits et al., 2018).”

[Note: [Phthalates](#) are [synthetic](#) odorless plasticizers used as solvents, binders or fixatives [in many fragrances](#). Why are phthalates [in the news](#)? [Phthalates](#) are considered Endocrine Disrupting Chemicals. On the [California Safe Cosmetics Program Product Database](#): [DEP](#), [DIDP](#), and [DBP](#) are reported as fragrance while [DEHP](#) and DBP are perfume solvents. [IFRA](#) lists DEP and DMP, as “reported fragrance ingredients”.]

[Note: [Endocrine Disrupting Chemicals](#) (EDC’s) are [commonly used in perfumes and fragranced products](#) as preservatives or fragrance. [What are EDC’s](#) and how can they [affect us](#)?]

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