



# Evaluation of pollutants in perfumes, colognes and health effects on the consumer: a systematic review

Zahra Kazemi<sup>1,2</sup> · Ehsan Aboutaleb<sup>3</sup> · Abbas Shahsavani<sup>4</sup> · Majid Kermani<sup>1,2</sup> · Zohre Kazemi<sup>1,2</sup>

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## Abstract

Cosmetic products, especially perfumes and colognes, are widely used in various communities. However, the use of these products can have side effects on consumers. This article aims to review the relevant literature published up to August 2020 to determine whether perfumes and colognes can affect people's health. Relevant articles were identified through electronic search. A total of 562 articles were selected and finally 37 related articles were included in the study after the screening process. The results of this systematic study showed that phthalates, aldehydes, parabens and aluminum-based salts are the most important contaminants in aromatic products that cause side effects such as allergies, breast cancer, reproductive disorders, especially in males, skin allergies, nervous system damage and migraine headaches for consumers. The incidence of complications in people using these products depends on parameters such as age, gender, race, amount of substance consumed, duration of use and economic status, and regarding the relationship between diseases such as cancer, respiratory disorders and endocrine with common contaminants in aromatic products, incidence of these diseases is probable in consumers which require further research to prove.

**Keywords** Allergies · Aromatic products · Health effects · Perfume

## Introduction

Smells play a significant role in human behavior. A pleasant scent can have a calming effect, but an unpleasant odor can lead to anxiety and discomfort. The first evidence of perfume use by human dates back to thousands of years ago, when Egyptians used herbs, gums, and resins as aromatic compounds in their religious rites [1]. Today,

perfumes are used in various applications, including deodorants, laundry products, shampoos and conditioners, cleansers, etc. These compounds include two groups, natural and synthetic. Natural perfumes are divided into two categories: aromatic compounds and musk, which are extracted from plants, lichens, seaweed and special oil obtained from different parts of a plant. The other group is synthetic aromatic compounds, which are often used as alternative sources due to low production costs and problems related to low product quality or lack of resources [2]. Aromatic products contain a complex mixture of chemicals such as volatile organic compounds (VOCs), limonene, alpha-pinene, beta-pinene, ethanol, acetone, acetaldehyde, etc. [3]. Phthalates such as diethyl phthalate (DEP), dibutyl phthalate (DBP), dimethyl phthalate (DMP), and diisobutyl phthalate (DiBP) in deodorants, shampoos, soaps, cosmetics, nail polishes and parabens, among others. Methyl paraben (MP), butyl paraben (BP), ethyl paraben (EP), and propyl paraben (PP) are used as fungicides, bactericides, and preservatives in cosmetics, perfumes and deodorants [4, 5]. Diethyl phthalate is a chemical used to make perfumes last longer. The U.S. Clean Water Act lists it as a toxic and priority pollutant

✉ Majid Kermani  
kermani.m@iums.ac.ir; majidkermani@yahoo.com

✉ Zohre Kazemi  
Zohreh.Kazemi201797@gmail.com

<sup>1</sup> Research Center of Environmental Health Technology, Iran University of Medical Sciences, Tehran, Iran

<sup>2</sup> Department of Environmental Health Engineering, School of Public Health, Iran University of Medical Sciences, Tehran, Iran

<sup>3</sup> Department of Pharmaceutics, School of Pharmacy, Guilan University of Medical Sciences, Rasht, Iran

<sup>4</sup> Environmental and Occupational Hazards Control Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran

[5]. Dimethyl phthalate and diethyl phthalate lead to slower evaporation of perfume aromas which results in longer persistence [6]. Scientific evidence shows that four phthalates in 102 hair sprays, perfumes, fragrances and nail polishes, DBP in 19 of 21 nail polishes and 11 of 42 perfumes, as well as DEP in 24 of 42 perfumes and 2 of 8 aromatic substances were observed [7]. Triclosan is an antimicrobial substance that was widely used in antibacterial hand soaps and was banned by the FDA in 2016, but is still used today in some compounds such as fragrances, toothpaste, mouthwash and acne cream [5]. Complications of using perfume include neuropathy (depression, autism), neoplasms (breast cancer, prostate cancer), effects on the liver, migraine headaches, asthma attacks, mucosal symptoms (watery or red eyes, sneezing), neurological problems (dizziness, convulsions, headache, fainting, imbalance), respiratory (cough, shortness of breath), skin (skin rash, urticaria, redness of the skin, skin tingling, dermatitis), immune system (swollen lymph nodes, fever, fatigue), gastrointestinal tract (nausea, bloating, diarrhea) and cardiovascular (rapid or irregular heartbeat, tremors, chest discomfort) [3, 8]. About 75% of people with shortness of breath have experienced asthma attacks caused by perfumes [8]. Also, risk of asthma and high IgE serum levels were increased in the children who were exposed to phthalates during pregnancy. [9]. Furthermore, there are some concerns about the effect of diethyl phthalate on male fertility; so this group should avoid using perfume products that contain large amounts of diethyl phthalate [10]. Triclosan and some parabens have significant effect on the spread of cancer and triclosan can disrupt thyroid function [5]. The findings of a survey in the United States, Australia and the United Kingdom indicated that on average, in all three countries, about 30% of people were exposed to at least one fragrance [3]. Among many factors, aromatic compounds with estrogenic properties (parabens, phthalates, nitro musks) have been an important and main cause of breast cancer. These compounds penetrate the bloodstream through the skin and lead to impaired endocrine homeostasis [8]. Studies on children in the age range of 5–15 showed that the most common allergens in the development of dermatitis are paraben (43%), potassium dichromate (27%) and perfume (26%) [11]. Many studies show that most perfumes, even in small amounts, can cause neurological disorders in the fetus of pregnant mothers [8]. One of the causes of autism is exposure to chemicals (perfumes and medications) during pregnancy and after birth through breast milk [8]. Studies show that aromatic products emit more than 100 volatile organic compounds (VOCs), which can pose a serious threat to human health. The purpose of this study is a comprehensive review of different types of contaminants identified in these products and the adverse effects observed in people

exposed to them. Attempts were also made to identify and categorize the incidence of complications in these individuals and the factors affecting the incidence and severity of complications.

## Material and methods

### Literature review

The search was done in three databases: Scopus, Pubmed, and Web of Science in 2020 for finding relevant articles regarding perfume pollutants and their effects. As shown in Table 1, a total of 672 articles were found, of which duplicates were removed.

### Eligibility criteria

The final papers were chosen on the basis of the eligibility criteria; for this purpose, the focus was on articles which were related to the pollutants in perfumes: 1) Articles which studied the presence of pollutants, 2) measured the concentration of pollutants, and 3) articles which evaluated the effects of pollutants on consumers or people exposed to perfumes.

### Study selection

The literature was screened independently by all the authors, based on the criteria mentioned above.

Three screening steps were performed to select the final articles. In the first step, according to the title of the article, articles related to perfumes were selected (83 articles). In the second step, articles focusing on perfume's pollutants were selected after reviewing their abstracts (52 articles). Finally, (37) articles which carried information about the quantity or effects of pollutants in perfume were selected for writing this review (Fig. 1).

### Data extraction

We extracted the following data on the content of the eligible articles: (1) Pollutants in perfumes and colognes, (2) Concentrations of pollutants in perfumes and colognes (3) Diseases attributed to aromatic products consumption (4) Factors affecting the incidence of effects (5) Methods of prevention or treatment.

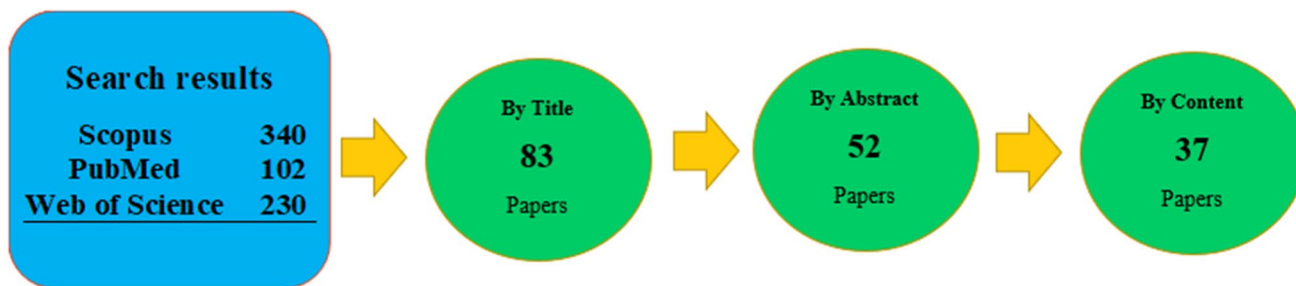
## Results and discussion

### Pollutants (harmful compounds) in perfumes

Aromatic consuming products contain a complex mixture of chemicals that have different uses including odor production,

**Table 1** Search protocol and the number of articles found in each database

*Aromatic products	*Effects on health	* Others	
Perfume	breast cancer	Ethnicity/Race	
cologne	prostate cancer	Nationality	
fragrance	asthma attacks	Income	
aromatize	migraine headaches	Kindergarten air	
flavor	cough		
scent	shortness of breath		
Antiperspirant	dizziness		
	dermatitis		
*Air pollutants	diarrhea		
phthalate	nausea		
Monoethyl phthalate	rapid or irregular heartbeat		
Monobutyl phthalate	* Demographic		
Debutyl phthalate	Age		
Diethyl phthalate	Gestation		
Diisobutyl phthalate	Postnatal exposure		
paraben	Prenatal exposure		
Butyl paraben			
Propylene paraben			
Ethyl paraben			
Alpha-pinene			
Beta-pinene			
Benzophenone			
Triclosan			
Terpenes			
...			
Web of science	PubMed	Scopus	database
230	102	340	Founded article

**Fig. 1** Outlines of the screening process and selected 37 articles used in this study

solvent and fluidizer, perfume stabilizer, preservative, anti-perspirant, denaturing agent [12–17]. Numerous studies have been conducted on the compounds in these products and the results are presented in Table 2. Although the use of these compounds in aromatic products has been mentioned for a number of reasons, many of them have negative effects on health and are known to be contaminant. Examples of volatile organic compounds (VOCs) of ethanol, alpha pinene, acetone, limonene, beta pinene and acetaldehyde are mentioned in aromatic products as indoor air pollutants [3]. The

number of compounds in aromatic products reaches tens of compounds, many of which have toxic effects on humans; (2015) Steinemann in his study identified more than 150 different VOCs distributed from 37 aromatic consumer products in the United States, 42 of which were classified as toxic or hazardous pollutants under U.S. federal law [3]. It is possible to identify the harmful effects of exposure to these compounds on human health; in a way that the concentration of monoester phthalate in cologne in a urine sample was measured by liquid chromatography with

**Table 2** Compounds identified in perfumes and their applications

Remarks	Ref.
The main ingredients of fragrances were dimethyl octanol, eucalyptol, dimethyl heptenal, alpha-citroneline, methoxy benzaldehyde, limonene, benzylacetone and decanal	[13]
Phthalates such as Diethyl phthalate (DEP), di-n-butyl phthalate, di (2-ethylhexyl) (DEHP) and butylbenzyl phthalate (BBzP) are versatile chemicals used in personal care products, especially perfumes.	[7]
DEP as the main ingredient in MEP is found in many perfumes, deodorants and fragrances.	
The amount of phthalate measured in different brands of deodorant, aftershave and cologne was generally different.	[7]
P-t-butyl- $\alpha$ -methyl hydrocinnamic aldehyde, eugenol, geraniol, hydroxycitronellal and ethanol, diethyl phthalate or a combination of the two were found in fragrances.	[22]
Terpenes were found in perfumes as pollutants.	[2]
Phthalates such as diethyl phthalate (DEP) and di-isobutyl phthalate (DiBP) were used in perfumes and fragrances.	[9]
Salicylates are compounds found in perfumes.	[23]
Most of the chemical compounds in natural perfumes were terpenes, limonene, hexyl cinnamal and linalool.	[24]
The most common contaminants found in most spray products are Toluene, benzene, styrene, methyl ethyl ketone and butyl acetate in the range of concentration of 5.3–125 mg L <sup>-1</sup> .	[18]
DEP and to a lesser extent DnBP were detected with higher concentrations than other phthalates in perfumes and other aromatic products.	[25]
The major metabolite of DBP (MBP) was present in deodorants and perfumes.	[26]
Diethylhexyl phthalate (DEP) was observed in many products, including fragrances.	[27]
One of the most commonly used contaminants in the perfume industry is Allyl esters, which contain some free allyl alcohol.	[28]
Monoterpene hydrocarbons (e.g., limonene), sesquiterpene hydrocarbons (eg, $\alpha$ -farnesene), alcohols (eg, cis-3-hexenol), monoterpene alcohols (eg, linalool), sesquiterpene alcohols (e.g., farnesol), phenols (eg, eugenol), aldehydes (eg, 2,6-nonadienal), terpene aldehydes (eg, citral), ketones (eg, cyclohexanone), terpene ketones (eg, $\beta$ -ionone), lactones (eg, $\gamma$ -undecalactone), esters (eg, methyl salicylate), terpene esters (e.g., linalyl acetate), oxides (e.g., eucalyptol), two polycyclic and two nitro musks are present in many cosmetic products, including perfumes.	[1]
Phthalate DEP was the most common of the ten selected and analyzed fragrances. Of the other phthalates, only DAP, DCP, DMP and DNPP were found in some samples.	[4]
DEP diethyl phthalate is abundant in both men's and women's fragrances.	[10]
Geraniol, citronellol and DEP are among the compounds of perfumes.	[29]
Diethyl phthalate (DEP) is used in many perfume formulations as a solvent and fluidizer.	[13, 24, 30]
Ethanol As one of the main solvents and pentanes, 2- propanol and acetone were present in low concentrations in these products. Terpenoids, aldehydes and lactones are common substances in producing odors.	
DEP is a known aromatic additive.	[9]
Dibutyl Phthalate (DBP), Diethyl Phthalate (DEP), Dimethyl Phthalate (DMP) and Dialkyl Phthalates are mainly used as fragrance stabilizers.	[12]
Salicylates include alkyl (e.g., methyl-, ethyl-, butyl-, isobutyl-, pentyl-, isoamyl-, hexyl-, and ethyl hexylsalicylate), alkenyl (e.g., cis-3-hexenyl-, trans-2-hexenyl-, 1,3-dimethyl-3-butenyl, and 3-methyl-2-butenyl salicylate), aromatic ring compounds (e.g., benzyl-, phenyl-, p-cresyl- and phenethyl salicylate) and other derivatives (4-methyl salicylate) (e.g., 4-methylsalicylate) salicylic acid are used as aromatic materials.	[23]
Limonene is used as an aromatic additive in perfumes.	[31]
EDCs are used in personal care products (PCPs) as antiperspirants, preservatives, deodorants, air conditioners, and air fresheners.	[15]
Coumarin is used as a fragrance in perfumes.	[32]
Diethyl phthalate (DEP) is widely used in the perfume industry as a fragrance production agent.	[16]
Manufacturers use low molecular weight phthalates, such as DEP and DBP, in various personal care products such as fragrance, colognes, and deodorants products as a denaturing agent and fixative.	
Lower molecular weight phthalates such as diethyl phthalate (DEP) and dimethyl phthalate (DMP) are commonly used as solvents and odorless diluents in cosmetic products like deodorants and perfumes.	[4]
TCS is mainly used as a disinfectant in deodorant and many personal care products.	[17]
Methyldibromo glutaronitrile 0.5% petrolatum (pet) is widely used as a preservative in cosmetics and fragrances.	[33]
Phthalate esters (PEs) are widely used in various products such as fragrances as solvents and fixatives.	[34]

mass spectrometry [7]. Also in another study, five phthalate monomers was observed in 75–100% of people; it was found that MEP was the most common (100%), followed

by MBP (95%) and MBzP (90%), while MEHP and MMP were observed for 75% of people [7]. In addition, some compounds in fragrance products can cause secondary

contaminants. Due to the high content of terpenoids in air fresheners, large amounts of secondary pollutants such as formaldehyde and fine particles may be created as a result of their release [18]. It has also been reported that terpenes (e.g. beta-pinene, limonene and alpha-pinene) as important contaminants in aromatic products can react with ozone and spectrum and from a wide range of secondary contaminants such as formaldehyde, acetaldehyde and secondary organic aerosols [13, 19, 20]. Therefore, the release of pollutants from the consumption of aromatic substances, in addition to the consumer, can affect the health of other people directly or by producing secondary pollutants in indoor air. For example, the results of an indoor air survey of kindergartens and apartments show that DEHP, and to some extent measured DBP in kindergarten air, was significantly higher than in apartments, and that DEHP accounted for approximately 80% of the most important pollutants in house dust [21]. The highest share of air pollutants was in DBP with a ratio of approximately 32%, followed by DEP with diethyl phthalate in a ratio of approximately 19%, while DEHP had a higher share (5–12%) in kindergarten air [21].

### Adverse effects of using perfume and cologne

The compounds identified in aromatic products can be the source of several adverse health effects. One of the side effects of using these products that has been mentioned in most research results is allergies. Sensitivity to the potential for allergenicity is when the compounds penetrate the skin and trigger an immune response [35]. For example, the results of the Marie Api study suggested that 3.5% of the population were allergic to aromatic compounds [14]. Terpenoids and other herbal fragrances have also been shown to cause skin allergies [18]. On the other hand, inhaling DEHP aerosols in combination with allergens can lead to asthma and allergies in children [6]. Dermal or inhalation exposure has been shown to lead to skin and bronchial sensitization [8]. However, according to the research results, allergies and allergic symptoms do not appear in all people exposed to aromatic products, and the proportion of people with these side effects in the study population has been reported differently. According to a study on 90 student nurses, 12 cases (13%) showed fragrance allergic [2]. In a survey of 567 unselected individuals aged 15–69 years, 6 cases (1.1%) reacted to fragrance mix [36]. Also, when allergies were tested with ten popular perfumes, it was found that complications appeared in 6.9% of women with female eczema patients. In a study, sensitivity to popular commercial fragrances was reported in 57% of patients [36]. In addition, the degree of allergic symptoms incidence in people will have different consequences depending on which aromatic product is used, in a way that the most common allergen reported in 50 patients with suspected CACD in 2000 in India was perfume

(47%) [37]. Perfumes were also identified as the most common allergens when patients with suspected allergic cosmetic dermatitis were examined [36]. Research has shown that perfumes can also cause allergic reactions in pets. In a study in European centers on 5% of pets, the rate of 1.5–3% of contact allergies caused by perfume was observed [33]. Of course, it should be noted that different compounds in aromatic products can cause allergic symptoms in humans, which are mentioned in Table 2. However, the presence of several allergenic factors has led to some studies to mention perfumes as one of the main allergens [37, 38]. Also, in a study conducted in skin clinics on patients with allergic dermatitis, “perfume” was considered as the second main cause of allergic reaction [5].

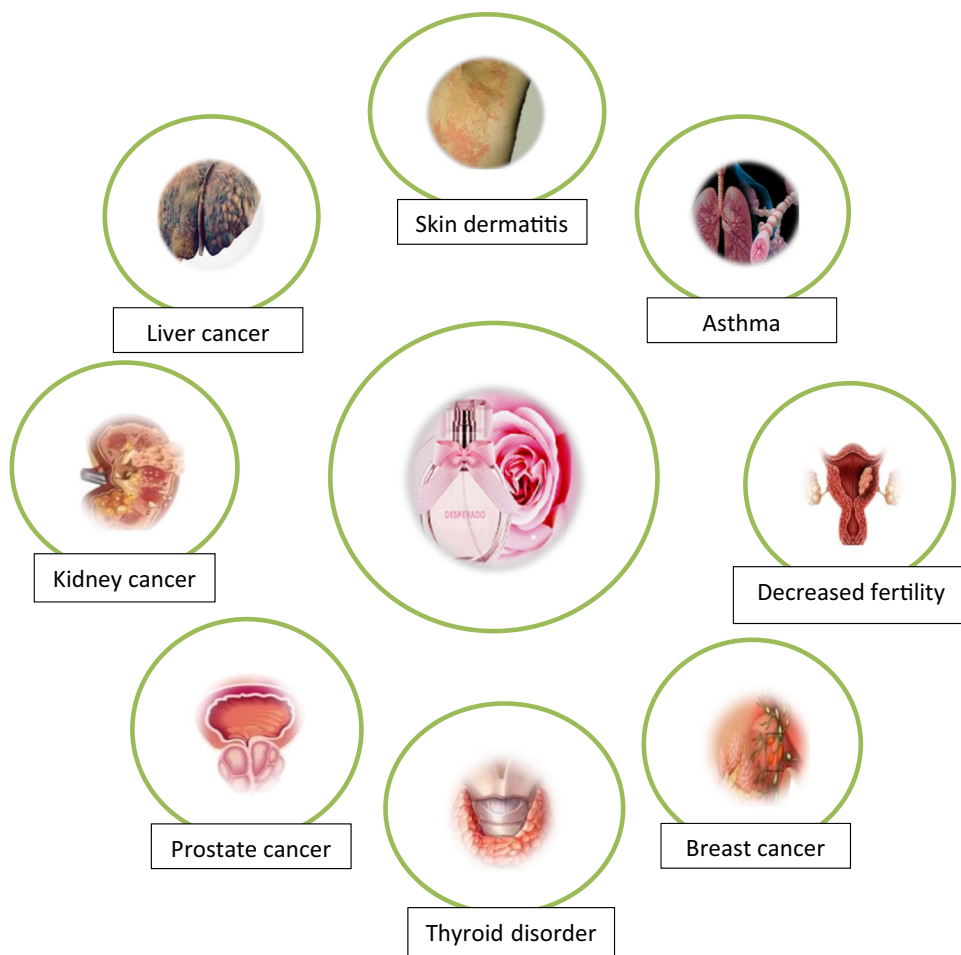
In addition to allergies, the use of perfumes and colognes, as shown in Fig. 2, have other adverse effects on the health of consumers, the most important of which are respiratory problems and diseases such as asthma [1, 5, 8, 24, 39]. A Swedish study reported respiratory problems (20.0%) and asthma attacks (5.5%) in the population exposed to perfumes and colognes [3]. In other studies, respiratory problems were observed in 9.1, 11.6 and 18.6% of people exposed to perfumes and colognes [19, 20, 40]. It is confirmed that respiratory problems in addition to perfume and cologne can be due to the use of other similar products such as body spray products [18].

The use of aromatic products can lead to other side effects such as migraine headaches, which have been reported in some studies with proportions of 4.2, 16.1, 8.4, 15.7 in people exposed to perfumes and colognes [3, 19, 20, 40]. Although the use of aromatic products has proven side effects for exposed individuals, the proportion of people with these symptoms or side effects is between 20 and 35% of all people exposed to aromatic and health products [3, 19, 20, 40]. Also, other observed effects of perfume and cologne are stated in Table 3.

### Factors affecting the side effects of using perfume and cologne

Although the presence of perfume and cologne compounds and their adverse health effects have been proven in exposed individuals, a high proportion of people who use these products are unaware of their health effects. For example, it was reported that 70.9% of perfume and cologne consumers were unaware that fragrance products, even those called green and organic, could emit potentially dangerous pollutants [3]. This issue can be effective in increasing the incidence of side effects of using aromatic products in the whole society. In addition, other factors are effective in causing adverse effects of aromatic products. Gender is an important factor in the effects of the use of aromatic products. Research shows that women are more likely than men to suffer from the effects of using fragrance

**Fig. 2** Effects of exposure to perfumes and colognes



products. One study found that of 33.1% of the population, who reported adverse health effects, 64.0% were female and 36.0% were male [3]. Similar conditions have been reported for a higher proportion of complications observed in women than men with a difference of about 10% in other studies [20, 40]. In addition to gender, age also affects the symptoms and side effects of using aromatic products. This effect can be due to the different uses of aromatic products by age groups or due to the sensitivity of some age groups to the pollutants in them. For example, parabens have been shown to have more severe effects in young children than in adults because protective mechanisms such as a competent immune system are not yet developed in children, and exposure to chemicals in the early stages of development can disrupt normal patterns of growth [57]. However, another study showed an increase in perfume allergy with aging [36]. One of the reasons for the difference in side effects between the sex and age groups is the difference in the sensitivity in these groups, as evidenced by the higher use of health products in certain age groups and women, in a way that fragrance products is an important cause of complications in teenage girls [58]. Studies have also shown that the differences in the side effects of fragrance products

are the result of physical differences, income levels and well-being of individuals [7, 17]. Environmental conditions such as temperature, humidity and chemical properties of the product will affect the incidence of adverse effects due to the effect on skin absorption [29]. Another factor influencing the occurrence of complications is the type and area of use, so that the use of axillary health products especially on the left side of the body, because of the right-handedness of most people, is associated with higher incidence of left breast cancer [29]. Important factors which show the negative effects found in other studies are collected in Table 4.

### Solutions to prevent complications and odor control

Given the significant effects of these products, it is very important to mention solutions to reduce its problems. One of these solutions is to increase consumer awareness about their adverse health effects through education [5]. Since aromatic products play an important role in causing breast cancer, changing the formulation of the product or deciding to discontinue consumption are other measures that can be effective [55]. Huang and his colleagues believed that in

**Table 3** Observed effects of perfume and cologne

Remarks	Ref.
Phthalates affect male reproductive development by inhibiting androgen biosynthesis.	[41]
Some phthalates and their metabolites cause abnormal or absent epididymis, testicular damage, increased prevalence of hypospadias, cryptorchidism, anogenital prolapse, and late detachment of the penis skin in the male reproductive system.	[41]
There is a relationship between urinary monoethyl phthalate (MEP) concentration and sperm DNA damage and between urinary monobutyl phthalate (MBP) and mono-benzyl phthalate (MBzP) concentrations with decreased sperm motility.	[7]
Dibutyl phthalate, bis (2-ethylhexyl) phthalate, benzyl butyl phthalate lead to reproductive dysfunction in male infants.	[34]
Exposure to DBP and DEHP in perfume vendors increases damage to the reproductive system.	[42]
In a Danish group, reduced fertility was observed with MEP exposure.	[43]
Di-n-butyl phthalate may interfere with the normal shape of testicular tissue. It can also increase sperm abnormalities and shorten the life of Sertoli cells.	[44]
Exposure to parabens can seriously damage sperm DNA, male reproductive health and the reproductive system of male animals.	[45–47]
Exposure to parabens during pregnancy leads to dysfunction of the thyroid gland and weight gain of the infant, especially the male infant at birth.	[47]
Daily consumption of 1000 mg / kg body weight methyl paraben and iso-BuP leads to vaginal opening delay, decrease in the length of estrous cycle, decrease in corpora lutea, increase in the number of cystic follicles, and thinning of the follicular epithelium.	[47]
Exposure to (100 mg / kg) of butyl paraben affects the growth of the reproductive system.	[24]
Prostate or testicular cancer and decreased sperm count in men and reproductive abnormalities in women are among the destructive effects of EDC chemicals.	[48]
EDCs disrupt the function of steroid hormones. Since one of the functions of these hormones is to regulate the function of the reproductive system, they can affect reproductive health.	[15]
Paraben as one of the contaminants of perfumes, colognes and deodorants, has been found in human breast tumors; so it may play a role in increasing the incidence of breast cancer.	[15, 45, 47, 49–54]
There is a significant relationship between malignant ovarian tumor tissues and increased exposure to high paraben concentrations.	[54]
A relationship has been found between the use of aluminum-based underarm antiperspirants and breast cancer.	[15, 45, 55]
Excess breast growth of men (gynecomastia) can be attributed to EDCs such as phthalates and musks.	[15]
Ethyl-, Propyl-, and n-butylparaben lead to breast cancer in humans	[49]
Among several factors studied, parabens, phthalates, nitro parabens, phthalates, and nitro musks were identified as the main causes of breast cancer.	[8]
An increased incidence of breast cancer was observed in Mexican women exposed to MEP.	[43]
Breast cysts and fibroadenomas are common benign breast conditions that commonly occur in breast UOQ and have been observed when using underarm antiperspirant.	[55]
Triclosan can lead to thyroid hormone disorders. Because this hormone is essential for the development of the fetal nervous system and the differentiation of the brain, its deficiency may affect the fetal neurodevelopment.	[9, 17, 24]
Prolonged exposure of rats to DEP resulted in an increase in triglyceride levels over three generations.	[16]
Parabens can lead to obesity.	[15, 53]
In Japan, a study of 128 female students found a significant association between high concentrations of parabens and shorter menstrual periods.	[56]
The destructive effects of EDCs include their role in glucose imbalance in insulin resistance and type 2 diabetes. In addition, they can lead to dysfunction of the adrenal glands, thyroid, immune system and endocrine cancer.	[15]

order to minimize the possibility of damage to the reproductive system, sellers of perfumes, sprays, colognes, etc., especially pregnant women, should work in areas that are not exposed to phthalates [42]. Other applications are as follows:

Development of national laws on the non-sale of cosmetics containing harmful ingredients [60].

Proper washing of the area with soap and water.

Using 20% ACH in SAGB to remove underarm odor.

Using indomethacin, diltiazem, cardism, clonidine, propranolol to eliminate odor [61].

## Conclusion

Contaminants in perfumes and colognes and their health effects on the consumer were systematically reviewed. It was found that the most attention of researchers was to

**Table 4** Factors affecting the incidence of effects

Remarks	Ref.
Higher levels of triclosan have been reported in the serum of men than women.	[59]
.An increase in urinary MEP was observed in men who used cologne	[7]
Higher levels of monobutyl phthalate (MBP), monoethyl phthalate (MEP), and mono-2-ethylhexyl phthalate (MEHP) in women's urine was found to be more than men which suggests more exposure to dibutyl phthalate (DBP), diethyl phthalate (DEP), and di-(2-ethylhexyl) phthalate (DEHP) due to the use of perfumes and colognes.	[42]
The amount of triclosan observed in the urine of people aged 31 to 45 years was higher than other age groups.	[59]
People above the age of 25 are more exposed to triclosan than those below the age of 25.	[17]
According to a national survey, Africans, Americans and Hispanics had higher levels of MEP and MBP in their urine than Caucasians in the face of perfume contaminants.	[7]
There is a direct relationship between the habit of daily use of people and less use of perfume with the amount of urinary MEP.	[44]
The rate at which a chemical compound is absorbed into the skin depends on its properties, such as lipophilicity, molecular weight, and volatility.	[29]
Aluminum chlorohydrate, which is an axillary antiperspirant compound, is absorbed from intact skin and stripped skin 1.81 µg/cm <sup>2</sup> and 11.5 µg/cm <sup>2</sup> , respectively.	[45]
D4 and D5 were absorbed from the axillary skin within 1 h and observed in the blood so that the maximum absorption of D4 was 0.12% of the dose for men, 0.3% for women and 0.05% for D5 in women and men.	[45]

identify the compounds in perfumes and colognes and their concentrations. Among the most common pollutants phthalates and their derivatives can be mentioned. Other pollutants included parabens, triclosan, salicylates, terpenes, aldehydes, benzene, toluene, styrene, and aluminum-based salts. These pollutants have also been shown to have adverse effects on consumer health such as asthma and allergies, cardiovascular disease, central nervous system damage, breast cancer, endocrine cancer, respiratory disorders, reproduction, thyroid, adrenal gland function and immune system. Factors affecting the occurrence of effects in people exposed to these products include age, sex, amount and place of use, physical differences and income levels. It was also found that not all people exposed to these products reported identified side effects. Therefore, increasing consumer awareness about the negative effects of perfumes and colognes, and trying to produce products with fewer side effects through the use of low-risk raw materials can be beneficial for protecting consumer's health.

**Abbreviations** PP: propyl paraben.; BP: butyl paraben.; PE: Phthalate ester.; FDA: Food and Drug Administration.; VOC: Volatile organic compound.; CACD: cosmetic allergic contact dermatitis.; EDC: endocrine disrupting chemical.; PCP: personal care product.; UOQ: upper outer quadrant.

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## Declarations

**Ethical approval** IR.IUMS.REC.1399.1379.

**Conflict of interest** The authors of this article declare that they have no conflict of interests.

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