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A Review: Toxic Chemicals Emitted from Air fresheners & Disinfectants

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Abstract: ***Health and wealth are closely related to indoor air quality (IAQ). Breathing clean air can lead to a better quality of life, it reduces the risk of respiratory infections, and it minimize the risk of developing a number of chronic diseases. According to data from the WHO, 90% of people around the world spend their time indoors. Outdoor pollution is 2 to 5 times lower than that found indoors. In this review article, we discussed about how air fresheners, cleaning agents, and disinfectants affect people's health and how they release air pollutants. Air pollution is a significant hazard to people's quality of life. The majority of diseases and early deaths are brought on by breathing this contaminant air. since everyone today uses a variety of cleaning reagents and air fresheners without considering the potentially harmful effects. Spray cleaning technology and disinfectants have been linked to negative respiratory effects. The common Volatile Organic Compounds Emitted by air fragrance products are limonene, alpha-pinene, beta-pinene, and other terpenes. These pollutants have been linked to a number of adverse health effects, including contact dermatitis, migraine headaches, asthma attacks, respiratory problems, neurological issues, and mucosal symptoms. This review article emphasizes the drawbacks of chemical-based air fresheners and cleaning products. Here we also focus the unexpected respiratory diseases caused by long term exposure of chemical pollutants emitted by air fresheners on indoor environment.***

Keywords: Air fresheners, Chemical disinfectants, IAQ, Health effects, Respiratory illness and VOC's.

I. INTRODUCTION

Poor indoor air quality is now a significant health risk for humans. 90% of people worldwide spend their time indoors, as per WHO data. Breathing polluted indoor air, which is 2 to 5 times more prevalent than outdoor air, is the primary cause of most respiratory illnesses and early deaths. Young children, newborns, elder people, and pregnant women are the people who are most susceptible to getting sick from indoor air pollution. Stale air can reduce the quantity of oxygen our bodies receive, and a lack of fresh air can decrease immune system performance, making it more difficult to fight off viruses like COVID-19. (Nagendra Kumar Rai et al. 2020; Dindarloo et al. 2020). Therefore, breathing purified air can prevent the spread airborne diseases like asthma, Pneumonia, flu and COVID-19. This is due to the fact that bacteria and viruses have a lower chance of surviving in fresh air. Our lungs' blood vessels enlarge as a result of increased oxygen exposure, which improves gas exchange, speeds up tissue healing, and promotes lung cleaning. Consumer products with strong fragrances, such as air fresheners, cleaning reagents, and personal care products, are one of the primary sources of indoor air pollutants. Especially air freshener emits a variety of volatile organic compounds (VOCs), includes terpenes (like limonene), which commonly dominate indoor pollution and cause secondary pollutants like formaldehyde. The toxicity of the ingredients used in fragrances is well known. Asthma attacks, headaches, and in some cases, cancer have all been linked to breathing fragrances (David A. Basketter et al. 2019). Throughout and after the COVID-19 epidemic, everyone used a variety of cleaners, disinfectants, and air fresheners without being aware of the potential side effects.

During the COVID-19 epidemic, a lot of incorrect information and myths regarding corona viruses were circulated on social media. According to research data, some people have attempted to consume disinfectants after cleaning with hand sanitizer and bleach, applying them to their skin, and washing food items (Nagendra Kumar Rai et al. 2020). Such extreme activity has the potential to be hazardous and may result in life-threatening illnesses including irreversible blindness, epilepsy, coma, and damage to the neurological system. The digestive tract can be seriously damaged by accidentally consuming caustic chemicals, which are found in cleaning reagents. Pathogens and other harmful microbes that cause disease are destroyed by disinfectants. The use of disinfectants has an effect on both the environment and individuals. Numerous researches (Uhde et al. 2014) have shown that exposure to disinfectant substances like quaternary ammonium compounds (quats), sodium hypochlorite, hydrogen peroxide, alcohol, and glutaraldehyde increases the risk of COPD, asthma, eye irritation, and other respiratory illnesses.

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Chemical residues on a surface can become airborne and contribute to poor indoor air quality, which can be dangerous for those with asthma, allergies, or other sensitive or receptive respiratory systems. In addition, the disinfectants would pollute the air, water, and land after being washed away by rain. The negative effects of these disinfectants on both people and the environment should be discussed. The International Fragrance Association (IFRA) creates guidelines with the goal of ensuring the safety of fragrance production and use (David A. Basketter et al. 2019). The chemicals released by air fresheners and disinfectants, as well as their negative effects, were extensively investigated in this review article. Nearly all air fresheners on the market today contain a variety of chemicals, such as LPG, alcohol, and chemical fragrances.

II. EVIDENCE BASED AIR POLLUTANTS EMITTED FROM AIR FRESHENERS

Air freshener is a fragrance-emitting device, used to get rid of odours by absorbing and masking an unpleasant odor in the air. Aerosol propellants (butane and propane), fragrances, and odor-neutralizing solvents including 2-butoxyethanol and glycol ethers, etc., are the major ingredients it comprises. In today's world, air fresheners are often utilized in workplaces, schools, hospitals, theatres, stores, hotels, health clubs, restaurants, restrooms, and other indoor facilities. They may also be found in automobiles, taxis, buses, trains, terminals, boats, and other forms of transportation. There are several fragrances available in the market that emit various kinds of pollutants. For example, scented candles may release 28 mg/m3 of 4-methoxybenzaldehyde and 13 mg/m3 of gamma-nonalactone, whereas wax-type candles such as paraffin, stearin, plant wax, and tallow can emit large amounts of formaldehyde, acetaldehyde, and ethanol into the environment. Major air pollutants emitted from diffuser-type air fresheners are benzyl acetate, malonic acid diethyl ester, linalool, linalyl acetate, 2-hexenylpropanoate, and dihydromyrcenol (Bhat et al. 2021; Uhde et al. 2014). A typical air freshener may release a variety of volatile organic compounds (VOCs), including terpenoids such aldehydes and lactones as well as terpenes like limonene, alpha-pinene, and beta-pinene. Terpenes that are released into the air can combine with ozone to form variousa new oxygenated volatiles compounds such formaldehyde, dicarbonyls, and peroxides. They can also condense to create ultrafine secondary organic aerosols (SOA) and cause adverse health effects (PederWolkoff et al. 2020; Steinemann et al. 2016; Mary B. Johnson et al. 2019). Nowadays, it is impossible to imagine daily life without scents and scented products. Sprays, diffusers, evaporators, scented candles, and automatic devices for the distribution of fragrance liquids are typical examples of consumer air fresheners. Using these products in our daily life can cause many health disorders. However, people may not know what kinds of fragrance substances and solvents are released. High doses of these pollutants can cause direct health hazards such as respiratory and cardiovascular diseases, as well as impair lung functions. (Mary B. Johnson et al. 2019) Although scents can improve mood, reduce stress, and improve memory, consumers may limit their use due to negative health consequences.

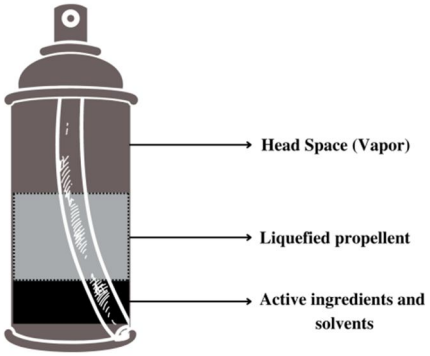


Figure 1: Schematic Diagram of Typical Aerosol Fragrance Spray Can

A study conducted by (Steinemannet et al. 2016) on 37 consumer fragrances shows that each one of the 37 products released at least one of the 156 VOCs, 42 of which were categorized as dangerous or hazardous under US federal rule. VOCs are organic chemicals that easily vaporize at room temperature and contribute significantly to indoor air pollution. According to the report published by the Aerosol Dispensers Directive (Risk and Policy Analysts, 2014), about 80% of all aerosol dispensers employ LPG as the propellant (Amir Nourian et al. 2021). Thus, it proves that the presence of a higher amount of propellant is the major reason for the explosion as well as LPG is a non-methane volatile organic compound; it can undergo physical and chemical processes in the atmosphere leading to their transformation into secondary compounds like Ozone (O3). (Bhat et al. 2021) reveals that a typical spray contains very high solvent concentrations like ethanol, 2-propanol and high limonene concentrations, he also mentioned that the level was reached 12 mg/m3 after 0.5 hours.

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Several studies have done to find out the amount and type of pollutants released from potpourri types of fragrance, it can emitt 216 mg/m3 of caryophyllene, 204 mg/m3 of linalyl acetate 105 mg/m3of linalool, 93 mg/m3 of alpha-methylionon. Domestic aerosol sprays also contain non-methane volatile organic compounds (NMVOCs) that have a significant harmful effect on both human health and the environment. There are numerous studies done to test different consumer and commercial products like body washes, detergents, air fresheners, insecticides and also measured the NMVOC emissions from plug-in air fresheners, kitchen cleaning agents, and perfumes (Dinh et al. 2015; Bartzis et al. 2014) where, (Kim et al. 2018) showed the highest level of air pollutants (fifty nine out of eighty-two air fresheners) and the detection rates of ingredients were in the following order: linalool 72.0%, limonene 5 64.6%, α-amyl cinnamic aldehyde 47.6%, benzyl benzoate 47.6%, 6 hexylcinnamaldehyde 47.6%, and geraniol 41.5%. Few studies on household products, shows that the water-based air fresheners had the lowest non-methane volatile organic compounds (NMVOCs) (33.8 wt%), while solvent-based air fresheners had the highest level of NMVOCs (98.9 wt%) (Amir Nourian et al. 2020). So, using water-based air freshener has more benefits like pollutant free environment as well as it makes our room smells good.

III. EVIDENCE BASED AIR POLLUTANTS EMITTED FROM DISINFECTANT

Disinfectants are chemical germicides developed to sterilize the nonporous surfaces. Each disinfectant has a perfect pH and temperature range where it works best. The impact of pH is significant because it influences how ionic disinfectant binds to a bacterial cell wall, ensuring that a large number of germs are bound by disinfectant molecules (N. James MacLachlan et al. 2016). Disinfectants act to kill microorganisms in a wide range of ways, including by oxidizing microbial cells, hydrolyzing them, mixing their proteins with salts, coagulating their proteins, denaturing their enzymes, or altering the permeability of their cell walls (Tim Sandle et al. 2019). For example, aldehyde achieves their antimicrobial action through the alkylation of enzymes as well as by destroying the lipoproteins in the cell membrane and cytoplasm of vegetative bacterial forms, glutaraldehyde kills microorganisms. The most commonly used chemicals in disinfectants are phenol, hydrogen peroxide, formaldehyde, glutaraldehyde, 60–90% ethyl or isopropyl alcohol, quaternary ammonium compounds (quats), chlorine and chlorine compounds, calcium hypochlorite, sodium hypochlorite (bleach), and alcohols (Nagendra Kumar Rai et al. 2020; Mary B. Johnson et al. 2019). Formaldehyde is a water-based solution known as formalin, which has 37% formaldehyde by weight and is utilized as a powerful sterilant and disinfectant. Formaldehyde has bactericidal, tuberculocidal, fungicidal, viricidal, and sporicidal properties in its aqueous state as well as when combined with low-temperature steam. Benzalkonium (quats) is a major chemical present in disinfectants. This type of disinfectant is based on a permanently positively charged ion. Quats get electrically neutralized and their anti-microbial effect can be completely inactivated if a surface is not fully washed. The complex detergent–quat residue provides nutrients for the growth of bacteria and microbes (Nagendra Kumar Rai et al. 2020).

These microbes may colonize, forming communities called biofilms. Soap scum in a shower is an example of such a type of residue buildup. If a surface feels slippery or slick because of biofilms, it leads to increased slip-and-fall risks, which are the cause of 15% of accidental deaths, according to the US Occupational Safety and Health Administration (OSHA). Combining disinfectants with other chemicals is the common cause of household air pollution and health effects.

For example, some people unknowingly combine bleach with ammonia-containing cleaners, which release chloramines that can irritate the eyes, nose, throat, and airways when inhaled. On the other hand, if bleach is combined with an acid-based cleanser, it may release hypochlorous acid, or gaseous chlorine, which, even in small doses, may cause acute lung injury if inhaled. Another potentially dangerous scenario is when disinfectants are mixed with other substances; they can produce risky secondary chemicals like trihalomethanes or haloacetic acids. These trihalomethanes can have harmful effects on human health, including cancer and reproductive issues, when direct and indirect sewage effluents mix with drinking water or reach lakes and rivers. They also constitute a threat to aquatic habitats and wildlife.

IV. HEALTH IMPACT OF AIR FRESHENERS AND DISINFECTANTS ON HUMANS

The air fresheners and disinfectants that are available in markets have a negative effect on both people and the environment. Almost everyone has a habit of using one of these disinfectants or scented products. In the US, 71% of households buy the products to clean the air.

There are many different types of air cleaning items, such as scented pump sprays, diffusers, gels, candles, and plug-ins. Several studies mentioned that, 60% of the people would stop using these items if they knew that the majority of fatal diseases are brought on by exposure to the chemicals released by these products shown in figure2.

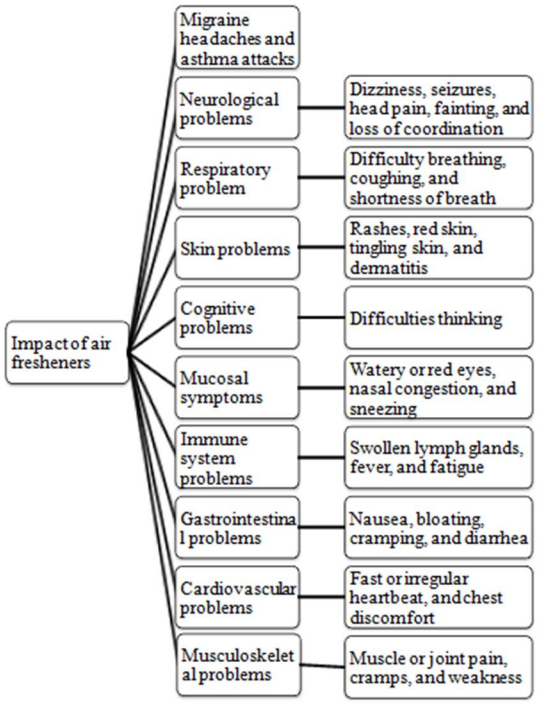


Figure 2: The diagram above illustrates the classification of illnesses brought on by exposure to air fresheners.

Products with fragrances can have a wide range of negative health impacts, including contact dermatitis, migraines, asthma attacks, respiratory issues, neurological issues, and mucosal symptoms. Especially, toxic pollutants like benzene, toluene, formaldehyde, xylene, acetaldehyde, and ethyl benzene are obviously harmful to human health and can raise the risk of cardiovascular issues as well as cause cancer, airway irritation, bronchitis, and mucosal irritation. According to a study conducted in the USA using an online survey of individuals (n = 1136) from a nationally representative fragranced sample, (Dindarloo et al. 2020) mentioned that 34.7% of the population experienced health issues, such as migraine headaches and respiratory problems, furthermore, due to exposure to fragranced products at work, 15.1% of people have missed workdays or lost their jobs. The ability of fragrance ingredients to cause allergic sensitization of the respiratory system will be discussed in this section. The negative health effects that could arise from the activation of a particular (adaptive) immune response are known as allergies. Typically, allergies go through two stages of development. Sensitization occurs during the first phase (induction phase), which is when a susceptible patient is exposed to an inducing allergen in adequate quantities through a relevant route (a heightened level of immune responsiveness to that allergen). An increased and more severe secondary immune response will be triggered if the sensitized patient again comes into contact with the same allergen, triggering an allergic (inflammatory) reaction and T lymphocytes [T helper 2 (Th2) cells] play a key role during this second, or elicitation, phase (David et al. 2019). Chemicals found in disinfectant residues have been linked to a number of adverse health effects in humans, including cancer, reproductive disorders, respiratory conditions (including occupational asthma), eye and skin irritation, CNS dysfunction, and oxidative damage. Especially, spray cleaning and disinfection products have been associated with adverse respiratory effects in cleaning professionals and in people cleaning their homes (Per A. Clausen et al. 2020).

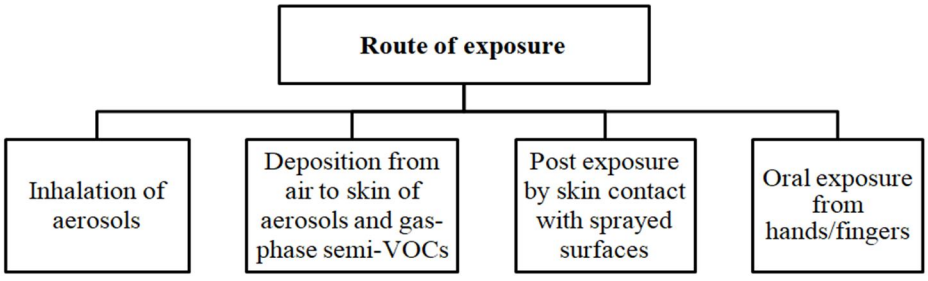


Figure 3: All possible exposure to cleaning and disinfection products during and after the application

Reactive dyes, chloroplatinate salts, acid anhydrides, and diisocyanates are among the chemical types that are commonly associated with respiratory tract sensitivity. Mixing chlorine with ammonia-containing cleaners is dangerous because chlorine disinfectants could combine with nitrogen, forming chloramine or N-nitroso dimethylamine, (Nagendra Kumar Rai et al. 2020) says that, exposure to chlorine bleach causes asthma symptoms, gastrointestinal discomfort, ear, nose, and throat lesions, mucosal erosions and cause cancer.

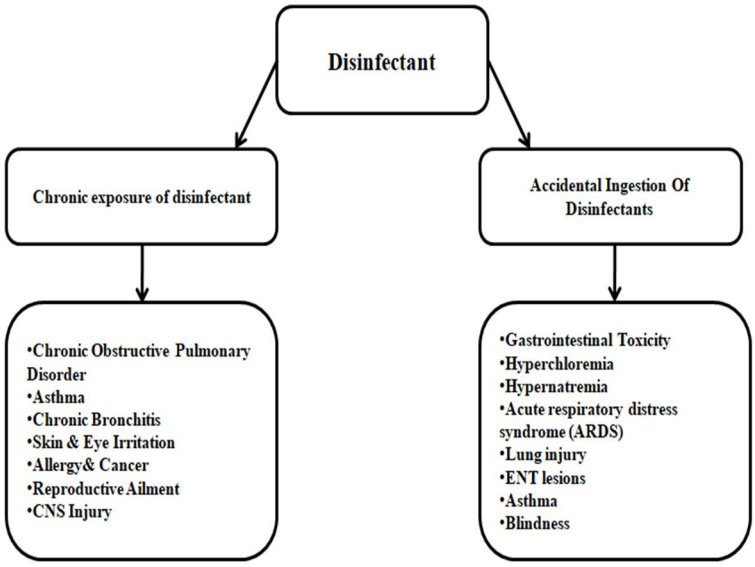


Figure 4: The above image represents the toxic effect of improper use of disinfectants

While reviewing adverse health effects of air fresheners reported in research article, asthma is frequently cited as an outcome. (Gibbs et al. 2019) reported that asthma affects more than 334 million people in the United Kingdom, Australia, New Zealand, Canada, as well as 30% of childhood asthma and 5% of childhood cancer in the US are due to exposure to chemical released by disinfectants. Asthma is characterized by chronic airway inflammation.

Disorders due to chemicals emitted by disinfectant	Percentage of participants experienced at least one disorder
Skin dryness	76.3%
Irritation on hand, feet, eyes, respiratory or gastrointestinal system.	42%
Obsession	42.2%
Skin Itching	41.2%
Coughing	41.1%
Eyes Irritation	39.5%

Table 1: The above table shows the percentage of people affected due to disinfectants among 1090 participants

It is defined by respiratory symptoms such as wheezing, shortness of breath, chest tightness, and coughing that vary over time and in intensity, together with variable expiratory airflow limitation (Mary B. Johnson et al 2019). Pathologically, asthma is characterized by inflammation, remodeling of the smooth muscle layer, submucosal mucous gland alterations, and lamina propria abnormalities. 1–18% of the population in many countries suffers from asthma, making it a prevalent condition. (Per A. Clausen et al. 2020), reported that occupational exposure to allergens cause 15% of adult-onset asthma, and patients with allergen-induced asthma frequently have high eosinophil levels in their blood and sputum. It is characterized by T-cell activation (T-helper type 2) which triggers the release of inflammatory cytokines such as IL4, IL5, and IL13 and promotes the production of IgE. (Immunoglobulin E).

In a descriptive-analytical study (Dindarloo et al. 2019) on disinfectants using 1090 participants, shows that 87% of participants used the incorrect proportions of water and alcohol to make this disinfectant available at home, and the percentage of people with the wrong proportion of sodium hypochlorite was 74.2%. Itching, redness, dryness, and sores were reported to be the main skin impacts on the hands and feet. Eye effects include eye irritation and itching, tearing, and decreased vision.Vomiting, diarrhoea, and abdominal discomfort are typical gastrointestinal symptoms and throat irritation, obsessive-compulsive disorder, lack of concentration, headaches, dizziness, and fatigue have been other adverse effects of disinfectants on people. Use of cleaning agents and disinfection products may lead to a broad range of exposure scenarios, some of which are associated with respiratory effects that range from acute temporary upper airway irritation to obstructive lung disease. Potential mechanisms underlying the development of asthma and a decline in lung function due to occupational risk factors these include sensitizer-induced asthma, involving non-IgE and IgE-dependent pathways, as well as irritant-induced asthma. To avoid this challenge, there should be proper information available in the public domain about the toxic effects of disinfectants, wearing skin and eye protection for potential splash hazards, ensuring adequate ventilation, and storing and using chemicals out of the reach of children and pets.

V. RESULT AND DISCUSSION

Air fresheners and disinfectants have been recognized as a primary source of volatile organic compounds throughout buildings from an indoor air-quality perspective (Ibrahim ALshaer et al. 2019). Numerous studies have been carried out by different researchers on the composition of air fresheners and their frequent causes of relative health effects (Steinemann et al. 2016; David et al. 2019. For instance, (Anne Steinemann et al. 2017) indicated some compounds in such products, including benzene derivatives, pinene and limonene, aldehyde, phenol, and cresol, may pose serious health effects when reacting with other indoor pollutants. In addition to these substances, air fresheners may also contain VOCs such benzyl alcohol, toluene, myrcene, phthalates, synthetic musks, lilial, and linalool. The results of previous research show strong evidence that consumers may experience negative health effects from using fragranced products. Also, few researchers mentioned that, in national surveys of the US population, 19 % reported breathing difficulties, headaches, or other health problems when exposed to air fresheners and deodorizers, and 10.9 % reported health problems from the scent of laundry products vented outdoors. Overall, 34.7 % of the population reported one or more types of adverse health effects from exposure to one or more types of fragranced products. Of these, 56.1 % are female and 43.9 % are male (Mary B. Johnson et al. 2019). The most common types of health problems in 1136 people are mentioned below (table 2). Chlorine and ammonia are frequently exposed during daily cleaning, particularly after combining hypochlorite with acid or ammonia where, 19.7% of health issues related to staying in a room after it has been cleaned with scented items are related to exposure to cleaning agents. The World Health Organization assessed the contribution of various risk factors to disease stress and identified indoor pollution as the eighth most important risk factor, accounting for 2.7 percent of global disease burden (Anne Steinemann et al. 2019). The majority of the NMVOCs identified in their work are ethane, propane, iso-butane, butane, iso-pentane; LPG components, and ethanol. LPG propellants from domestic aerosol sprays also have global warming potential effects with a cumulative carbon dioxide equivalent of 129.8 ktCO2e in the UK, which is around 0.2% of the total greenhouse gas emissions of the UK residential sector (Amir Nourian et al. 2021). Chemicals such as chlorine, ammonia, hydrochloric acid, chloramines, and sodium hydroxide can cause irritant-induced asthma where as QACs and ethanolamine has been considered to be both sensitizers and irritants (Per A. Clausen et al. 2019).

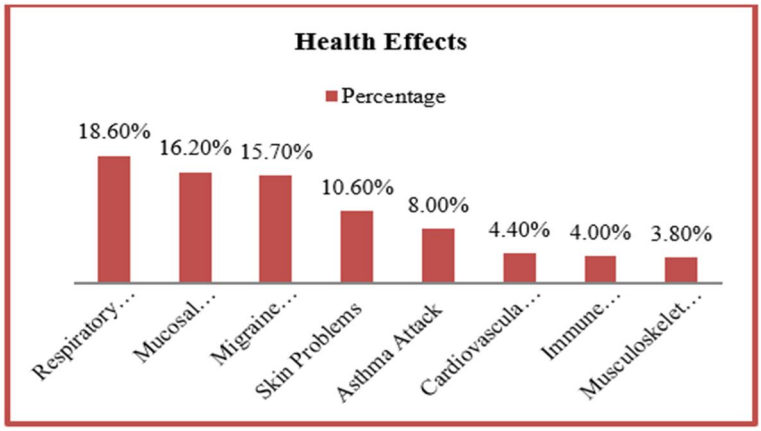


Table 2: Most common health effects

In conclusion, evidence from a limited number of researches suggests that aerosolized chlorine, chloroamines, ethanolamines, hydrochloric acid, formaldehyde, glutaraldehyde, benzalkonium chloride, and other QACs may cause inflammatory responses in the airways. Human and field exposure studies on disinfectants and air fresheners, as well as in vivo and in vitro toxicological studies of cleaning chemicals, demonstrate the detrimental effects of pollutants emitted, including those from disinfectants like QACs like benzalkonium chloride and lauryl dimethyl benzyl ammonium chloride, which cause asthma and other respiratory disorders. The greatest preventive measures to reduce the impact are raising public knowledge of the effects of disinfectants and air fresheners, labeling every product with the potentially hazardous effects, chemical used and developing water based / chemical free air fresheners and disinfectants are the best preventive way to reduce the impact.

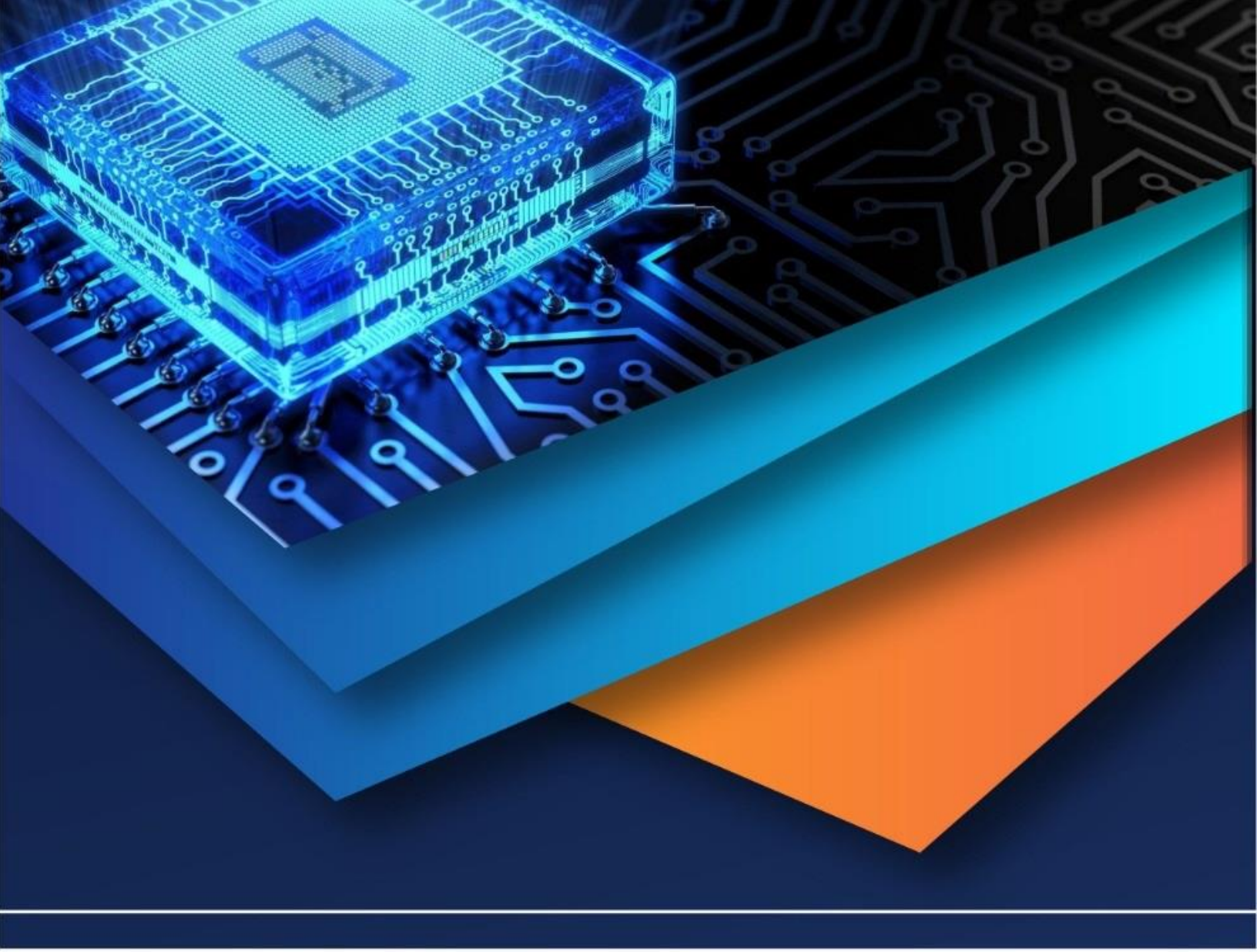
VI. CONCLUSION

In this article we have done a technical comprehensive study on pollutants emitted from air fresheners and disinfectants as well as discussed about its health effect on humans and its environmental impact. As the primary focus was on the identification of the chemical compounds discovered in the products and their health consequences, the current study did not contain any laboratory testing or assessments about the potential health impacts of air fresheners and disinfectants. Nearly everyone among us has been using some kind of pollutant-emitting product. The common pollutants released from air fresheners and disinfectants are volatile organic compounds and non-methane volatile organic compounds, and some of them can cause secondary elements (like ozone) and affect the environment as well as human beings. Exposure to these pollutants may cause numerous disorders, which are also discussed. The most common mono-terpenes (-pinene, geraniol, limonene, linalool, and terpineol) are recognized skin allergens despite being minor sensory irritants. Most spray-style air fresheners include gas propellants that contribute to global warming, such as LPG, propane, and butane. Chemicals that can cause asthma, such as chlorine, can be created via the wrong or accidental mixing of chemical compounds. Inflammatory responses have been shown in human cell bioassays using ozone-initiated terpene reactions. Inflamed airways will probably be more susceptible to inhalation exposures, such as re-suspended dirt particles and their chemically reactive surfaces. For example, elevated exposure to re-suspended dust and dirt particles during domestic cleaning and use of spray products reduced heart-rate variability, a marker of autonomic cardiac dysfunction; this might impact the general health of the cleaning personnel. The reduction of the heart-rate variability appeared more severe among those with obstructive lung diseases.

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