



## Prevalence and impact of emerging chemical contaminants in the life style products on human health

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### Abstract

In recent times, the increasing prevalence of harmful pollutants in our environment, originating from chemicals of various lifestyle products, has emerged as significant challenge for mankind. The purpose of this article was to explore the past literature concerning the consequences of various emerging contaminants in the everyday lifestyle products on human health. The chemical compounds, derived from various human activities, have become an integral part of our global ecosystem and are essential for the functioning of modern society. Chemical compounds are discharged into the environment from different origins, including rural, urban, and industrial areas. These compounds can come from everyday products such as cosmetics, personal care items, household cleaners, and pharmaceuticals. Additionally, consumer products like soaps, shampoos, conditioners, lotions, and perfumes are used on a daily basis worldwide. These products contain a variety of chemicals that can contribute to environmental pollution. Various substances such as paraben, triclosan, phthalate, fragrances, antimicrobial agents, UV filters, and heavy metals are commonly found in these products. Scientists have determined that these ingredients can have detrimental effects on both humans and other organisms. The impacts of these chemical contaminants vary from changes in reproductive health and various types of cancer in humans. Additionally, aquatic organisms are also impacted by these substances. The significance of this matter is heightened by the rising global demand for beauty products, which commonly utilize a diverse array of chemical compounds in their production.



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### Introduction

Today improvement of life style, urbanization, and industrial practices a new class of emerging chemical

compounds has been increase into the environment.

The use of emerging lifestyle contaminants is believed to have detrimental impacts on both the

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environment and human well-being. However, there is currently a lack of established health standards to govern their usage. Chemical contaminants are introduced into the environment from different sources, including industries, personal care products, cleaning agents, and health services. These contaminants include synthetic chemical compounds like perfluorinated substances, by-products of water disinfection, pharmaceuticals, man-made nanomaterials, and UV-filters. These substances are widely used to enhance the quality of life in modern society worldwide.<sup>1-3</sup> The use of chemical compounds in industry, transport, and urbanization has been rapidly increasing, leading to their entry into the environment as hazardous wastes and non-biodegradable elements.<sup>1,4</sup> These compounds include pharmaceutical and personal care products, steroids, and hormones benzothiazoles, benzotriazoles, perfluorochemicals, polychlorinated alkanes, artificial musks, triclosan, triclocarban, bisphenol-A, engineered nano-materials, and industrial compounds/by-products.<sup>5</sup> The majority of chemical compounds found in beauty products serve as both preservatives and fragrances. However, it is crucial to understand that certain preservatives can be harmful and have been associated with different health problems such as cancer, mutation, reproductive toxicity, and disruption of the endocrine system.<sup>6</sup> Additionally, everyday family care products often contain endocrine disruptor compounds (EDCs) such as heavy metals, bisphenol-A, polyfluorinated compounds, polychlorinated biphenyls, phthalates, benzophenones, parabens, and brominated flame retardants.<sup>7</sup> There are multiple ways in which people can be exposed to endocrine disrupting compounds. These include consuming contaminated food or water, coming into contact with specific cosmetics and personal care products on the skin, and inhaling hair sprays and fragrances.<sup>7-8</sup> Additionally, these compounds can be transferred from the mother to the child through the placenta or breast milk. The presence of these compounds has been reported in various human tissues such as serum, fat, urine, and blood.<sup>9-12</sup> It is a well-known fact that these harmful substances, even when present in small amounts, can find their way into living organisms through various means such as eating, breathing, or coming into contact with the skin.<sup>13</sup> The environment is at risk due to the presence of ECs, which can pose various dangers to the ecosystem and all living beings,

including humans. These dangers include chronic toxicity, genetic damage, disruption of the endocrine system, as well as the harmful effects known as the "tri-effects" which encompass carcinogenic, teratogenic, and mutagenic effects.<sup>14</sup> Managing these contaminants becomes a challenge due to the difficulty in monitoring them and the absence of sufficient regulatory measures. Additionally, their persistent and bio-accumulative characteristics further complicate the task of controlling them once they are released into the environment.<sup>15-16</sup> In addition, there is a lack of comprehensive documentation regarding the sufficient and robust data on the behavior of epidemics in relation to human exposure, as well as the concentrations of these epidemics in serum and tissues, and the potential threats they pose to both ecological and human health. This issue has not been adequately addressed on a global scale.<sup>1</sup> The objective of this chapter is to highlight the various elements present in everyday fashion care products that have a significant impact on fitness. A major challenge faced by the current generation is ensuring the well-being of our bodies when using household products that contain chemicals labelled as toxic, as their usage has significantly risen in recent times. This paper aimed to provide an overview of the previous studies conducted on the subject of how lifestyle products can influence human health. The current investigation focuses on the detrimental sources of lifestyle products and their impact on humanity.

## Methods

In this study, Science Direct, PubMed and Google Scholar, were the databases employed to extract pertinent manuscripts. The search terms included personal care products or lifestyle products, emerging contaminants, various types of lifestyle products, toxicity, degradation, ecotoxicity, occurrence, environmental risk, fate and behaviour, and bioaccumulation of lifestyle products. Any manuscripts published in languages other than English were not considered for inclusion.

The methodology employed for screening and selecting pertinent manuscripts in this review involved extracting a total of two hundred and twenty-eight (228) manuscripts from the specified three databases. After excluding one hundred and fifteen (115) manuscripts with irrelevant abstracts and titles, as well as nine (9) duplicate manuscripts,

one hundred and four (104) manuscripts remained for thorough examination. Subsequently, eighteen (18) irrelevant studies were further excluded, leaving eighty-four (86) manuscripts that were deemed relevant to the study's theme and were ultimately utilized for this review. This review paper relies on previously published articles and does not present new research. Several studies were included in the review that focused on the effects of emerging contaminants in lifestyle products on human health.

## Results and Discussion

### Endocrine Disruptors Compounds (EDCs)

#### Perfluorochemicals

PFCs, also known as perfluoro chemicals, are synthetic chemical compounds that have been utilized to produce items with exceptional resistance to heat, oil, stains, grease, and water. These compounds are found throughout the environment due to their widespread distribution. Perfluoroalkyl sulphonates (PFASs) and perfluoroalkyl carboxylates (PFACs) are the two most frequently detected groups of PFCs in environmental samples. The primary compound in PFASs is perfluorooctane sulphonate (PFOS), while perfluorooctanoic acid (PFOA) is the main representative compound in PFACs. PFCs, find wide application in numerous products. These include fire-fighting foams, lubricants, metal spray plating, cleanser items, inks, varnishes, furniture, carpeting, coating formulations for walls, and meals packaging, waxes, and water. Additionally, they are used as oil repellents for paper, leather, and textiles.<sup>17-19</sup> These substances are recognized for their exceptional resistance to heat, light, and chemicals, and they are not easily broken down by the digestive systems of microorganisms.<sup>19</sup> PFCs are widely recognized as substances that exhibit persistence, bio-accumulation, and potential harm to both humans and animals.<sup>18,20</sup> The presence of PFOA and PFOS in various environmental and biological samples such as surface water, sea, flora and fauna, human serum, and breast milk.<sup>18</sup> The adverse effects of PFOA include reduced semen quality<sup>21</sup> and increased time to pregnancy or infertility.<sup>22</sup> On the other hand, PFOS has been linked to preeclampsia in pregnant women<sup>23</sup> and an increased risk of high LDL cholesterol.<sup>24</sup>

#### Siloxanes

Siloxanes find wide application in the fields of paints, cosmetics, and clinical products due to

their remarkable thermal stability, smooth surface, physiological inertness, and lubricating properties. Among the commonly employed siloxanes, cyclotetrasiloxane and cyclopentasiloxane are notable, albeit toxic. Cyclotetrasiloxane, in particular, acts as an endocrine disruptor, interfering with hormone function and exhibiting reproductive toxicity, thereby posing a potential drawback to human fertility.<sup>25</sup>

#### Sunscreen

Sunscreens or UV filters is commonly utilized in cosmetics and noncosmetic items such as furniture, carpets, plastics and washing powder.<sup>26-27</sup> Sunscreens are widely recognized as effective protective products against the harmful effects of ultraviolet radiation, including premature aging, skin damage, and skin cancer.<sup>28</sup> It is important to note that certain lipophilic sunscreens have the ability to disperse into aquatic environments through activities such as showering, washing clothes, and swimming.<sup>29</sup> Several studies conducted on laboratory animals, both *in vitro* and *in vivo*, have consistently revealing the disruptive impact of sunscreen on the endocrine system. The consequences encompass interference with the hypothalamic-pituitary thyroid axis (HPT) and adverse effects on processes related to reproduction and development.<sup>27</sup> Additionally, the durability of sunscreens has been linked to the development of dermatitis.<sup>28</sup> Furthermore, exposure to oxybenzone during pregnancy has been found to cause Hirschsprung's disease, a neonatal intestinal abnormality that occurs during embryogenesis.<sup>30</sup>

#### Parabens

Parabens have gained significant popularity as antimicrobial preservatives in various cosmetic products, pharmaceuticals, and certain food items.<sup>31</sup> Parabens such as benzyl, butyl, ethyl, methyl isobutyl, isopropyl, and propyl hydroxybenzoate are widely employed in various products.<sup>32</sup> The use of methylparaben on the skin can have adverse effects when combined with other chemicals, leading to an expedited process of skin aging and potential DNA damage.<sup>33</sup> The use of cosmetics exposes women to a daily dosage of 50 mg of parabens, reported by earlier study.<sup>34</sup> Parabens have been linked to several harmful health effects, including cancer, neurotoxicity, hormonal imbalances, and possibly even breast cancer.<sup>35</sup>

### **Bisphenol-A**

Bisphenol-A is used to create a wide range of items, such as water bottles, baby bottles, medical devices, sports equipment, dental instruments and fillings, CDs, DVDs, household electronics, eyeglass lenses, and many others. These products are made from plastic materials that are derived from Bisphenol-A. Additionally, BPA is extensively utilized in the production of epoxy resin and polycarbonate (PC) unsaturated polyester plastics. It is also commonly found in various types of internal coatings for food and beverage packaging, as well as in infant bottles and dental sealants.<sup>36-37</sup> Bisphenol A (BPA) is a potent disruptor of the endocrine system, capable of inducing carcinogenesis.<sup>38</sup> It exhibits estrogenic activity, leading to attention deficits, hyperactivity, and heightened susceptibility to substance abuse.<sup>39</sup> Moreover, BPA has detrimental effects on the action of thyroid hormones<sup>40</sup> and has been linked with a higher risk of cancer.<sup>41</sup> Research conducted on individuals working in BPA factories in China has demonstrated that they are considerably greater tendency to face issues related to erectile dysfunction, decreased sexual desire, and overall dissatisfaction with their sex life compared to individuals who have not been exposed to BPA.<sup>42</sup> It is important to note that exposure to BPA primarily occurs through the consumption of contaminated food.<sup>43-44</sup>

### **Artificial Fragrance/Perfume**

The majority of conventional skincare and beauty products contain synthetic fragrances that are known to be carcinogenic, allergenic, endocrine disruptors, and irritants. There are numerous fragrance components that are not mentioned on the label can cause irritation and trigger symptoms such as severe headaches and allergies. In addition, the application of fragrance can worsen asthma symptoms and potentially play a role in the onset of this condition among children. A study conducted earlier revealed that fragrance ranks as the second most frequent cause of hypersensitivity among patients.<sup>45</sup>

### **Polyethylene Glycol (PEG)**

Polyethylene Glycol (PEG) is commonly used as a thickening agent in various cosmetic products, including moisturizers, shampoos, and sunscreens. Unfortunately, PEG is often contaminated with ethylene oxide, a known carcinogen, as well as

1, 4-Dioxane. The persistence of PEG in the environment, even after being washed down the shower drain, is a cause for concern as it does not readily break down.<sup>46</sup> Additionally, there is evidence suggesting that PEGs may have genotoxic effects and can cause irritation and systemic toxicity when applied to damaged skin. In addition, 1, 4-dioxane is an ether that possesses emulsifying, cleansing, as well as solubilizing properties. It is frequently present in various products like shampoo, toothpaste, and mouthwash. However, it is crucial to note that these beauty products often contain high levels of this contaminant, which is a potent carcinogen. This chemical substance has the potential to initiate the development of breast, skin, and liver cancers.<sup>47</sup>

### **Phthalates**

Phthalates are often utilized in a variety of consumer and household items, such as cosmetics, perfumes, deodorants, hair sprays, skin cleansers, toys, medical devices, and fuels, to boost their color or fragrance and enhance their overall effectiveness. Moreover, phthalates also found in a range of everyday personal care products, including perfume, moisturizer, nail polish, eye shadow, liquid soap, and hair spray.<sup>48</sup> A significant amount of recent research has focused on investigating the effects of phthalate exposure specifically through personal care products.<sup>49</sup> A range of ordinary products contain phthalates, including floorings, roofings, divider coverings, and cables, toys, clothing, and packaging materials. Furthermore, they are commonly employed as industrial solvents and lubricants, and are also incorporated as additives in the textile industry and personal-care goods.<sup>50-51</sup> In addition, Di-2-ethylhexyl phthalate (DEHP) is widely used as the main plasticizer in various PVC-based medical equipment, including blood bags, parenteral sustenance sacks, tubings, and catheters.<sup>52</sup> Additionally, the use of Di butyl Phthalate (DBP) is prevalent in beauty care products for nails, where it serves as a solvent for colors and a plasticizer, ensuring that nail polishes do not become brittle or fragile. However, earlier reported that DBP can lead to developmental defects and alterations in the prostate, testes, and sperm counts.<sup>53</sup> Moreover, prolonged consumption of products containing phthalates can lead to severe health consequences, including liver and kidney failure, especially in young children.<sup>54</sup>

### **Triclosan & Triclocarban**

TCS and TCC are widely utilized antimicrobial agents in various personal care items, including soaps, shampoos, creams, deodorants, cosmetics, toothpastes, mouth rinses and skin-care lotions<sup>55</sup>. Triclosan (TCS), a common EDC, is a broad-spectrum antibacterial agent that is extensively employed in everyday chemical products like soaps, toothpastes, and facial cleansers<sup>56</sup> and have several negative effects on the body. Research has shown that it can lead to lower levels of thyroid hormones<sup>57</sup> and increase the expression of genes related to androgen and estrogen sensitivity.<sup>58</sup> Triclosan is widely recognized as one of the prevalent organic toxins frequently detected in wastewater. It holds a prominent position among the top 10 most commonly encountered organic pollutants in wastewater systems.<sup>59-60</sup> In addition, Triclosan possesses antiseptic properties and functions as an antibacterial agent. It specifically targets enzymes that bacteria can develop resistance against.<sup>61</sup>

### **Diazolidinyl Urea**

Diazolidinyl urea is an additive extensively utilized in the manufacturing process of a wide range of personal care products. These include items specifically designed for children, as well as cosmetics for the eyes and face, skincare products, hair and nail care essentials.<sup>47</sup> Nonetheless, the presence of this compound has been associated with the potential development of allergic contact dermatitis, alongside its classification as a mutagenic and carcinogenic agent.<sup>62</sup>

### **Heavy Metals**

A wide range of harmful metals, including lead, arsenic, mercury, cadmium, aluminum, zinc, nickel, and chromium, have been found in various personal care products such as lipsticks, whitening toothpaste, eyeliners, nail colors, sunscreens, eye shadows, and moisturizers.<sup>63</sup> The accumulation of these metals on the skin and internal organs can result in harmful effects, which can present as various disorders affecting both the surface of the skin and the entire body.<sup>64</sup> It has been observed that pigmented cosmetics with a reddish color are particularly prone to contamination with arsenic (As), lead (Pb), and mercury (Hg).<sup>65</sup> The presence of antimony (Sb) in everyday cosmetic products like lipsticks, eye pencils, and face powder can lead to various health issues including pneumoconiosis, changes in lung

function, emphysema, bronchitis, vomiting, diarrhea, ulcers and abdominal pain. In contrast, makeup powder and skin cream frequently contain arsenic (As), which can give rise to numerous ailments such as skin issues, circulatory disorders, an augmented chance of developing lung cancer, and an increased probability of developing gastrointestinal and urinary tract cancers. Moreover, hair creams, lipsticks, and skin creams often contain cadmium (Cd), which can have harmful effects on the kidneys and lead to bone fragility and fractures.<sup>66</sup> Cosmetics that include chromium (Cr), such as eyeliner, lipstick, eye pencil, eye shadow, and make-up powder, have been associated with various types of allergies.<sup>66</sup> Cobalt (Co) and nickel (Ni) are commonly found in beauty care products like eye shadow, face paint, hair cream, and lipstick, and can trigger allergic reactions like contact dermatitis.<sup>62</sup> The presence of lead has been found in various cosmetic products such as hair dyes, lipsticks, eyeliner, and hair cream in its inorganic form. However, the absorption of lead through the skin is minimal with the help of the skin.<sup>47,65</sup> The harmful effects attributed to lead from its correlation with a range of health concerns, including premature birth, disruptions in hormone levels, diminished reproductive capabilities in both males and females, irregularities in menstrual cycles, and delayed onset of puberty in girls.<sup>67</sup> Additionally, lead has been identified as a carcinogen for humans.<sup>68</sup> In addition, it should be noted that this substance also acts as an endocrine disruptor, leading to a decrease in sperm count and semen volume, as well as changes in sperm movement and shape in humans.<sup>69</sup> Furthermore, mercury can have severe and hazardous effects, especially for pregnant women and young children. This is because mercury has the ability to pass through the placenta and affect the growth of the developing foetus. In addition, it has the potential to be passed on to babies via breastfeeding and accumulate within their skeletal structure.<sup>64,70</sup> Mercury is commonly found in skin-lightening soaps and creams, as well as in various other cosmetics like eye makeup and cleaning products. The main concern is the potential kidney damage caused by inorganic mercury present in these skin lightening products.<sup>66</sup> When these soaps, lotions, and other cosmetic products are disposed of, the mercury they contain is released into the environment through wastewater. In the environment, it undergoes methylation and transforms into highly toxic methyl mercury, which

then enters the food chain through fish. When pregnant women consume fish contaminated with methyl mercury, it can be transferred to their foetus, leading to neurodevelopmental impairments in children.<sup>71</sup> Hence, our living environment is under a significant threat due to the high levels of contamination from toxic heavy metals.<sup>72</sup>

### **Disinfection By-products**

Chemical compounds employed for disinfection in swimming pools and the purification of drinking water play a crucial role in safeguarding individuals against waterborne diseases.<sup>20,73</sup> These chemicals, commonly known as oxidizing agents, exhibit robust chemical properties that not only eliminate harmful pathogens but also interact with various reducing agents.<sup>74</sup> The widespread use of chemical substances has led to the emergence of disinfection byproducts (DBPs) in treated water. Among these DBPs, chlorinated DBPs (CDBPs) are specifically common, as they are produced in significant amounts due to the extensive utilization of chemicals. Consequently, a large number of individuals residing in developed regions are exposed to these chemicals through activities such as swimming in pools and consuming water, leading to potential health risks.<sup>75</sup>

### **Hair dye**

Hair serves as a symbol of attractiveness, elegance, masculinity, health, and beauty. With society placing increasing importance on youthfulness and beauty, both men and women have embraced the trend of hair coloring to enhance their appearance.<sup>76</sup> Paraphenylenediamine (PPD) is a commonly used chemical compound for achieving permanent hair color.<sup>77</sup> The use of hair color can result in mild reactions such as dermatitis on the upper eyelids or edges of the ears, as well as redness and swelling of the scalp and face.<sup>78</sup> Additionally, Toluene-2, 5-diamine (PTD), a common oxidative hair dye, has been found to have strong immune activating properties that can lead to both pro- and anti-inflammatory responses.<sup>79</sup> In addition, it should be noted that hair coloring products have been associated with various negative health effects, particularly dermatitis and allergic contact.<sup>80</sup> Furthermore, these products have also been linked to more serious and systemic conditions, including certain types of cancer.<sup>81</sup> The wide range of chemical compounds present in hair dye products can lead to

more severe allergic reactions and skin infections, resulting in symptoms such as redness, sores, itching, burning sensation, discomfort, and local inflammation on the scalp, eyelids, neck, forehead, and ears.<sup>82</sup>

### **Nanomaterials**

In recent years, there has been a widespread utilization of nanotechnology-based nanomaterials in a diverse range of beauty care products, such as sunscreens, hair and skincare essentials. These materials have also been found in deodorants, lotions, toothpastes, shampoos, anti-aging creams, and nail polish. This trend has been observed for the past few decades, indicating the increasing incorporation of nanomaterials in the beauty industry.<sup>63</sup> In contrast, nanoparticles with low solubility, including zinc oxide, titanium dioxide, silver, fullerenes, silica, and carbon black, tend to be more harmful than larger particles of the same material.<sup>83</sup> The inhalation of nanomaterials can also result in oxidative stress and inflammation.<sup>83-84</sup> Therefore, chemistry in nanomaterials has the ability to bring joy to people through chemical compounds in the lifestyle products. Nevertheless, it is important to be cautious and aware of the potential risks that come with certain aspects of chemical compounds.<sup>85</sup>

### **Conclusion**

In conclusion, it can be inferred that the increasing presence of contaminants in our lifestyle poses ongoing and significant threats to water, natural resources, ecosystems, and human well-being. Consequently, it is imperative to educate individuals about the harmful effects of toxic lifestyle products across all sectors of society in today's globalized world. Therefore, greater attention should be devoted to safeguarding the environment from the negative impacts of manufactured lifestyle products, as well as enhancing research efforts pertaining to the health consequences on human beings. Additionally, there is a need for further investigations to determine the level of risk associated with several personal lifestyle products that have not yet been thoroughly examined.

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### Conflict of Interest

The author state that they have no conflict interests in publishing this manuscript.

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