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ENVIRONMENTAL POLLUTION AND PUBLIC HEALTH

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Pollution is one of the major problems persisting in our environment causing an increase in the morbidity and mortality, which ultimately affects the economic growth of a world. Therefore, environment quality sensing tools have become inevitable in everyday life. Environmental health concerns are a critical issue nowadays that needs joint efforts from multiple sectors to achieve better public health outcomes. The holistic approach, relevant to food safety and control of diseases (e.g. Covid-19) through usage of green technologies should be considered. The application of cleaner and effective technologies can be expanded to management and control pollution. The potential topics from the following research areas are expected: Global environmental health; environmentally friendly processes and their effects on human health; outdoor air quality, surface and ground water quality improvements; toxic substances and hazardous wastes reduction; environmental pollution, microbial degradation of pollutants, nanomaterials, nontoxicity and safety issues, food safety and agricultural products etc. Simultaneously, there is an increasing demand for natural bioproducts of therapeutic and industrial significance (in the areas of healthcare, environmental remediation, microbial biotechnology). Growing awareness and an increased attention on environmental issues such as climate change, energy use, and loss of non-renewable resources have carried out a superior quality for research that provides potential solutions to these problems. Emerging microbiome approaches potentially can significantly increase agriculture productivity and human healthcare and henceforth can contribute to meet several sustainable development goals. The aim of this study is to illustrate the novel research contributions on innovative approaches to manage, mitigate and valorize wastes produced by different sectors, with the aim of transforming our society towards a sustainable and circular bioeconomy. The present study discussed aspects including risk factors in atmospheric and water environment, public health improvement, changes of food trend, and living environment to elucidate the importance of environmental allergen

***Keywords**: environmental pollution, metal contamination, xenobiotic, clean technologies, public health*

INTRODUCTION

Environmental pollution resulting from agricultural practices and operations has become an issue of critical concern in recent years. Pollutant discharge from agricultural systems has been documented as one of the key non-point sources of pollution chiefly responsible for soil and water quality impairment in the worldwide. As major polluters, enterprises are expected to behave responsibly toward the natural environment. However, enterprises often do not pay enough attention to the environment and may even be environmentally irresponsible. Encouraging enterprises to actively accept environmental responsibility is the key to solving the problem of environmental pollution. Perhaps, nothing is more important today for businesses and societies than the management of the global and local environmental changes that are degrading all aspects of life—a trend at risk of worsening for future generations.

The main ambition of most nations in recent times is to reduce the environmental implications of greenhouse gas emissions which have resulted in global warming and climate change. Various chemical amendments have been effectively used to immobilize pollutants resulting from agroecosystems. Reduction in the mobility and solubility of contaminants such as P, Zn, Cu, Pd, Cd, has been achieved by the use of various pure and industrialwaste materials, limiting the environmental toxicity of these pollutants. However, the continuous addition of most of these amendments and their associated impurities could in turn have a detrimental effect on soil and water quality.

To reduce production costs and pursue profit maximization, enterprises tend to overdevelop and generate excessive emissions, which creates shocking problems such as air pollution, water pollution, land pollution, and resource depletion. Nowadays, air pollution is a burning problem for every part of the globe. More than 100 pollutants which pollute air have been identified. They may be in the form of solids, liquids or gases. They differ significantly from place to place depending upon the particular complex of contaminant source and atmospheric conditions. The air pollutants emitted from both natural as well as anthropogenic sources.

A series of serious problems has been caused by environmental pollution, and corporate environmental responsibility has received increasing attention. Contaminants such as nitrogen, phosphorus, dissolved organic carbon, arsenic, heavy metals, and infectious pathogens are often associated with agroeco systems. The environment has become ever more hazardous due to industrialization for city development in many countries. This includes the sky and the soil where humans reside. Tiny particles from vehicles (e.g., diesel exhaust particles, particulate matters (PM)), dusts containing ultrafine particles (e.g., diameter below 0.1 μm), smoking (e.g., first- and second-hand smoke), chemicals from factories (e.g., coloring dyes, cotton, epoxy resins, isocyanates), and the emerging electromagnetic field (EMF) in telecommunications.

Tiny particles such as $PM_{2.5}$ and PM_{10} have diameter 2.5 μm and 10 μm, respectively or below can pass through and are trapped in our lung cells. The trapped PM affects breathing rate as it agglomerates into insoluble particles in the lungs that obstruct airway, thereby inducing breathing difficulties linked to chronic obstructive pulmonary disease. Tiny particles of chemical sources such as coloring dyes have been reported to be allergic to some people. Carmine (e.g., red), tartrazine (e.g., yellow), and annatto (e.g., orange or yellow) have been used in food coloring for meat, or peanuts, and many other types of foods. The common symptoms of allergic associated with food coloring include severe headache, itchy skin, breathing difficulty, and chest tightness.

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Air pollution is one of the biggest environmental health problems in the world; accumulative studies have shown that air pollution was closely related to metabolism disorders. HbA1c is a stable indicator for blood glucose level monitoring. However, studies on the impact of ambient air pollution on HbA1c have inconsistent conclusions. Inorganic gaseous pollutants (such as ozone, nitrogen dioxide, and sulfur dioxide) and volatile organic compounds (VOCs) have been the focus of attention in many studies in the literature because of their serious effects on human health and the ecosystem. Especially, ozone (O_3) is of primary interest because of its phytotoxicity at ambient concentrations and widespread existence in Europe, particularly in the Mediterranean area.

The study is going to explore the influence of ambient air pollution on HbA1c. By searching keywords, a systematic literature retrieval was carried out on PubMed, Cochrane Library, Web of Science, and Embase databases up to April 2022. Pooled percentage change (%-change) and 95% confidence intervals (95% CI) were estimated using random effect models for particulate matter (PM) and nitrogen dioxide (NO_2).

LASER, and most importantly, mobile phones. Power and phones range from 10^1 to 10^4 Hertz (Hz), radiowaves range from 10^4 to 10^9 Hz, and LASER communication is at 10^{14} Hz. Some reports on triggered sensitivity have been linked to mobile phones which lie in the 2–4 GHz. However, the future is 5 GHz with yet unknown effect on our health. Previous study reported that weak magnetic field shares similarity with chemical reactions from drug, indicating that magnetic field may affect humans at molecular level. Symptoms that have been reported include headache, nausea, and dermatological symptoms. However, the reported symptoms are yet to be medically diagnosed.

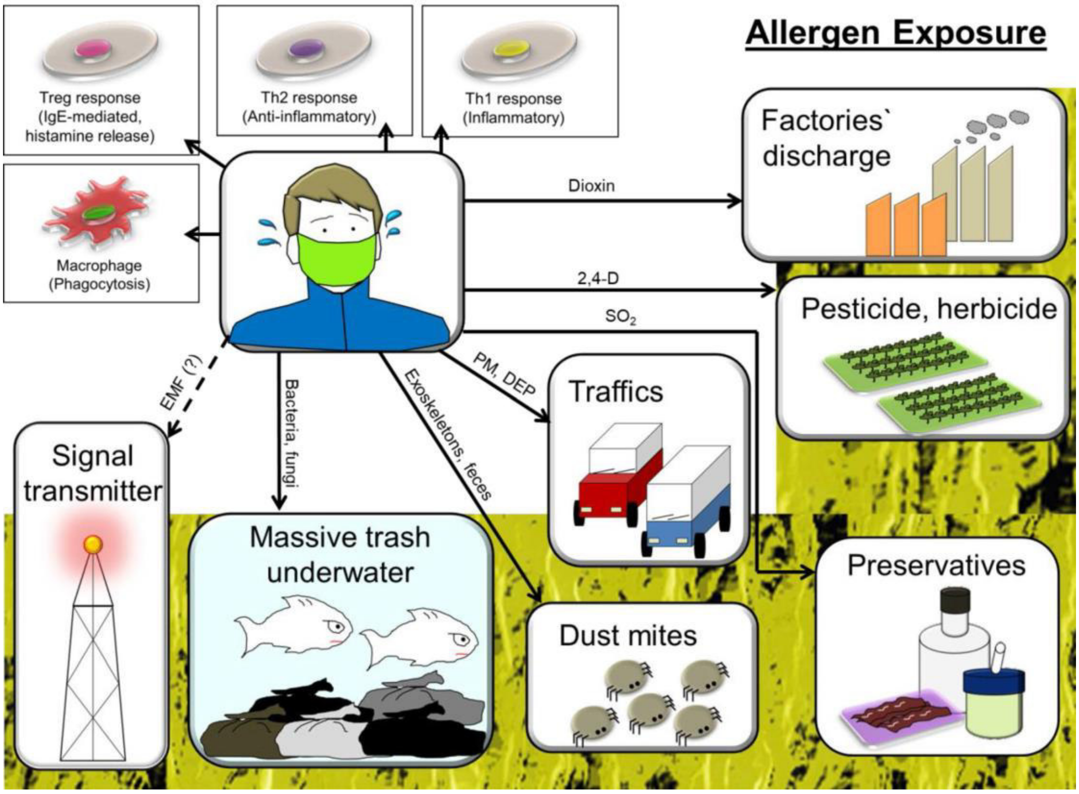

Figure 1. The currently known allergen exposures (Source: Yong et al., 2022[1])

HEAVY METALS IN THE ENVIRONMENT

Heavy metals generated by a variety of industrial practices can cause significant environmental harm if not efficiently eliminated from the wastes. These heavy metals adversely affect human health, the environment, and aquatic systems when they accumulate in living organisms at levels above the permitted limits.

Heavy metal accumulation in soil interrupts the normal functioning of soil ecosystems and plant growth [2,3]. Plants absorb various kinds of heavy metals when available in the soil or irrigation water [4]. Metals like manganese (Mn), magnesium (Mg), copper (Cu) and iron (Fe) is classified as plant essential metals. These metals are required in specific amount and their deficiency or elevated concentrations will result in toxic effects and reduce the plant productivity. For example, Mn is involved in splitting water molecules necessary for photosynthesis. Other metals like magnesium deficiency is responsible for cholorosis in plant leaves [5,6] and also induces oxidative stress [7]. Zinc (Zn) is essentially required for plants. However, too high concentrations can damage plants [5] and inhibit their growth. Zinc is responsible for chlorosis in leaves by reducing chlorophyll [8]. However, heavy metals including Cd and Pb are toxic metal and influence the plant growth adversely by affecting the leaves and root growth and inhibit enzymatic activities and resulted in reduce production [9,10]. Cadmium is considered as phytotoxic as it inhibits plant growth parameters including respiration, photosynthesis and water and nutrient uptake [11]. Further it reduces the rate of new cell production and root growth [12], inhibits the ant oxidative enzymes activities [13] and induces oxidative stress in cells [14]. Moreover, Cd induces changes in plants at all biochemical, physical and genetic levels, which are responsible for the reduction in the growth of plants [15], leaf chlorosis, and leaf or root necrosis [15] and ultimately plant death occurred [16]. Like Cd, Pb is also phytotoxic in nature. It affects the plants photosynthesis by reducing the chlorophyll content. This is because Pb reduces the uptake of chlorophyll-essential elements such as Mg and Fe, affecting chloroplast, changing essential enzymatic processes for photosynthesis and disturbing the closing of stomata [17]. Lead has significant impacts on seedling dry mass, root and shoot length, and weight [18,19]. It adversely affects the process of respiration and metabolism of plants [20]. Soils are contaminated in the environment with a number of heavy metals by natural (weathering and erosion of parent rock material or ore deposits) or artificial (wastewater irrigation, mining activities) sources. The presence of one contaminant can increase or decrease the impacts of others. To date, majority of studies have focused or investigated the effects of a single metal on plant species [21–23]. However, the study of plant to a mixture of heavy metals requires more attention throughout the world.

POLLUTION AND HUMAN HEALTH

Human exposure via the oral pathway (*i.e.*, eating food) is one the major routes for heavy metal exposure [24]. *Spinacia oleracea* is a member of the Caryophyllales order, comprising broad, green and leafy vegetables possessing large surface areas, relatively high growth rates and rather elevated heavy metal absorption rates. Recently, due to these unique characteristics, *S. oleracea* and other members of the Caryophyllales order have been researched in a number of scientific studies to observe their growth and toxicity responses to heavy metal contaminations [25–28]. *Spinacia oleracea* has an imperative position in the order due to large and expanded leafs, fast growth and by being a common part of the human diet. Nevertheless, there is a lack of information regarding growth behavior, metal accumulation, total protein content, fiber characteristics, moisture content and inorganic nutrients response to individual and combined heavy metals with respect to this plant. Therefore, it is necessary to unravel the response of *S. oleracea* to a range of individual and combined heavy metals.

Heavy metal contamination in soils is the cumulative results of intensive smelting and mining activities [29]. For instance, Liu et al. [30] reported that the concentrations of As, Cu, Pb, and Zn in four sampling regions of a typical Chinese smelting assembly greatly exceeded the nation limits of Soil Environmental Quality Standard. Zhao et al. [31] also reported that the average concentrations of Cd, Cu, Pb, and Zn in mining and smelting–impacted soils from Baiyin district exceeded the background values of Gansu province. Previous studies have shown that about 40–70% of anthropogenic metals were emitted from smelters into the environment, including soils (Pacyna and Pacyna, [32]). It must be emphasized that Pb/Zn mineral deposits are widely distributed in China, and Pb/Zn smelting activities are responsible for the enrichment of heavy metals such as As, Cd, Cu, Pb, and Zn in soils [33].

As a consequence, the environmental impacts of smelter operations on the soils need to be identified and better quantified for the risk management and remediation of smelter–contaminated sites. At present, mineralogy studies have been successfully applied in the areas of pollution identification and risk assessment for soils, dusts, and slags in mining and smelting areas. Bari et al. [34] have revealed that the main As hosting minerals were identified as tooeleite, arsenopyrite, scorodite, and arsenolite. Palmer et al. [35] confirmed that As–rich minerals (arsenic trioxide) were generated from roaster stack emissions. Berryman and Paktunc [36] have indicated that Cr (VI) was closely related to the Ca– and Mg–rich micro–spherules in ferrochrome smelter dusts. Similarly, Ettler et al., [37] found that the high bioaccessibility of V, Pb, and Zn was mainly caused by the solubility of metal–rich Mn oxides, slag glass, hemimorphite, and carbonates. Despite the extensive global studies reported for heavy metal contamination in soils around smelters, limited literatures address the soil mineralogy as the potential control that influences element geochemistry in soils around smelters [38]. In addition, there remained poorly understood about the relationship between the metal hosting phases and the environmental behavior of heavy metals in smelter–impacted soils.

Among the heavy metal ions, e.g., Pb^{2+} and Co^{2+} represent a greater hazard to human health. Acute Pb^{2+} exposure, e.g., can result in newborn brain harm and nervous system, kidney, as well as vascular system disorders. Removing these harmful metals from polluted water is critical for both human health and environmental conservation. Associations between environmental pollutants such as heavy metals and harmful chemicals and adverse human health effects have emerged recently, but the links among environmental metals and respiratory diseases need more studies.

Cadmium is considered as one of the most toxic non-essential heavy metals that can cause negative impacts due to exposure in humans and other living organisms. It is occurring as pollutant in the environment resulting from industrial and agricultural procedures. Primary Cd^{2+} exposure routes include consumption of contaminated food and water, and inhalation from smoking. Studies show that exposure to Cd^{2+} has been linked with kidney, lung, breast, pancreas, prostate, and nasopharynx cancers. Pollution from plastic toys is one of the most important potential routes of exposure to toxic metals such as Cd^{2+} and Pb^{2+}.Regarding Pb^{2+}, the toxic effects of this metal in children have been associated with learning difficulties, attention deficit, low intelligence quotient (IQ), and antisocial behavior. Lead pollution can occur during the food production process through specific migration from packaging into the foods contained. With regard to Cd^{2+}, the main toxicological effects include renal damage, hypertension, emphysema, malformation, and impaired reproductive function. Exposure to Cd^{2+} can take place through occupational activities involving contact with the meta and by ingesting foods contaminated by this metal. Childern exposure to these heavy metals is a worldwide health problem, where children are especially vulnerable both because of their hand-to-mouth behavior and the fact their gastrointestinal and nervous systems are undergoing development.

ENVIRONMENTAL POLLUTION

Chemical pollution arising from heavy metals and metalloids is a growing global concern and a major cause of pollutionrelated diseases in the world today, especially in low- and middle-income countries.
Environmental pollution has become more diversified in recent years as technologies for urbanization is increasingly more advanced. Several environmental factors such as air and water pollutants have been linked to allergic symptoms. For instance, because of industrialization for city development in many countries, polluted soil or tiny particles in the air could result in an even more hazardous environment for people to reside. Aside from the aspects of environmental issues, other newly emerging factors such as the electromagnetic field (EMF) also require further investigation. Issues regarding environmental factors in the influence of immune system have become clinically critical.
The pollution does not stop in the atmosphere, but continues in the hydrosphere. Since a decade ago, global warming has become a concern for health and environment. On the lands, human civilizations thrive as new products along with heat-trapping air pollutants. To solve the heat trap in atmosphere, some countries have used aerosols. The amount of wastes include plastics, heavy metals, alloys, and chemicals (e.g., pesticides from farmland), nuclear materials (e.g., uranium-238 (half-life of 4.47 billion years), hydrogen-3 (half-life of 12.3 years), and carbon-14 (half-life of 5,730 years)), and various other materials are increasing quickly. However, for some of the wastes such as plastics, burning could potentially cause severe influence on the environment and thus could not be fully relied on [39]. Some of the wastes such as heavy metals are not decomposed [40]. To save the lands from being drowned by massive trash, the trash are in fact submerged in water [41]. The atmospheric pollution and the wastes that are kept underwater help breed bacteria, fungi, and other microorganisms that are yet to be discovered. The health concern due to sea pollution arises from the fact that fishes are being consumed worldwide. In some nations, aquatic lives are staple foods; in other nations, people live on the water as a lifestyle. The metals foundbreed bacteria, fungi, and other microorganisms that are yet to be discovered [42]. The health concern due to sea pollution arises from the fact that fishes are being consumed worldwide. In some nations, aquatic lives are staple foods; in other nations, people live on the water as a lifestyle. The metals found in contaminated water such as chromium, mercury, and tin are consumed by fish at the top of food chain [43]. In addition, fish contaminated with heavy metals has been associated with eczema in children [44]. However, one of the most toxic by-products from industrial waste is dioxin which is manufactured during paper bleaching, metal refining, and incineration. According to the US Environmental Protection Agency, dioxin can be found in the drinking water from factories discharge and waste incineration, and has been associated with allergy [45].

HYGIENE IMPROVEMENT

As modernization rapidly grows worldwide, an increased ways of sanitation which results to improved hygiene in personal and public environment. The applications of bactericidal agents, pesticides, as well as angenies have reduced bacterial and parasitic and other microbial infections. Reduction in microbial infections reflects the fact that less microbe’s invasion in our immune system. An immune system that experiences reduced or no foreign invasion might be unable to act rapidly against foreign pathogen while being attacked the second time [46]. However, previous study suggested that the gut microbiota is linked to an IgE-mediated food allergy, rather than microbial infection [47].

The adaptive human immune system can be modulated by T helper 1 (Th1) (e.g., fighting against intracellular invaders such as virus and bacteria) or Th2 cells (e.g., triggered by extracellular invaders). The Th1 response activates macrophages to kill the invaders. Th1 cells secrete interferongamma (IFN-γ) to trigger Th1 development and suppress Th2 response. The Th2 is known as a humoral response which produces antibodies to generate isotype switch to fight against foreign pathogens. While Th1 cells secrete IFN-γ, Th2 cells secrete interleukin-10 (IL-10) to trigger Th2 response while inhibiting Th1 development. Since the antibodies are triggered from a humoral response, the immune system can store a memory of the pathogens that have been encountered in an earlier period, such that identical pathogens can be killed efficiently upon the second encounter. Evidence has shown that reduced microorganism infection can affect the Th1/Th2 response. If the Th2 response is less triggered, the immune system has reduced ability to fight various pathogens, the immune system is inclined to Th1 response, causing an autoimmune response [48].

CHANGES IN FOOD TREND

Globally, manufacturing of food products has become modernized in many ways. To prolong storage period, or to make foods taste better, foods are chemically processed Preservatives such as antioxidants (e.g., sulfur dioxide, sodium benzoate, and nitrates) are added in meat products and beverages to prevent bacterial infection. The beer and wines, sausages, meat patties for burgers, and even pickled vegetables can be preserved with sulfur dioxide to restrict oxidation. Unfortunately, some people are allergic to the added antioxidant.

To grow foods more efficiently, seedlings are cultivated with herbicides (e.g., 2,4-dichlorophenoxyacetic acid and glyphosate) or pesticides (e.g., rodenticide warfarin, permethrin, and carbaryl). The 2,4-dichlorophenoxyacetic acid (2,4-D) is an active ingredient in herbicides for removing unwanted vegetation. The 2,4-D has been linked to allergic wheezes as it is widely used in public parks, playground, and crops [49]. The pesticide warfarin is widely being used to kill rats. Since the 1970s, even stronger type of warfarin was being developed to overcome rats that were resistant to warfarin which was then called “Superwarfarin.” The molecule brodifacoum is found in the superwarfarin which restricts the function of vitamin K by stabilizing the inactive form of vitamin K, vitamin K epoxide (Card et al., [50]). Furthermore, warfarin was found to induce skin conditions such as dermatitis, urticaria, purpura, hemorrhagic necrosis, and purple toe syndrome (Kwong et al., [51]). In addition to food making, plasticizers are used in various cooking utensils, plastics, which can be dissolved after a period of time and be mixed in the lipids of foods during cooking. Phthalate ester is a plasticizer commonly used for increasing flexibility in plastics and has been associated with atopic dermatitis (Takano and Inoue, [45]). As a result, human consumes various types of molecules apart from the original foods themselves.

RESIDENTIAL ENVIRONMENT

Dust mites are prevalent in residential areas worldwide regardless of geographical locations. The factors that determine mites prevalence are dependent on their need to humidity and to avoid light. The prevalences of dust mites are added on by pets inside the residential areas. In addition to pets, the use of air conditions can stabilize humidity in the living environment. Clinical symptoms for dust miteassociated allergy include wheezing and breathing difficulty. *Dermatophagoides farinae*, *Dermatophagoides pteronyssinus*, *Euroglyphus maynei*, and *Blomia tropicalis* belong to the arachnid class. Components from the mites (e.g., exoskeletons, feaces) can affect skin through proteolytic effect on epithelial cells (Erban et al., [51]). The dust mites can activate the pattern recognition receptors which recognize conserved pathogen associated molecular patterns (PAMPs) to induce innate immune system. Clinical symptoms from dust mites include rhinitis, asthma, and atopic dermatitis.

POTENTIAL PREVENTION AND PUBLIC HEALTH APPROACHES OF HUMAN HEALTH

In prevention of respiratory diseases aroused by air pollution, approaches could be applied in the aspects of environmental policy and personal prevention (Pfeffer et al., [52]). As for personal prevention, avoidance of places with high risk of allergen exposure could be effective in lowering the adverse influence in respiratory system. Moreover, antioxidants could also serve as feasible option as pharmacotherapies for allergen-associated allergic reaction prevention (Pfeffer et al., [52]). For instance, in a previous translational study, vitamin D was reported to play a protective role in the pathogenesis of pollutant-induced inflammation (Pfeffer et al., [53]).

Other substances or medications such as vitamin C, vitamin E, N-acetylcysteine, and sulforaphane could also provide similar effect on antioxidant response (Pfeffer et al. [52]). However, given that there were many risk factors regarding the development of allergic diseases, it is important to consider the effect of confounders while setting allergic diseases as observational outcomes in studies (Paller et al. [54]). Therefore, while considering the preventive effect to pollutant-induced allergic reaction, potential influence of confounding biases should be noticed in studies. To further clarify the interaction between public health and allergens, future studies should focus on the effectiveness of different policy implement and the influence on environmental toxicant-associated pediatric allergic diseases.

As a conclusion, different environmental allergens pose various extent of risk in people. The influence does not only limit in respiratory system but also could potentially lead to systemic influence and changes in the comorbidity status (Gau et al. [55]). Identifying potential interaction between environmental pollution effects and allergy could be protective for future allergic statuses. Clarifying interactions between allergens, pollutions, and microbiomes could be effective in understanding the influence to the severity and onset time of allergic diseases (Burbank et al. [56]). The Global Burden of Disease study showed that air pollution is the fourth leading cause of death and disability [57]. More than 92% of the world's population lives in places with $PM_{2.5}$ concentrations higher than 10 $\mu g/m^3$, on the basis of an air quality standard announced by the World Health Organization (WHO) in 2005 (WHO [58, 59])

Accumulative studies have shown that ambient air pollution (including diameter ≤ 10 (PM_{10}) and ≤ 2.5 μm ($PM_{2.5}$), NO_2, ozone (O_3), etc.) is the biggest environmental problem caused by industrialization, increasing the risk of metabolic disorders (such as insulin resistance) and related diseases (such as type 2 diabetes) (Eze et al. [60,61]). In order to improve global air quality, a series of policies have been adopted to improve energy efficiency and reduce energy pollution, but the protective benefits of improving air quality are largely offset by harmful factors caused by aging population, economic polarization, climate change, and other factors (Geng et al. [62]). Meanwhile, health hazards can still be observed in Europe and America where air quality levels reach those of the WHO air quality guideline in 2005 (Strak et al. [63]), suggesting that the health effects of air pollution have been seriously underestimated.

HbA1c (HbA1c is a combination of hemoglobin and glucose with a slow, nonenzymatic reaction in red blood cells; the levels of HbA1c in the blood remain relatively stable for 2–3 months until the red blood cells are metabolized and was normally measured using a high-performance liquid chromatography throughout the blood sample (Riant et al. [64]) is a stable biomarker, which can reflect the average blood glucose level, and this meta-analysis showed that higher levels of HbA1c were significantly associated with the exposure to PM_{10}, $PM_{2.5}$, and NO_2. The subgroup analysis showed that exposure period, sample size, and Body Mass Index were associated with HbA1c in response to air pollution. Public awareness of the health impact of air pollution should be enhanced and the mechanism of the air pollution's effect on metabolism needs further exploration. According to Lauri [65], China's CO_2 effusions increased by approximately 1.7% per year on average from 2015 to 2020. Irrespective of the economic consequences of the COVID-19 pandemic, the country's CO_2 exudates continued to surge by about 1.5% in 2020..

Nowadays, the world is experiencing carbon emission and climate change which knock down the environment and the economy, so all the countries raise their concern towards green technology innovation to restore the environmental degradation without compromising the growth and development. Environmental regulation plays a crucial role in attaining sustainable development as it improves energy efficiency and reduces pollution emissions.

Exposure to environmental chemicals and metals causing adverse health effects is a major concern leading to numerous conditions including hypertension, cardiovascular disease, sleep disorders, decrease in cognitive function, and allergies (Rahman et al., [66-72]). Exposure to heavy metals has

been associated with chronic diseases likely due to oxidative stress and inflammation in the lungs causing tissue destruction [73]. Among occupational respiratory diseases, there has been a shift from exposure to mineral dust such as coal and silica in the 20th century to low-dose allergens and irritants. This has led to a change in respiratory diseases from pneumonoconiosis to occupational asthma. Approximately 15% of all chronic obstructive pulmonary disease (COPD) cases in western societies have been attributed to dust, fumes, vapor, or gas (De Matteis et al. [74]).
In 2018, it was found that pollution was responsible for 9 million deaths worldwide. And it was corresponded to 16% of the total global deaths, and to 21% of all deaths from cardiovascular disease, 26% of deaths due to ischaemic heart disease, 23% of deaths due to stroke, 51% of deaths due to chronic obstructive pulmonary disease, and 43% of deaths due to lung cancer" (Landrigan et al. [75].

HEALTH RISKS: INFECTIOUS DISEASES CLIMATIC CHANGES

Climate change is now becoming a critical public health challenge by increasing exposure to rising temperature, extreme weather, declined air quality, and new pests and pathogens. Actions can be taken to lessen the effects of climate change and to build resilience to reduce the impact on human health.
A multidisciplinary and collaborative effort from the scientific community is needed to establish a comprehensive understanding of these topics. Several studies explored some interesting topics on the relationship between climate change and human health. the direct and indirect effects of carbon emissions on public health; when the average temperature of the year exceeds 17.75°C, an increase in greenhouse gas emissions will have a more significant negative impact on public health. However, the climate change and environmental pollution problems induced by rapid economic development has caused a great threat to our human lives (Watts et al. [76]).

DISPOSAL OF HEALTHCARE WASTE

Globally, disposal of healthcare waste is a key issue of environmental sustainability. The amount of healthcare waste is increasing every day, and it is necessary to adequately dispose of this kind of waste. There are various treatments for healthcare waste disposal, of which incineration of healthcare waste is one of the solutions. Waste generated in healthcare institutions is classified into three main groups: municipal waste, healthcare wasteH and hazardous waste. At the same time, Healthcare waste represents very big challenges for public authorities Healthcare waste raises high levels of concern about public health and the environment. Improper management of healthcare waste can cause significant environmental pollution (Kumar, et al., [77]) and health problems in terms of the spread of diseases caused by viruses and microorganisms and can generate groundwater pollution as a result of continuous disposal of untreated medical waste in municipal landfills (Lu, et al., [78]). Healthcare waste directly and indirectly affects health and the environment risking more risks (Geetha, et al., [79]).
Healthcare institutions do not have a different approach to healthcare waste which is often mixed with municipal waste (Lee, et al., [80]) which further has consequences for human health and the environment. HCW waste must be disposed of properly. There are different ways of treating healthcare waste such as: incineration, autoclaves, chemical disinfection, disposal in the ground, and deep burial (Geetha, et al., [79]). Process of selection of the best and most effective healthcare waste treatment technology has been the subject of huge research interest (Shi, et al., [81]), especially because of great environmental and financial effects. When choosing treatments for HCW management, it is necessary to provide a reliable and environmentally friendly healthcare waste management system that is, according to Aung, et al. [82], one of the most important topics on the agenda for health institutions and local communities.
However, healthcare waste incinerators have a role in increasing environmental air pollution (Datta, et al., [83]). Sometimes, there are conflicting criteria existing in the selection process; thus, the problem of incinerator selection can be done by applying the method of multi-criteria analysis which is a very useful tool for analyzing complex real-world problems.

ENVIRONMENTAL PERSISTENCE AND HEALTH IMPACTS

Recent research suggests a definite distinction between indoor and outdoor microplastics. However, knowledge of different microplastic kinds and relative exposure via inhalation to humans in outdoor and indoor locations is lacking. Notably, microplastics formed from various plastic types could have distinct features, and the relative health risk varies by environment. For example, outdoor polyethylene goods have recently become more popular. These products are generally of poor structure and recycled material, making them more susceptible to decay.
Particularly in the outdoor environment, the constant exposure to an open-air environment increases the risk of fragmentation and atmospheric mixing and thus facilitates microplastic's availability. It is reasonable to assume that breathable microplastics in indoor outdoor environments are more harmful than inhalable microplastics, whereas exposure to indoor breathable polyethylene - microplastics could be highly hazardous (Figure 2).

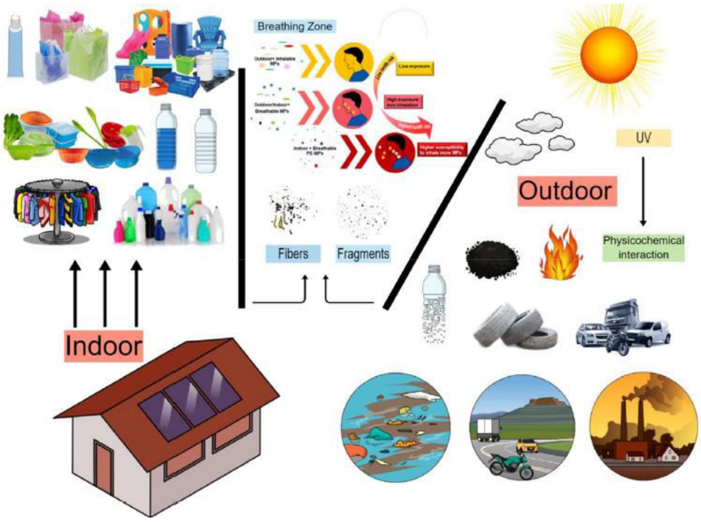

Figure 2. Occurrence, human exposure, and risk of microplastics in indoor and outdoor environments (Source: Mehmood et al., [83])

Exposure to these microplastics from the environment may pose a severe health risk to humans (Goodman et al. [84]). The size and shape of airborne microplastics determine their ability to be inhaled and their fate in the human body. Smaller, angular particles, for example, pass through membrane barriers more quickly than those with longer edges or irregular surfaces (Mehmood and Peng, [85]).
Those coarse microplastics (size: ≤ 10 μm) that can reach the human respiratory system and deposit in the upper airways or enter the intrathoracic cavity (≤ 10 μm) are called inhalable particles. On the other hand, fine microplastics (size: ≤ 10 μm) are called breathable particles and can reach and deposit in the deep lung (gas exchange zone in lungs) (Liao et al., [86]).
Mainly microplastics concentration, distribution, and transport are explained by anthropogenic and climatological factors, leaving physicochemical interaction with environmental attributes like ultraviolet (UV) radiation, oxygen, and other pollutants. Likewise, the variability of different microplastics and their corresponding levels in contrasting environments such as indoor and outdoor is also unclear (Mehmood and Peng, [85]). Several studies suggested that atmospheric microplastics contain a substantial concentration of polyethylene (Mehmood and Peng, [85]).
Subsequently, Zhang et al. [87] reviewed the intake of microplastics in humans and reported that the estimated range of daily microplastics intake of the individual is 0 to 5.7×10^3 items ・ m^{-3} (Liu et al., [88]), which was higher in indoor ($1.9 \times 10^3 – 1.0 \times 10^5$) than outdoor ($0–3.0 \times 10^7$).
In the case of polyethylene - microplastics, the dominant sources are (1) disintegration of outdoor plastic trash polluting cities (Zhou et al., [89]), (2) wind-driven microplastics mobility and fiber release from drying of cloths (Liu et al. [90]), (3) synthetic material cutting or grinding (Dilara and Briassoulis, [91]), (4) tires, (5) incomplete burning of plastic trash (Liu et al., [92]), (6) cyanobacterial and algal biodegradation, (7) surface water bubble bursting (Sarmah and Rout, [93]), and (8) polyethylene sheets

(which are extensively used in farmland for mulching and greenhouse cover) that have been identified as critical agricultural microplastics (Wang et al., [94]).
Since most polyethylene - microplastics) emission sources are linked to the outdoor environment and considering the role of UV radiation in fragment formation of polyethylene, it can be concluded that atmospheric polyethylene - microplastics are mainly released from outdoor polyethylene sources, which is in reasonably good agreement with the findings of Gaston et al., [95]) who reported that polyethylene - microplastics concentration (12.6 ± 8.0 fragments per m^3) were twice in outdoor compared to indoor (5.6 ± 3.2 fragments per m^3) concentration, indicating higher polyethylene - microplastics level in outdoor. Moreover, Liu et al., [92] found that polyethylene - microplastics were higher in the breathing zone than in dust and upper atmosphere (above 83 m). Hence limited use of polyethylene -based products substantially reduces adverse health impacts such as respiratory and lung disorders.
In brief, a detailed health risk assessment of microplastics requires more work and needs to look at a wide range of microplastics for their toxicity and persistence in the breathing zone, relative exposure intensity, and tendency to reach the deeper respiratory tract. Indeed, it consumes a lot of effort and resources, but it is necessary.
Meanwhile, switching to or correcting outdoor use of polyethylene products could cut exposure to atmospheric microplastics by up to 50% in some cities worldwide. In addition, indoor microplastics concentrations are mainly influenced by direct emissions from indoor sources (toys, clothing, mats, curtains, kitchen tools, furniture, mattresses, and so forth) from outdoor sources by ventilation supplies. Besides, indoor environments may also influence transformation processes in pollutants (e.g., inter-zonal transport, mixing, coagulation, re-suspension, and phase change). Therefore, physicochemical changes attributed to microplastics transportation between indoor and outdoor environments may also be important to assess the corresponding changes in microplastics and associated chemical species.

CONCLUSIONS

The current article provided current evidences regarding the association between various pollutants and the potential diseases that could be induced. For people with high skin exposure to air pollutants such as PM2.5, PM10, or sulfur dioxide, potential onset of dermatological allergic events should be alerted. The detailed immunological mechanisms and clinical implications could potentially provide readers with clearer view to the interaction between allergic status and pollutants. For personal prevention, avoidance of contacting potential pollutant and consuming antioxidants could be possible approaches. It is also conculated that critical public health implications because increasing and widespread exposure to environmental heavy metals and their mixtures may be a key contributor to human health conditions. The management of HCW gets increasing importance due to the increasing amount of waste that occurs during the operation of healthcare institutions. There are different types of HCW that can be treated in different ways.

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