World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(REVIEW ARTICLE)

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Public health implications of plastic pollution: Reducing national healthcare burden

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World Journal of Advanced Research and Reviews, 2024, 24(01), 1755–1763

Publication history: Received on 07 September 2024; revised on 16 October 2024; accepted on 18 October 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.24.1.3181

Abstract

Among the materials that are most prevalent in use universally. They exist as one of the most commonly used materials in our everyday world although serious health hazards are associated with plastic pollution, which may result in higher nationwide health care costs. Understanding how plastic pollution affects health and how lowering it might lower medical expenses and enhance public health outcomes is necessary to address these issues. However, there are several matters through use besides discarding, like refuse accumulations in natural environments and landfills, corporeal harm to wildlife from taking in or becoming caught in plastic, chemical leaking from plastic substances, and the likelihood of plastics spreading substances to people and nature. The worldwide implementation of the SDGs has further proven to be effective in curtailing plastic pollution and hopefully would be fully achievable by 2030.

Keywords: Plastics; Plastic Pollution; Human Health; Healthcare; Public health

1. Introduction

As plastic production rises quickly worldwide, more and more plastics are being unrestricted into the location throughout their cycles. In the 1950s, the world produced 1.5 million tons of plastics; by 2016, that amount had grown to 335 million tons [1]. Plastic production has been steadily increasing globally due to several factors, including rising consumption, cheap production costs, packaging trends, and rapid urbanization and population expansion. The global COVID-19 pandemic has complicated matters by increasing single-use plastics, personal protective equipment, and environmental waste [2]. Despite the widespread use of disposable items and the expectation that plastics would be long-lasting and versatile, the issues with waste management and plastic pollution remain a nightmare [3]. Numerous factors contribute to plastic contamination with detrimental repercussions as well as ecological and socioeconomic ones. With increasing hazards to trophic relationships, biodiversity, predicament, and toxicologic consequences from plastic ingestion, suffocation, malnourishment, diffusion, and propelling of organisms, the creation of innovative territories, and the introduction of invasive species are all important ecological repercussions [4]. Nonetheless, numerous beneficial properties of plastics are difficult to get with other materials. The integrity of plastics can be preserved through sterilization and heating, contingent on the type of polymer. They can also be used as substitutes for products made from non-sustainable animals, such as ivory and fur. Additionally, because plastics are lightweight, they produce less carbon dioxide when being transported. [5].

2. History of plastics

Even though mass production and use of plastics and chemically manufactured polymers only started in 1950, it is hard to envisage a world without them today. It was not until the end of World War II that plastics became widely used, even though the first plastic products, such as bakelite, appeared outside of the military in the early 1900s. As a result, the

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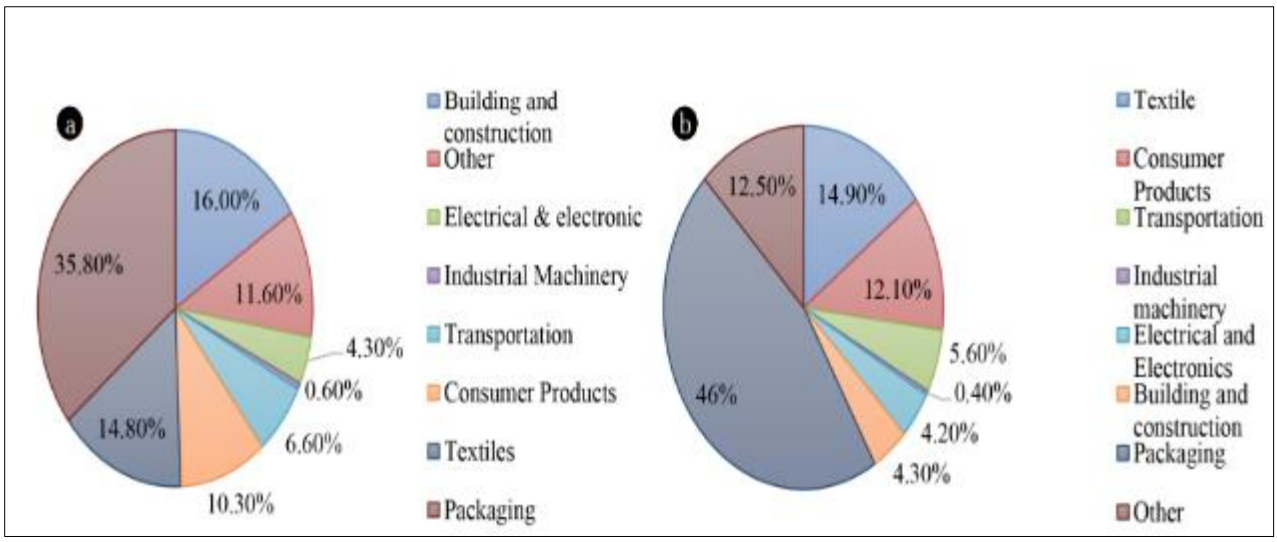
output of plastics has increased at an astounding rate, surpassing that of the majority of other man-made materials. The percentage in middle and high-income communities, the percentage of plastics in municipal solid waste rose from less than one percent in 1960 to over ten percent in 2005 [6].

Almost a single person produces at least two plastic-related wastes per day, accounting for around 12% of all disposed waste. With 7.7 billion people on the planet as of 2019, an average of 15.4 billion pieces of plastic garbage are produced daily. There are numerous types of plastics based on their producers and methods of polymerization [22]. Plastic as described by Karasik et al. [24] is cheap, soft, flexible, and mechanically strong. It can also be molded and sanitized, and it acts as a moisture barrier. Because of these characteristics, plastic is perfect for medical devices and food packaging where hygienic conditions are crucial. Plastic is frequently used in health instruments.

Olatunji [7] in a review on plastics, explained that one of the biggest economic achievements in the creation of nylon fiber was its broad use as a commonly utilized invention illustrating plastic usage in common user goods. Various plastic processing methods have been created in response to the demand for workable procedures to turn these plastic materials into goods. Leo Hendrick produced bakelite, the first synthetic plastic, in 1907. Telephones were made from this material for many years. Plastic was created much earlier [8].

Nowadays, most people's cultural opinion of plastics is that they are cheap, trash, and disposable due to the criticism of the misuse of plastic resources and how they affect the environment after they are turned into waste [9]. Bergmann et al. [10] recorded plastic pellets in each of the 20 red phalaropes (Phalaropus fulicarius) that were analyzed during the 1969 influx throughout southern California of this species and Mexican shores. A lack of surface plankton allegedly caused the birds to hunger, likewise, many were seen nibbling because there were several plastic pellets along the strand line. The manufacturing of nanoplastics is also growing. Products that may contain nanoplastics include paints, adhesives, medicine delivery systems, and electronics [13]. Figure 1 according to Hossain et al. [38] shows the role of plastic consumption and plastic waste generation globally in the year 2018.



Source: Hossain et al. [38]

Figure 1 (a) The rate of plastic consumption worldwide in 2018 (b) The rate of plastic waste generation in the year 2018

2.1. Hazards of Plastics to Human Health

Numerous harmful substances are released by plastics. Due to their widespread use and the numerous chemicals they contain, plastics present several possible dangers to human well-being alongside the environment. Among these, we focus on additives and components of plastics that are of primary concern. The monomeric ingredient in polycarbonate plastics, bisphenol A (BPA), is well-known to most people. Created in 1891, it is often added to supplementary plastics, including polyvinyl chloride [3,11].

According to Rakesh et al. [12], humans have come into contact with MPs and NPs from a variety of sources, with tap and bottled water. MPs are harmful to the immunological, reproductive, digestive, and respiratory systems both in vivo and in vitro. About 4 billion fibers km−2 pollute the deep Indian Ocean floor, whereas 5.25 trillion plastic particles are

believed to pollute the global sea surface. Even the Arctic Sea ice acts as a sink for microplastics, as evidenced by the discovery of microplastics in ice cores from remote locations [13].

There is growing evidence that microplastic exposure in humans is possible. Microplastics have been found in processed foods and drinks like beer, salt, and sugar, as well as in seafood. There have been new reports of microplastics' atmospheric fallout, which could be an exposure pathway through inhalation. It is unknown if humans can acquire microplastics and the substances they are linked to through their diet or breathing [13]. A review by Halden et al. [14] expatriates that the period when macroplastics break down and the fragment is especially crucial because it leads to the creation of microplastics first, followed by nanoplastics, which are hard to detect with current sampling and detection methods but have the greatest potential to enter the body through the body. The circulatory system then distributes these exposure agents into human organs and tissues.

Thompson et al. [18] opined that future research on hormone-altering substances that leak after plastic objects is a necessity, however, concentrate on chemical mixes that people are exposed to when using everyday household items as a result of the intricately interwoven nature of the hormone structure. The healthiness effects of accumulated acquaintance with certain substances must be ascertained. For instance, in research carried out in the USA, 80% of infants were visible to detectable amounts of nine distinct phthalate metabolites. Toxic plastic trash includes a variety of chemicals that are purposefully or inadvertently added to plastic to give it particular abilities including color, strength, flexibility, fire-resisting ability, and water resistance. These substances are carcinogens, neurotoxicants, and hormone disruptors. The environment in addition to living things' bodies may be exposed to these harmful substances [14,15,18].

Human health is at risk from plastic. Throughout its entire life cycle, including obtaining the gas and oil used to make plastics, transportation, manufacturing, refining, consumption, recycling, combustion, and more, it results in illness, disability, and early death [15]. It was discovered by Sharma and Kaushik [20] that microscopic particles in mammals can pass through the gastrointestinal tract and into either the cardiovascular or lymphatic systems, here, they remain subsequently breathed and ingested into the lymphatic system. Due to its ability to cross the placenta and influence the immune system, microplastics can also impact the developing fetus.

2.2. Burden of Plastic Pollution on the National Healthcare System

Due to its widespread, almost uncontrollable hazard to both living and nonliving systems as well as the burden it places on the environment, plastic pollution is a major worldwide concern [25]. [17]. The universal well-being community is urged to adopt a vast perspective and link the fight against plastic pollution catastrophe, driven by the goal of promoting healthy living as well as reducing health disparities in social populations [21]. By putting laws, action plans, and policies into place, some nations have started national initiatives to decrease marine litter. For example, Australia adopted the Marine Debris Research, Prevention and Reduction Act (2006), which was subsequently updated in 2012, while the United States passed the Environment Protection and Biodiversity Conservation (EPBC) Act in 1999, classifying the aquatic species that were threatened [16].

The US Environmental Protection Agency (EPA) gave an overview that 35.7 million tons of plastics are produced annually in the USA, making up 12.2% of all municipal solid garbage. The US Association of Plastic Recyclers reports that when materials like throwaway diapers, garbage sacks, cutlery, and medicinal materials are taken out of the equation, just about almost 9% of plastic left over is cast off. High-density polyethylene flasks with maximum reprocessing proportion in 2018 (29.3%), closely followed by Polyethylene Terephthalate flasks alongside containers (29.1%). 5.6 million tons of plastics were burned in 2018 [30].

Many international organizations and initiatives, with the UN international organizations, have demanded immediate action to address problems of maritime plastic clutter in the context of global governance on marine litter [19]. Karasik et al. [24] explained that nearly 25% of the more than 10,000 chemical compounds discovered in plastic items are thought to be harmful to humans if ingested. Due to their sophisticated typical interactions with home objects and feminine hygiene products, women and menstruation individuals may be more exposed to plastics containing toxins than men and non-menstruating individuals.

The most pernicious aspect of marine plastic contamination may be the fragmentation and dispersion of plastics as microparticles. Some of the dyes, flame retardants, and plasticizers included in FFPs are bioaccumulative, persistent poisons. These substances, in addition to waterborne contaminants absorbed into micro- and nano-plastics, can be ingested by organisms and contaminate them, their predators, and possibly even humans who eat seafood [23]. Plastics and resins have different chemical and physical characteristics related to the adsorption and

absorption of pollutants, depending on their chemistry. Degradation and disintegration of polymeric compounds take a lot longer in salty conditions because of the conserving impact of the ocean. These are some of the factors that make plastic persistent in particular ecosystems [21-22].

Even though plastic pollution is an issue that has existed for many decades, It is obvious that the harm it does will not go away, and repair will require more work than ever before, a thorough plan, and resolute commitments from all stakeholders [25]. Mishandled plastic water containers and face covers will add to the absorption of microplastics in marine via deterioration, but microbeads obtained through particular items from washing immediately penetrate the maritime ecosystem. Since most food production occurs near water sources (lakes, rivers, and oceans), there is a very high chance that these harmful substances will enter the food chain by way of plants absorbing nanoplastics [30]. Even despite the increased focus on plastic waste in the past ten years, data indicates that the issue is getting worse. In contrast to the COVID-19 pandemic's brief decrease in air pollution, the quantity of plastic debris that ends up in freshwater and marine environments has probably increased [33].

Using Nigeria as a case study where sachet water consumption is predominant, Chandran et al. [26] revealed that with 70% of Nigerians consuming at least one bag of sachet water each day, more than 60 million plastic sachets are used and thrown away every day. Plastic sachets have several detrimental consequences on the physical environment since they are made of nonbiodegradable elements, which prevent them from breaking down. However, a significant portion of the plastic garbage produced annually finds its way into the ecosystem. Most particle plastic comes from the decomposition of macroplastic garbage or is emitted when products are used (such as tire wear or textile fibers) [29].

2.3. Prevention strategies for plastic pollution in public health

The first step in reducing plastic pollution is managing plastic leaks, which calls for robust policy assistance [32]. In line with this, the long-awaited ban on cotton buds and plastic straws in England has been delayed for at least six months. Several states and towns in the US have either canceled or delayed some programs meant to reduce plastic contamination, as well as the elating of prohibitions that were originally planned. For instance, the Plastic Ban Reduction initiative in Hawaii projects that local retailers would prioritize using paper bags as long as their supplies persist; wetter or higher volume items may be packaged in plastic containers [27]. In the United States alone, billions of metric tons of solid garbage are buried, burned, and dumped every year. This comprises 50 billion bottles and cans that are not returnable. One-half of all solid trash is composed of paper products. Solid waste is recycled in natural ecosystems, but as humans, we either burn it or bury it in landfills [28].

Reusability is one major strategy that can be employed in controlling plastic pollution. The importance of reuse in tackling a variety of societal issues about poverty, health, and well-being is becoming more widely acknowledged. Public awareness should be raised that reuse is not a waste problem in and of itself. Goods have the chance to have a second life. Nevertheless, it did, in part, enable a decrease in the quantity of non-biodegradable plastic bags used [28]. While encouraging the usage of recyclable grocery sacks (preferably manufactured with fabric or plastics), it is important to emphasize the necessity of putting mitigation measures in place to guarantee the total eradication of the pathogenic agent. Such preventative measures can include washing your hands properly and giving your reusable bags a decontamination treatment [31].

According to Da Costa et al. [36], the 1982 United Nations Convention on the Law of the Sea, commonly referred to as a Constitution for the Oceans, went into effect in 1994 and represented a historic make effort to control entire aspects of the sea's resources and usages, and then cause a steady directive to the human basis of life. The United Nations Environment Program (UNEP) and the Marine Debris Program of the National Oceanic have worked together over the last decade to develop a global agenda that is specifically focused on the inhibition, decrease, and administration of maritime debris. Prioritizing averting, reducing, and abating the ecological, human health, and economic impacts of maritime remains worldwide," the report suggests ways to mitigate the increasing prevalence of maritime wastes [36].

Furthermore, the adoption of Conserve and use of the oceans, seas, and marine resources sustainably for sustainable development is the fourteenth Sustainable Development Goal and the ratification of international conventions demonstrates the demand for such strategies on a global scale, necessitating better management of plastic left-over [32]. This can further be attained through invention and study for the justifiable administration of plastics should be led by developed nations with more resources and facilities for this purpose. These nations should also create more affordable and better alternatives. Achieving the SDGs will also assist in ending both developed and poor nations experiencing plastic contamination through the transmission of ecologically friendly knowhows, associated bulk structures, and economic reserves [35].

The United Nations unveiled the seventeen Sustainable Development Goals in 2015 as part of the 2030 Agenda for Sustainable Development. With a focus on shared issues that impact economic, social, and environmental aspects, the SDGs aim to focus international efforts toward a sustainable future. All of the SDGs have obvious connections, and the 2030 Agenda places a strong emphasis on comprehending and addressing these connections in the policy domains of each SDG [33].

Walker [34] explained in his review that the UN and individual nations are addressing the problems associated with maritime plastics on a worldwide measure at national, subnational, and supranational levels, including regional ones. In 2019, the European Union implemented a directive intended to minimize the conservational effect of some plastic items. By this regulation, all member states are required to certify ecologically wide-ranging waste administration to prevent as well as reduce maritime clutter from the environment [40]. Countries all across the world are tackling the issue of plastic pollution head-on, implementing various regulations to reduce plastic usage and increase recycling. The European Commission declared that the Packaging and Packaging Waste Directive (PPWD) has been updated on November 30, 2022 [43].

3. Reducing the Burden on Healthcare

Traditional values in the healthcare sector do not consider the effects of pollution on public health from activities up and down the supply chain, such as environmental emissions from exploitation, manufacturing, packaging, transportation, use, and waste management. The public health effects of these initiatives should be included in an accurate assessment of healthcare expenses [39]. The mutuality of ecological, animal, and human well-being in the context of plastic pollution must be recognized by world health officials, who should also prioritize the search for solutions. Collaboration must be based on an understanding of these many sectors' common objectives and interests as well as their complementary skills and intervention strategies [21].

It is urgently necessary to plan the current epidemiologic findings in the zone because of the numerous hazardous and unknown hazard chemicals linked to plastic, the significant number of plastic materials utilized daily, potential health effects, and, among other non-plastic-related sources, human acquaintance with elements linked to plastic through interaction with food packing, integrated circuit technology, construction supplies, and household items and fixtures [37]. Initiatives to reduce plastic manufacture, ingestion, and use and the link between plastic and marine consumption cannot be postponed any longer by policymakers and public health organizations. To achieve these, many approaches can be taken, like promoting using tap water and other secure, plastic-free water sources by use of public health initiatives and educating the public about the advantages and safety of these alternatives to bottled water [41].

Customers can practice pro-environmental behavior and use less single-use plastic bags (SUPBs) daily [49]. According to the literature, recycling and the circular economy are potential solutions for managing plastic waste. Since every sector shares responsibility for the environmental issues caused by plastic, the obligations of businesses, customers, and the government by prolonged manufacturer obligation a component of the circular economy is crucial to lower or resolve the enormous issue of plastic administration. Haque et al. [42] used and conserved PPE sustainably by incorporating the 3Rs idea (reduce, refine, and replace). An estimated 78% of total trash can be decreased if all feasible reduction pathways are followed, including cutting consumption, boosting reuse, collecting and recycling garbage, and promoting innovation and design in the production of polymers and their derivatives [48].

However, Hyari et al. [44] highlight the value of recycling as a method to reduce the quantity of waste that must be disposed of, lowering the possibility that plastic debris would end up in rivers, seas, and other ecosystems. Like in many other parts of the world, Nigeria has made it urgent for local industries to reuse or recycle plastic bottles to manufacture other valuable materials since plastic pollution positions health and environmental risks. The lack of infrastructure for garbage collection, the insufficient funds for government agencies to develop, oversee, and implement waste administration policies, and the systemic lack that necessitates the importation of plastic waste from overseas are some of the particular difficulties faced by developing nations and communities. Furthermore, environmental protection frequently takes a backseat to more urgent concerns like public health, economic development, and poverty alleviation [50].

Table 1 Plastic waste policies and regulations and the countries

No	Plastic waste policies	Country	References
1	Strict restriction on plastic waste importation	Asia	Liang et al. [45]
2	Sustainable Manufacturing and Environmental Pollution Program (SMEP)	Sub-Saharan Africa, South Asia	Hira et al. [48]
3	Implementation of 3R policies (Reducing, Reusing, and Recycling)	Thailand	Wichai-kutcha [46]
4	Plastic Recycling Policies and Regulations	Malaysia and Japan	Kuan et al. [47]
5	United Nations Environment Program	United States, Canada	Kibria et al. [51]
6	Plastic waste recycling policy	Indonesia	Murti et al. [52]

Abbreviation

Microplastics: MP
Nanoplastics: NP
Fossil-fuel derived Plastics: FFP
United Nations Environment Programme: UNEP
Marine Debris Program: MDP
National Oceanic and Atmospheric Administration: NOAA
Sustainable Development Goals: SDGs
Personal Protective Equipment: PPE
PolyVinyl Chloride: PVC

4. Conclusion

Significant dangers to public health are posed by plastic pollution, including the increased spread of infectious diseases, cardiovascular disorders, and respiratory issues. These health issues increase the burden of healthcare. Significant amounts of chemical pollutants are released during the removal and conveyance of remnant energies required in the manufacture of plastic, endangering the ecosystem and air quality. Countries may lower these health hazards, enhance environmental quality, and alleviate the financial burden on healthcare systems by using less plastic and managing garbage better. The damage caused by FFP waste will continue to grow in the absence of efficient recycling, endangering marine life and eventually humanity. This review work gives a summary of various strategies for plastic waste administration in different countries and their implementation. For positive change to occur, various plastic management policies must be enforced. In addition to meeting the growing public demand for sustainable plastic waste management strategies, sound and properly implemented policies are crucial components of the shift to a low-carbon and circular economy.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest is to be disclosed.

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