Evaluating the Health and Ecological Risks of Plastic Waste Pollution in Lagos State

***Beatrice Onuoha., Elijah N E Mohammed**

Public Health Department. Ballsbridge University, Roseau, Commonwealth of Dominica, West Indies, Nigeria

***Corresponding author**

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ABSTRACT

Background: The use of plastics in many aspects of daily life has become a globally accepted practice and one that is here to stay. Plastic is inexpensive, readily available, lightweight, and strong, making it the preferred material for various applications in agriculture, packaging, electronics, and other human activities. Population increase and industrialization have led to the extensive production of plastic materials, which has resulted in the attendant generation of plastic waste. Improper disposal of this waste can lead to a vast accumulation of plastic waste in the environment, which can pose serious health and ecological risks to residents.

Aim: This study assessed the health and ecological risks of plastic waste pollution in Lagos State. It also examined residents' awareness of plastic waste pollution and identified factors contributing to its prevalence in the State.

Methodology: .The study was a cross-sectional survey targeting adult residents of the State - 18 years and above. A sample size of 385 was calculated from the estimated population of 15,500,000 [as reported by the Lagos State Bureau of Statistics, 2024], using Raosoft sample size calculator. The data collection instrument was a structured questionnaire which was shared electronically to the participants. Data was analysed using the Statistical Package for Social Sciences (SPSS) version 27.0. Descriptive statistics was deployed for data evaluation, and results were expressed as percentages and frequencies

Results: A total of 380 respondents participated, out of which 94.2% of the respondents are educated up to tertiary [57.4%] and post-tertiary [36.8%] levels. The results showed that most of the respondents [98.2%] were aware of plastic waste pollution, with 82% recognising the possibility of health risks and 79% acknowledging the possible ecological risks arising from plastic waste pollution.

Conclusion: The study found that plastic waste pollution poses significant health and ecological risks in the state. These risks can be reduced by implementing specific measures, such as enhancing plastic waste management, fostering collaboration between the government and stakeholders to promote eco-friendly alternatives to plastics, and enforcing stricter waste disposal regulations.

Key words: Ecological risks, Health hazards, Microplastics, Plastics, Plastic Pollution.

INTRODUCTION

Plastic refers to a group of polymeric materials derived from fossil fuels, including crude oil. During manufacturing, various chemical additives are incorporated to modify the strength, texture, and/or cost of this widely used packaging material [1]. The first plastics were produced in the 1860s, but it was not until the

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1940s that plastic manufacturing became one of the fastest-growing industries worldwide. Since then, plastics have gradually replaced traditional materials such as wood, metal, and leather [2], [1].

In 1950, the world produced just two million tonnes of plastic materials [3]. Over the following 70 years, however, annual plastic production increased nearly 230-fold to 460 million tonnes in 2019 [4]. Plastics have evolved as a necessary element of modern life; they are cheap, versatile, and synthetic materials used in various applications, including construction, home appliances, medical instruments, and food packaging. Plastics are made from synthetic organic polymers and are durable, lightweight, versatile, and relatively inexpensive to produce, making them one of the most widely used materials [5]. Due to their widespread use in packaging and other areas, large amounts of plastic waste are generated in many locations, which have significantly impacted the environment, causing visual pollution, posing potential hazards, and contributing to the degradation of urban landscapes [6] , [7]. Plastics become waste because of irrational production practices, improper disposal in landfills, and inadequate recycling management [8].

According to the United Nations Environment Programme [UNEP], single-use plastics, including grocery bags, containers, and bottles, make up the majority of plastic packaging. These plastics, designed for immediate disposal after use, are often discarded within the same year they are produced. Their increased use has significantly contributed to the rise in plastic waste [9]. UNEP statistics indicate that only 21 per cent of plastic waste is recovered, with incineration and recycling accounting for 12 per cent and 9 per cent, respectively. The remaining plastic waste is disposed of in landfills. [9]. However, when plastic waste is mismanaged—meaning it is not recycled, incinerated, or stored in sealed landfills—it becomes an environmental pollutant. Estimates vary, but recent high-quality studies suggest that between one and two million tonnes of plastic enter our oceans each year, impacting wildlife and ecosystems. This means that 0.5% of plastic waste ends up in the sea [10].

Since plastics are widespread environmental pollutants, plastic pollution remains a pressing global concern. These materials stay in the environment, potentially for over 400 years, leading to significant pollution of land and marine ecosystems and posing risks to wildlife through entanglement and ingestion. Furthermore, plastics break down into microplastics, which accumulate in food chains and can be harmful to humans and other organisms [11].

Statement of the Problem . The increase in human population and the consistent demand for plastics and plastic products drive the continual growth in plastic production, waste generation, and environmental pollution. For many years, plastic pollution has been recognised as a threat to the ecosystem and a global concern [12]. Plastics are non-degradable (persisting for many years where they are discarded), and their improper disposal significantly contributes to environmental pollution. They can block drainage systems, cause flooding, and are often mistaken for food by animals, leading to ingestion and entanglement issues. Oceans are especially affected, with millions of tonnes of plastic debris collecting in gyres and impacting marine life worldwide [11]. Lagos State is arguably one of the fastest-growing cities in Nigeria. With its rapidly expanding population and industrial development, large quantities of plastic waste are generated daily. It is subsequently disposed of everywhere—on roadsides, in gutters, and landfills, where it is often burned openly. These poorly managed disposal practices harm humans, animals, marine life, and the environment.

The extensive use of plastics, lack of effective waste management, and casual community behaviour towards their proper disposal pose a significant environmental threat [13]. The accumulation of plastic waste also poses health risks to the population, as it can attract disease-carrying insects and rodents [14]. Land-based plastics leaking into the marine environment disintegrate into microplastics, which can adversely affect human health by contaminating seafood. Similarly, large amounts of plastic waste can impact the ecosystem through soil pollution (via landfilling), marine pollution (via ocean dumping), and air pollution caused by open dumping and burning [15],[16]. Lagos State's extensive coastline and waterways are particularly vulnerable to plastic pollution, which exacerbates environmental issues. This study aimed to assess the health and ecological risks associated with plastic waste pollution in Lagos State.

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OBJECTIVES

The broader objective of this study is to assess the health and environmental risks associated with plastic waste pollution in Lagos State. The specific objectives are to:

Assess residents' knowledge about potential health risks associated with plastic waste pollution in Lagos State.

Examine the ecological risks associated with plastic waste pollution in Lagos State.

Determine the factors that enable plastic pollution in the State

Scope of the study. This study focused on the health and ecological risks caused by plastic waste pollution in Lagos State**.** It evaluated residents' knowledge of potential health hazards related to plastic waste pollution and its effect on the ecological aesthetics of the state. Additionally, it examined the factors contributing to plastic pollution in the area. Participants were randomly selected from different parts of the state, with eligibility criteria outlined in the research questionnaire**.** The geographical scope covers Lagos State, which comprises twenty local government areas, and respondents were adults aged eighteen years or older.

LITERATURE REVIEW

Plastics: According to Ocean Conservancy, plastics are defined as 'repeating chains (polymers) of carbon-based compounds (monomers) that, when linked together, form a stable, solid shape that can easily be moulded or formed using heat and/or pressure' [17]. Plastics are synthetic or semi-synthetic polymeric materials, sometimes resinous, with high molecular weights produced through the industrial polymerization of simple organic monomers in either linear or cross-linked forms. They can be classified into thermoplastics and thermosetting plastics (thermosets) based on their manufacturing processes and the properties of the final products [18] .

Plastic Pollution: This refers to the accumulation of synthetic plastic waste materials in the environment (Encyclopaedia Britannica.com). It is the accumulation of plastic particles and objects in the Earth's environment that adversely affect humans, wildlife and wildlife habitat [19]. Plastics that act as pollutants are classified by size into microplastics, nano-plastics, meso-plastics and mesoplastic [20].

Microplastic: Microplastics are small plastic fragments less than five millimeters long, which can be harmful to our oceans and aquatic life [21]. Plastic has been recognized as the most common form of marine debris in the Great Lakes and the ocean. The term "microplastics" refers to plastic particles under five millimeters in size, and they come in various shapes and sizes [21]. One of the many sources of microplastics is bigger plastic waste that breaks down into ever-tinier fragments. Furthermore, microbeads, a subset of microplastics, are small fragments of synthetic polyethene plastic used as exfoliants in cosmetics and beauty products, such as some cleansers and toothpastes. Aquatic life may be at risk from these microscopic particles, which can readily evade water filtering systems and find their way into the ocean and the Great Lakes.

Nano-plastic: These are formed by the degradation of microplastics into minute particles characterized by their size of less than one microgram. Both micro- and nano-plastics pose unique environmental and health challenges due to their minute scale and increased potential for bioavailability. These microscopic particles, whether formed from the breakdown of larger plastics or intentionally manufactured, are pervasive and persistent [22].

Plastic waste management in Lagos State. The Lagos State government is responsible for managing its waste, including plastic waste. Nonetheless, the suggestions and input of various stakeholders, including environmentalists, are required for effective waste management. Thus, according to the administrative structure, the Lagos State Ministry of Environment delegated responsibility for waste collection, transportation,

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and disposal to the Lagos State Waste Management Authority [LAWMA] to achieve the goals of environmental sustainability and sanitation in Lagos State. LAWMA has provided commendable services in meeting these objectives. Still, their services are grossly inadequate as waste generation rises daily due to population growth, urbanisation, and industrialisation [23]. Population growth rates, size, and density have a significant impact on waste generation and management in the state. The municipal solid waste characterisation conducted by LAWMA in 2016 shows that plastic waste accounted for nearly a quarter of the total waste collected and was the predominant type of inorganic waste [24]. This trend has persisted consistently since 2016 [25]. Lagos State's extensive coastline and waterways are especially vulnerable to plastic pollution, which worsens environmental issues. Inadequate waste management systems in Lagos and high population density contribute to the State's plastic pollution problem. This pollution poses serious risks to local ecosystems, public health, and the economy. The increase in human population and the consistent demand for plastics and plastic products are responsible for the continuous growth in plastic production, the generation of plastic waste, and the accompanying environmental pollution [26].

To address this escalating problem, the Lagos State Environmental Protection Agency [LASEPA) and the Lagos Waste Management Authority [LAWMA] have implemented several initiatives aimed at tackling the growing environmental issue of plastic waste, including environmental education, advocacy, and awareness campaigns [LASEPA and LAWMA, 2022]. These efforts have shown limited effectiveness as the scope of environmental problems caused by plastic waste continues to expand. Moreover, the use of plastic bags and other single-use plastic products such as food packs, spoons, cups, straws, and similar items contributes significantly to Lagos state's plastic waste challenge [27]. It can be inferred that plastic waste derived from polyethylene would more than double the total municipal waste in tonnes if sustainable management strategies are not urgently adopted [24]. It must also be noted that residents' daily habits of dumping, discarding, or improperly disposing of plastic waste into the environment exacerbate plastic pollution, especially during the rainy season, due to Lagos's unique atmospheric and meteorological conditions. It cannot be overstated that indiscriminately discarded plastic in the environment worsens the environmental problem, leading to street littering, blocked drainage systems, and polluted waterways. The situation becomes more complicated as the Lagos government's waste disposal system, including the blue recyclable bins intended for plastic waste separation and sorting, is limited. Residents are required to purchase these bins individually from LAWMA at high prices ranging from 30,000 to 40,000 Naira, without regard to the disposable income of the average Lagos resident [Lawmabin.com, 2022]. Consequently, this has hindered efficient plastic waste management, prompting some residents to find alternative methods of disposal, such as using plastic sacs and bags instead of dedicated bins. Furthermore, to combat plastic waste pollution, PUNCH Online reported that in January 2024, the state government imposed a ban on the use of Styrofoam and other single-use plastics [SUPs] for packaging across all government establishments and throughout the metropolis, in response to the increasing prevalence of plastic waste and its adverse environmental impact in recent years [28].

The widespread use of plastics, inadequate waste management, and casual community attitudes towards proper disposal present a significant environmental threat [13]. The buildup of plastic waste also poses health risks to the population, as it can attract disease-carrying insects and rodents. Land-based plastics leaking into the marine environment break down into microplastics and can negatively impact human health through the consumption of contaminated seafood. Likewise, large quantities of plastic waste can affect ecosystems through soil pollution (via landfilling), marine pollution (via ocean dumping), and air pollution caused by open dumping and burning [15], [16].

In addition to the government agency – LAWMA, plastic waste is also managed by unregistered individuals who scavenge plastic materials from household bins, dump sites, and event venues where these used plastics are carelessly discarded. The scavenged plastics are then sold to recyclers, providing a source of income for these scavengers. Improving plastic waste management strategies is crucial for tackling the issue of plastic pollution and the related health and ecological risks within the State.

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Plastic disposal methods: The main issue of plastic waste management and its pollution has been emphasised due to the widespread use of plastics for various purposes, including agriculture, industry, transportation, and packaging in both urban and rural areas. The most common methods of disposing of plastics are recycling, incineration, and landfill; each of these methods impacts health and the environment to different degrees.

Recycling: Recycling involves collecting and processing materials that would otherwise be discarded as rubbish and transforming them into new products. It is regarded as the most effective option in the solid waste management hierarchy for reducing the impact of post-consumer plastic packaging waste at the end of its use and lifecycle. Recycling is a vital and accessible practice within the plastics industry, helping to reduce the environmental impact of plastics. Only a small percentage of plastics [9%] are recycled [4]. Recycling can decrease the amount of waste that needs disposal, as well as lower carbon dioxide [CO2] emissions and oil consumption. Using recovered plastics from recycling enables the creation of new products. Since plastic does not decompose easily, recycling means it remains plastic but can be repurposed for entirely different uses [19].

Disposal in landfills: A landfill refers to a designated location where discarded plastics are stored before being buried beneath the earth's surface. The purpose of the landfill arrangement is to provide a safer area for the disposal of plastic waste, thereby safeguarding the environment in all its forms. Achieving these goals requires significant effort from the community, including digging deep holes, dumping waste into them, filling them, and allowing the waste to decompose. The disadvantage of disposing of plastics in landfills is that they occupy space that could be used for more valuable purposes, such as agriculture [29]. The problem is exacerbated by the fact that most plastics only degrade to a limited extent, meaning the contaminated land may remain inaccessible for a long time. Research has shown that landfills in the Lagos metropolis are unmanaged and do not meet international standards for similar operations elsewhere [30]. This noncompliance results in a proliferation of insects and rodents, leading to litter blowing around, which causes unpleasant odours and general environmental degradation. These negative impacts can only be minimized through pragmatic design and proper management of landfills in urban and peri-urban areas [30]

Incineration: Incineration of plastic waste refers to the complete combustion of plastics, resulting in water and carbon dioxide [CO_2] [31]. Due to a lack of space or dumping sites, small and underdeveloped countries prefer incineration or open burning to reduce the mass and volume of plastics. Nonetheless, these processes emit a significant amount of greenhouse gases [GHGs], including carbon dioxide, nitrous oxides, and various types of toxic gases into the environment. [32]. Burning is the most harmful method for managing plastic waste, as it transforms one form of pollution into others, such as air emissions, toxic ash, and wastewater. Incineration releases hazardous substances like dioxins, furans, lead, mercury, acid gases, and particulate matter. Workers and nearby communities, often low-income groups, face the most significant health risks associated with toxic air emissions, ash, and wastewater [33].

This study was underpinned by the Waste Management Theory [WMT].

The WMT was founded in 2004 by three scholars: Eva Pongracz, Paul Phillips and Rita Keiski. The theory was based on the expectation that waste management aims to prevent waste from harming human health and the environment. It was based on the hypothesis that 'the way we describe a target prescribes action upon it, which implies that sustainable management depends greatly upon how waste is defined' [34]. This theory emphasizes that the proper definition of waste is crucial to constructing a sustainable agenda of waste management. The Waste Management Theory [WMT] is based on the idea that how a target is defined dictates how it would be treated or acted upon, suggesting that the definition of waste [including plastic waste] significantly impacts its sustainable management. One of the most important factors in the sustainable management and processing of waste is the understanding that it harms both people and the environment. This fact highlights the importance of the Waste Management Theory in this study on assessing the health and ecological risks of plastic waste on residents. If used plastics are regarded as valuable and reusable materials, they would not be discarded haphazardly, which would help address the problem of plastic pollution, a issue that has become global.

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Plastic pollution and health : The World Health Organization in 2005 defined health as: "A state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." Health is only achievable where resources are available to meet human needs and where the living and working environment is protected from life-threatening and health-threatening pollutants, pathogens, and physical hazards.

Burning plastics releases dioxins and furans, which are highly toxic to human health, causing hazards such as neurological damage, growth defects, and disruptions to the reproductive, immune, and respiratory systems [35], [36]. Soot, ash, and other toxic compounds are released when plastics are burned in incinerators. Rainfall can cause some of these harmful compounds to sink into the soil, contaminate groundwater, or be absorbed by plants, which can then be incorporated into the food chain. The consumption of contaminated water or food ultimately poses risks to human health [37], [38], [22]. Plastic pollutants in air emissions, water, and residues can enter the human body through breathing harmful air, drinking polluted water, consuming food grown in contaminated soil, or eating contaminated fish, meat, or dairy products ,as noted by the Centers for Disease Control and Prevention [CDC] in 2019. Primary studies have demonstrated adverse health outcomes in populations near waste incinerators, including cancers and reproductive dysfunctions [39], [40]. Moreover, plastic debris can act as vectors, transporting pollutants in aquatic environments and exacerbating the spread of contaminants and their impacts on marine life [41], [42]. A recent study has shown that plastic polymers and their chemical additives, especially di-2-ethylhexylphthalate [DEHP] contribute to cardiovascular diseases and mortality [43].

Plastic Pollution and the Environment: Plastics contain harmful pollutants that can cause significant environmental damage through water, land, and air pollution. Since plastic is non-biodegradable, it can have devastating effects on the natural environment, leading to long-term consequences for animals, plants, and humans [44].

Plastic waste has a significant impact on the environment in numerous ways. The indiscriminate disposal of plastic and plastic products can cause pollution, evident in the deterioration of natural beauty, entanglement, and the death of aquatic organisms. Innovation in post-use plastic items could help address this issue [45]. Sewage system blockages in towns and cities, particularly in developing countries, also pose significant problems [46]. Plastic waste also creates environments conducive to breeding mosquitoes and other disease vectors, while emitting foul odour, especially near dump sites. Furthermore, plastic waste adversely affects soil aeration and water absorption, thereby reducing soil fertility and negatively impacting plant growth and yields [46]. The leakage of plastic waste into land and water ecosystems is happening at an unprecedented pace, creating serious challenges for waste management in growing populations, especially in developing countries [8]. Therefore, the ecological impact of plastic waste can be seen in the following areas:

Land pollution: Plastic pollution poses a significant threat to the survival of plants and animals, including humans, who live on land [47]. Most discarded plastic is neither recycled nor incinerated in waste-to-energy facilities; most of it is dumped in landfills, where it may take up to 1000 years to degrade, leaching potentially toxic substances into the soil and water [47]. Animals on land are also at risk from tiny plastic particles, which can have detrimental impacts comparable to or worse than those in the oceans. Scientists warn that microplastics in freshwater, sediments, and soils may negatively affect terrestrial ecosystems worldwide [47]. Agricultural land is also subjected to more significant pollution from plastic contaminants [48]. According to the Food and Agriculture Organization [FAO].approximately 12.5 million tons of plastic are used in agriculture yearly, while 37.3 million tons are used in food packaging [49]. The concern here is pollution by microplastics, which pose the most significant risk to human health, given their ability to enter the food chain through contamination of soil, air, and water basins [49]. Microplastics in the soil and plastic debris can hinder plants' ability to absorb nutrients. Animals and plants get vital minerals, food, and resources from healthy soil. Plastic pollution impacts all living things and the ecosystems. The ability of the soil to sustain plant and animal life is diminished if the conditions that promote soil fertility are not preserved [48].

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Drainage clogging and flooding: Obstructing drainage systems with waste debris, especially plastics and other bulky materials that are highly floatable due to their shape and density, increases the risk of flooding. Plastic tends to clog more quickly than organic materials, significantly raising flood risks in areas where such rubbish is common and poorly managed. During the dry season, plastic litter accumulates in drainage channels when water flow is minimal. These can be easily mobilized during subsequent rainstorms, which hinder water drainage at bottleneck points and cause sudden rises in water levels [50]. Due to its remarkable persistence in the environment, plastic waste in water systems poses a serious threat to our ecosystem. Besides reducing plastic pollution in the oceans, removing waste from rivers is vital for addressing social issues such as flood risks. The accumulation of plastic debris at trash racks can raise water levels upstream and increase cities' susceptibility to flooding [51].

Effect on biodiversity**:** Plastic debris harm biodiversity through physical, chemical, and biological impacts [52]. Due to plastic ingestion by wildlife: ecosystems with diversity are more robust and adaptable. Every species has a distinct function, and any loss can harm or disrupt these. A healthy ecosystem cannot survive without this diverse array of plants, animals, and microbes. One of the main causes of biodiversity loss is the manufacture, consumption, and disposal of plastic. Most plastics follow a linear system: ‘take, make, trash’. This system endangers biodiversity by harming species, polluting natural ecosystems, and exacerbating climate change. Smaller plastic particles contaminate soil, air, and water basins, while larger plastic materials, such as fishing nets and bags, can entrap aquatic animals, causing injury or death. Other animals may also mistakenly ingest plastics, which can block their digestive systems. The accumulation of plastics in natural environments can render them uninhabitable for native species, potentially displacing these species and causing an imbalance in the ecosystem. [53], [54].

Climate change issues: Traditional methods of plastic management mainly involve open dumping, landfilling, incineration, and similar practices, which ultimately lead to environmental pollution rather than achieving sustainable waste management goals. The harmful effects of plastic waste have become a global concern, as they are linked to global warming and climate change through the release of toxic gases and pollutants into the environment. The rising amount of plastic waste not only reduces soil fertility and contaminates groundwater but also causes serious damage to surrounding ecosystems and marine environments [32].

Challenges to effective plastic waste management – enabling factors: Several factors directly or indirectly contribute to plastic waste pollution in society. These include, but are not limited to:

Easy Accessibility**:** The widespread availability of plastics is a key factor to consider when addressing plastic pollution. Plastics are inexpensive to produce and durable, making them a popular choice for packaging and storage. Most plastics are single-use, following a linear ‘take-make-dispose’ pattern. Therefore, adopting a circular economy approach that promotes recycling and reuse is a positive step towards reducing plastic pollution, as it prolongs the life of plastic products and consequently decreases pollution [55].

Uncontrolled plastic production**:** The production of plastics has become unavoidable in modern life, as these materials—cheap, lightweight, and durable—have replaced more traditional packaging materials in various sectors, including agriculture, engineering, and transportation. Unfortunately, maintaining effective control over their production poses a significant challenge, as it impacts the private businesses of individuals. Dumbili and Henderson [56] suggested that the growing production of single-use plastics and the uncontrolled release of this plastic debris into land and marine ecosystems are contributing to plastic pollution.

METHODOLOGY

Study design: This study was designed as a cross-sectional survey, and the sample frame consists of adults residing in Lagos State, regardless of their social or economic standing in society, provided they are 18 years of age or above.

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Sample size: From a population of 15,500,000 [as estimated by the state's Bureau of Statistics in 2024], a sample size of 385 was targeted, with a 95% confidence interval, a 0.05% margin of error, and a 50% proportion exhibiting the required attributes for the study. The sample size was calculated using Raosoft sample size calculator. 380 duly completed and valid questionnaires were returned and used for this study.

Data collection: A structured questionnaire was used as the instrument for data collection. The questionnaire was carefully structured to gather comprehensive data aligned with the study objectives. The information collected through the questionnaire covered the following key areas:

a) Demographic Data: Including age, gender, marital status, level of education, and employment status,

b) Plastic pollution and health risks: Assessing respondents' knowledge of possible health risks associated with plastic waste pollution.

c) Plastic pollution and ecological risks: Analyzing how improperly disposed of plastic waste can impact the aesthetics and environmental conditions of the state.

d) Factors enabling plastic pollution: Assessing the challenges in managing plastic waste pollution and the contributing factors.

Question response format.: Some of the questions were closed-ended. However, a few open-ended questions were included to verify respondents' reactions to some of the closed-ended questions and to gather more data to confirm their understanding of the subject matter. Some of the response options, however, were presented on a 5-point Likert scale [Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree]. The questionnaires were distributed electronically for ease of collection and collation. 380 questionnaires were duly completed and returned. These were considered valid for the study.

Data analysis: Data obtained from the questionnaires were analysed using Statistical Package for Social Sciences [SPSS], version 27.0. Descriptive statistics was deployed and results were expressed in frequencies and percentages. Associations between :demographic information and knowledge of plastic waste pollution, demographic information and public health risks as well as , demographic information and ecological risks , were all determined $P<0.05$ was deemed to indicate statistical significance.

Ethical considerations: The objective of the study was clearly stated on the questionnaire, participation was voluntary. Identifying indices like name, phone number and email or home addresses were not required, in order to ensure anonymity and confidentiality of respondents.

RESULTS AND DISCUSSION

Data obtained from the questionnaires are presented as percentages and frequencies, as shown below**:**

TABLE 1: Socio-demographic characteristics

	Frequency	**Percent**
AGE		
18-30 Years	85	22.3
31-45 Years	131	34.5
46-60 Years	134	35.3

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>60 Years	30	7.9
Total	380	100.0
GENDER		
Female	211	55.5
Male	169	44.5
Total	380	100.0
MARITAL STATUS		
Single	93	24.5
Married	265	69.7
Separated	9	2.4
Widowed	13	3.4
Total	380	100.0
HIGHEST LEVEL OF EDUCATION		
Primary	1	.3
Secondary	15	3.9
Technical	6	1.6
Tertiary	218	57.4
Postgraduate	140	36.8
Total	380	100.0
OCCUPATION		
Professional	91	23.9
Self employed	10	2.6
Semiskilled	58	15.3
Skilled	149	39.2
unemployed	20	5.3
unskilled	52	13.7
Total	380	100.0

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EMPLOYMENT STATUS		
Executive management	60	15.8
Junior staff	57	15.0
Pensioner	12	3.2
Self employed	93	24.5
Senior staff	140	36.8
Unemployed	18	4.7
Total	380	100.0

TABLE 2A: Plastic pollution and health risks

	Yes	**No**	**Not sure**
	Freq. (%)	**Freq. (%)**	**Freq. (%)**
Do you know that plastic wastes can cause pollution	373(98.2)	7(1.8)	0(0.0)
Do you know that plastic waste pollution is harmful to health	368(96.8)	12(3.2)	0(0.0)
Do you think that plastic wastes are properly disposed in Lagos state to ensure adequate health protection	43(11.3)	283(74.5)	54(14.2)
Do you think that enough plastic is being recycled to in Lagos state to prevent plastic waste pollution	58(15.3)	246(64.7)	76(20.0)

TABLE 2B: Plastic pollution and health risks

	SA	**A**	**U**	**D**	**SD**
	Freq. (%)	**Freq. (%)**	**Freq. (%)**	**Freq. (%)**	**Freq. (%)**
Indiscriminate dumping of plastic waste can attract disease vectors, which help in the spread of diseases	238(62.6)	121(31.8)	13(3.4)	3(.8)	5(1.3)
Do you believe that degradation products of plastics can contaminate underground water, which can cause harm to human beings in the state	222(58.4)	129(33.9)	23(6.1)	3(.8)	3(.8)

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Toxins released into the air by burning plastic waste at dumpsites can cause respiratory problems to residents in the dumpsite area	259(68.2)	111(29.2)	6(1.6)	1(.3)	3(.8)
Microplastics washed into the soil can contaminate the waterbed from which humans draw drinking water, and contaminated water is harmful to health	212(55.8)	124(32.6)	30(7.9)	5(1.3)	9(2.4)

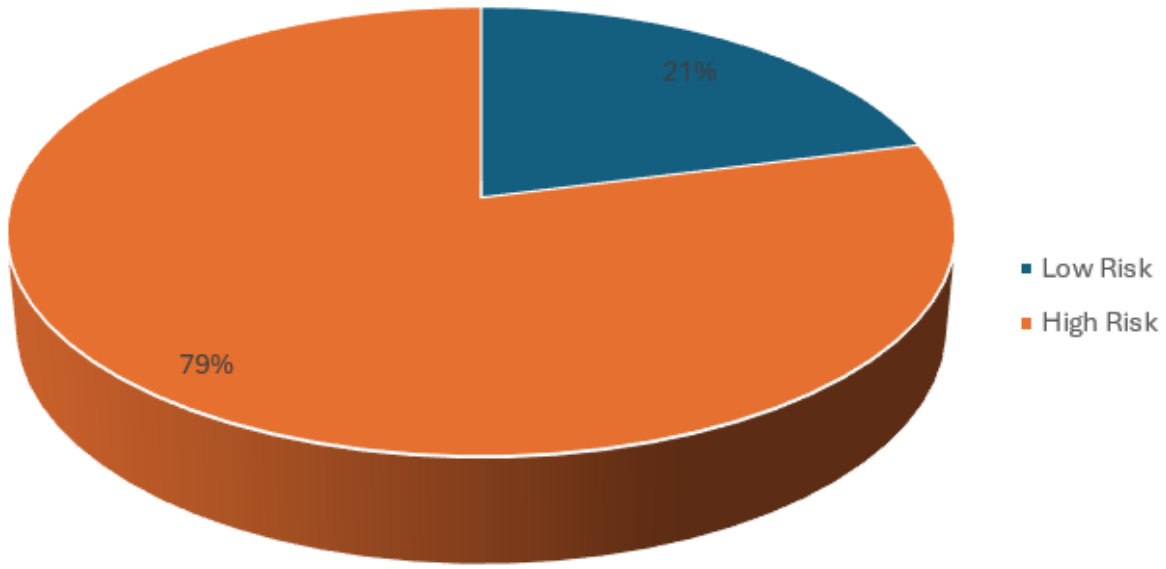

Fig 1: Plastic waste pollution and health risks

TABLE 3: Plastic pollution and ecological risks

	SA	**A**	**U**	**D**	**SD**
	Freq.(%)	**Freq.(%)**	**Freq.(%)**	**Freq.(%)**	**Freq.(%)**
Dumping plastic waste on the highways and street corners is disfiguring the landscape of Lagos metropolis	261(68.7)	107(28.2)	5(1.3)	1(.3)	6(1.6)
Plastic wastes that are washed into gutters can block drainage channels thereby causing flooding	320(84.2)	52(13.7)	2(.5)	2(.5)	4(1.1)
Plastic wastes washed into water ways, seas and oceans can entrap aquatic animals, causing their death and destabilizing the ecosystem	234(61.6)	120(31.6)	16(4.2)	6(1.6)	4(1.1)

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Toxic gases and other substances released by burning plastic waste can contribute to climate change and reduction of the ozone layer	206(54.2)	131(34.5)	28(7.4)	7(1.8)	8(2.1)
Ingestion of plastic particles by aquatic animals and wildlife can lead to their death, leading to disruption in biodiversity Abbreviations- SA=Strongly Agree, A=Agree, U=Undecided, D=Disagree, SD=Strongly Disagree	187(49.2)	146(38.4)	26(6.8)	12(3.2)	9(2.4)

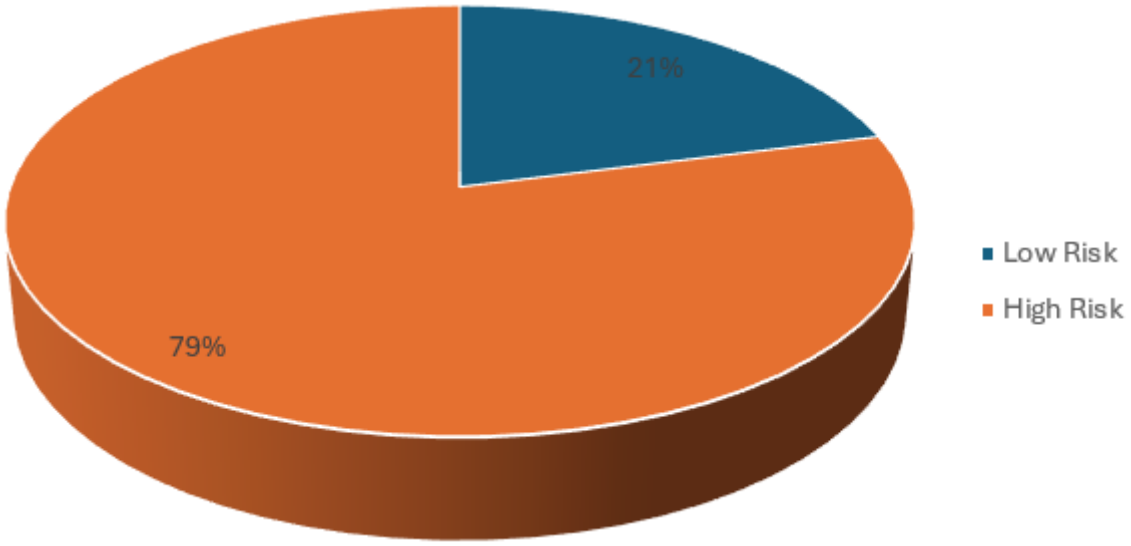

Fig 2: Plastic waste pollution and ecological risks

TABLE 4: Factors enabling plastic pollution

	Frequency	**Percent**
Factors enabling plastic waste pollution		
Easy access to plastic materials	23	6.1
Ineffective plastic waste disposal measures	92	24.2
Uncontrolled production of plastics	6	1.6
Weak implementation of plastic waste management regulations	61	16.1
All of the above	198	52.1

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Total	380	100.0
plastic waste pollution can be eradicated from Lagos state?		
Yes	246	64.7
No	39	10.3
Not sure	95	25.0
Total	380	100.0
Do you think that the government can regulate the production and proper disposal of used plastics to reduce plastic pollution		
Strongly agree	171	45.0
Agree	160	42.1
Neutral	27	7.1
Disagree	16	4.2
Strongly disagree	6	1.6
Total	380	100.0
There is a need for the government to strictly enforce plastic waste management strategies to avoid plastic pollution		
Strongly agree	228	60.0
Agree	135	35.5
Neutral	7	1.8
Disagree	4	1.1
Strongly disagree	6	1.6
Total	380	100.0

TABLE 5: Association between socio-demographic characteristics and Plastic pollution and health risks among the participants

	Plastic pollution and health risks			**Statistics**		
	Good n=327	**Poor n=53**	**Total n=380**	**x^2**	**df**	**pvalue**

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GENDER				.181	1	.670
Female	183(86.7)	28(13.3)	211(100.0)			
Male	144(85.2)	25(14.8)	169(100.0)			
AGE						
18-30 Years	65(76.5)	20(23.5)	85(100.0)	14.090	3	.003*
31-45 Years	110(84.0)	21(16.0)	131(100.0)			
46-60 Years	126(94.0)	8(6.0)	134(100.0)			
Above 60 Years	26(86.7)	4(13.3)	30(100.0)			
MARITAL STATUS						
Single	72(77.4)	21(22.6)	93(100.0)	8.775	3	.032*
Married	234(88.3)	31(11.7)	265(100.0)			
Separated	9(100.0)	0(0.0)	9(100.0)			
Widowed	12(92.3)	1(7.7)	13(100.0)			
HIGHEST LEVEL OF EDUCATION						
Primary	1(100.0)	0(0.0)	1(100.0)	10.104	4	.039*
Secondary	12(80.0)	3(20.0)	15(100.0)			
Technical	4(66.7)	2(33.3)	6(100.0)			
Tertiary	180(82.6)	38(17.4)	218(100.0)			
Post-tertiary	130(92.9)	10(7.1)	140(100.0)			
OCCUPATION						
Professional	82(90.1)	9(9.9)	91(100.0)	5.230	5	.388
Self employed	8(80.0)	2(20.0)	10(100.0)			
Skilled	122(81.9)	27(18.1)	149(100.0)			
Semiskilled	51(87.9)	7(12.1)	58(100.0)			
Unskilled	45(86.5)	7(13.5)	52(100.0)			
Unemployed	19(95.0)	1(5.0)	20(100.0)			

Note: * Means there is a statistically significant association difference at 0.05 ($p \leq 0.05$)

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The above table showed the association between socio-demographic characteristics and plastic pollution and health risks among the participants. There was a statistically significant association between age, marital status, and the highest level of education and plastic pollution and health risks among the participants at 0.05 ($p<0.05$) while other variables were insignificant at 0.05 ($p>0.05$).

TABLE 6: Association between socio-demographics characteristics and Plastic pollution and ecological risks among the participants

	Plastic pollution and ecological risks			**Statistics**		
	Good n=299	**Poor n=81**	**Total n=380**	**x^2**	**df**	**pvalue**
GENDER						
Female	168(79.6)	43(20.4)	211(100.0)	.248	1	.618
Male	131(77.5)	38(22.5)	169(100.0)			
AGE						
18-30 Years	58(68.2)	27(31.8)	85(100.0)	10.132	3	.017*
31-45 Years	101(77.1)	30(22.9)	131(100.0)			
46-60 Years	114(85.1)	20(14.9)	134(100.0)			
Above 60 Years	26(86.7)	4(13.3)	30(100.0)			
MARITAL STATUS						
Single	63(67.7)	30(32.3)	93(100.0)	8.941	3	.030*
Married	218(82.3)	47(17.7)	265(100.0)			
Separated	7(77.8)	2(22.2)	9(100.0)			
Widowed	11(84.6)	2(15.4)	13(100.0)			
HIGHEST LEVEL OF EDUCATION						
Primary	1(100.0)	0(0.0)	1(100.0)	9.297	4	.054*
Secondary	9(60.0)	6(40.0)	15(100.0)			
Technical	3(50.0)	3(50.0)	6(100.0)			
Tertiary	168(77.1)	50(22.9)	218(100.0)			
Post-tertiary	118(84.3)	22(15.7)	140(100.0)			
OCCUPATION						

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Professional	82(90.1)	9(9.9)	91(100.0)	24.544	5	.001*
Skilled	119(79.9)	30(20.1)	149(100.0)			
Semiskilled	41(70.7)	17(29.3)	58(100.0)			
unskilled	38(73.1)	14(26.9)	52(100.0)			
Self employed	3(30.0)	7(70.0)	10(100.0)			
unemployed	16(80.0)	4(20.0)	20(100.0)			

Note: * Means there is a statistically significant association difference at 0.05 ($p \leq 0.05$)

The above table showed the association between socio-demographic characteristics and plastic pollution and ecological risks among the participants. There was a statistically significant difference between age, marital status, highest level of education, occupational status and plastic pollution and ecological risks among the participants at 0.05 ($p<0.05$). At the same time, other variables were insignificant at 0.05 ($p>0.05$).

TABLE 7: Association between socio-demographic characteristics and Factors enabling plastic pollution among the participants

	Factors enabling plastic pollution			**Statistics**		
	Good n=302	**Poor n=78**	**Total n=380**	**x^2**	**df**	**pvalue**
GENDER						
Female	173(82.0)	38(18.0)	211(100.0)	1.842	1	.175
Male	129(76.3)	40(23.7)	169(100.0)			
AGE						
18-30 Years	64(75.3)	21(24.7)	85(100.0)	1.239	3	.744
31-45 Years	105(80.2)	26(19.8)	131(100.0)			
46-60 Years	109(81.3)	25(18.7)	134(100.0)			
Above 60 Years	24(80.0)	6(20.0)	30(100.0)			
MARITAL STATUS						
Single	72(77.4)	21(22.6)	93(100.0)	.441	3	.932
Married	213(80.4)	52(19.6)	265(100.0)			
Separated	7(77.8)	2(22.2)	9(100.0)			
Widowed	10(76.9)	3(23.1)	13(100.0)			

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HIGHEST LEVEL OF EDUCATION						
Primary	1(100.0)	0(0.0)	1(100.0)	.890	4	.926
Secondary	12(80.0)	3(20.0)	15(100.0)			
Technical	4(66.7)	2(33.3)	6(100.0)			
Tertiary	173(79.4)	45(20.6)	218(100.0)			
Post-tertiary	112(80.0)	28(20.0)	140(100.0)			
OCCUPATION						
Professional	82(90.1)	9(9.9)	91(100.0)	16.392	5	.006*
Skilled	121(81.2)	28(18.8)	149(100.0)			
Semiskilled	41(70.7)	17(29.3)	58(100.0)			
Unskilled	39(75.0)	13(25.0)	52(100.0)			
Self employed	5(50.0)	5(50.0)	10(100.0)			
Unemployed	14(70.0)	6(30.0)	20(100.0)			

Note: * Means there is a statistically significant association difference at 0.05 ($p \leq 0.05$)

The above table showed the association between socio-demographic characteristics and factors enabling plastic pollution among the participants. There was a statistically significant association between occupational status and factors enabling plastic pollution among the participants at 0.05 ($p<0.05$) while other variables were insignificant at 0.05 ($p>0.05$).

DISCUSSION

This study's results show that about 358 (94.2%) of the respondents are educated up to tertiary (n=218, 57.4%) and post-tertiary (n=140,36.8%) levels. The majority of the respondents (n=372, 98.2%) are knowledgeable about plastic wastes causing pollution in the state. This knowledge could be a result of their educational exposure.

The study results also showed an 86% possibility of health risks arising from plastic waste pollution, confirming the findings of studies from literature including: accumulation and circulation of micro and nano plastics in the blood stream [22], leaching of chemical constituents of plastic into the air, which causes respiratory hazards [35], chronic kidney disease, ulcers, low reproduction [38], and death due to cardiovascular diseases caused by exposure to plastic additives [43]. The high population density of Lagos State makes the residents prone to these health risks posed by plastic wastes pollution.

In the same vein, a 79% possibility of ecological risks from plastic wastes was recorded in this study. This also corroborates the findings of previous studies that plastic waste can lead to a variety of negative ecological consequences affecting both terrestrial and aquatic animals through ingestion and entangling [38], [48] Lagos State is a coastal state and accumulation of plastic waste in drainage channels can hinder water flow at drainage bottle neck points. During the rainy season this can cause a sudden rise in the water levels which can lead to flooding, as shown in another study [50].

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Many of the respondents [Table 4], believe that numerous factors contribute to the ongoing plastic waste pollution in the state, such as easy access to plastic materials, ineffective plastic waste disposal measures, uncontrolled production of plastics, weak implementation of waste management regulations, These factors account for approximately 52.1% of the elements enabling continued plastic waste pollution in the state. Many of these factors have already been identified in earlier studies, which noted that addressing them will minimize the negative health and ecological impact of plastic waste pollution [55], [56].

CONCLUSION

From the results of this study, it can be concluded that plastic waste pollution can pose significant health and ecological risks. The study also shows that:

Lagos state residents are quite knowledgeable about plastic waste pollution and its health and ecological risks.

Several factors have been identified as contributing to the continued plastic waste pollution in the state, including; easy access to plastics, ineffective plastic waste disposal measures, uncontrolled production of plastics and weak implementation of waste management regulations.

Health and ecological impacts of plastic waste can be minimized if certain measures are adopted.

These study findings are fundamental in safeguarding the health of Lagos residents as well as the ecosystems. It highlights the need for informed action by policy makers and stakeholders in the waste management sector, in terms of better policy formulation, enforcement, and improved infrastructure investments to mitigate plastic waste pollution in the State.

LIMITATIONS

Findings from this study cannot be generalised as it's focus was Lagos State only.

Other limiting factors to consider include:

selection bias and representativeness issues: since the questionnaire was shared electronically, residents in remote parts of the State and those without electronic gadgets would have been skewed out.

self reporting bias: Information used were as reported by the respondents themselves, and that could contain biased information**.**

However, due to the urban outlook of Lagos state, the population affected by these bias factors is quite minimal and does not affect the outcome of the study**.**

RECOMMENDATION

Following the findings in this study, and for health and ecological safety in the State, we recommend that**:**

Implementation of functional plastic waste disposal systems: There is a pressing need to implement a better plastic waste management system that focuses more on recycling to prolong the useful life cycle of already produced plastics.

Effective collaboration of relevant agencies: The government and other stakeholders should collaborate to promote eco-friendly alternatives to plastics especially as a packaging material.

Sustained enlightenment programs: Public enlightenment programs and events should be enhanced and sustained.

Policy formulation and enforcement: There should be better government policy formulation and strict enforcement in the plastic waste management sector.

SUGGESTIONS FOR FURTHER STUSDIES

Similar studies should be conducted in other states in Nigeria especially in the urban areas**.**

Further studies should assess the effectiveness of plastic waste disposal methods in the State.

Periodic repetition of this cross-sectional study is also suggested to assess temporal trends and to validate findings.

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