

Public Health Knowledge and Perception of Microplastics Pollution: Lessons from the Lagos Lagoon

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Research Article

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Abstract

Background: The magnitude of ocean plastic debris is forecast to triple within the next decade due to a number of factors such as increased plastic demands and production, inadequate waste disposal and management, unhealthy lifestyle and poor knowledge on the health impact of plastic waste among several others, all of which could be exacerbated by COVID-19 and climate change and cause humanity to face a disaster for ocean health in less than 20 years. Hence, microplastic pollution is globally flagged as one of the biggest threats to biodiversity in recent time as they are found nearly everywhere in the environment. While, the world confronts the plastic problem and transitions towards a circular system, turning the ubiquitous plastic loads around requires both momentum and careful navigation. So far, if the burning of plastics and the accumulation of the materials in oceans and landfill is to be reduced, the industry cannot continue to manufacture plastics at the current rate.

Objectives: This paper explores public health knowledge and perception of microplastics pollution

Methods: Data analysis was carried out using the Statistical Package for Social Sciences (SPSS version 20.0) and a significance difference was established at 5% with $p < 0.05$ considered to be statistically significant.

Results: The result reveals that out of the 102 respondents that participated in the study, 59 respondents representing 57.8% were aware of microplastic pollution. Nonetheless, a significant association between awareness of microplastic pollution and the category of workers ($p = 0.004$, $p < 0.05$) was observed. The mean score on knowledge of microplastic is less than the expected weighted mean of 3.00 for 5 points rating scale which implies that the respondents have poor knowledge of microplastic pollution though they show better knowledge of the serious global problem of microplastic pollution than other knowledge items. Result also indicates that the mean score on perception is greater than 3.00 (3.32) which indicates that the respondents have a good perception of microplastic pollution.

Conclusion: There is a need to strengthen advocacy coalition framework (ACF) communication and learning for the determination towards improving the opportunities to protect public interests, including a thorough review of all policy processes, with policy change. This will help highlight the learning importance and involving citizen stakeholder's participation through observing risk communication on environmental pollutants menace while advancing citizen risk perception, thus influencing risk perception on plastic pollution, as well as the citizens involvement in such environmental problems. Hence, research role as well as creating education awareness will help enlighten the development of policy on the dangers of plastic pollution.

Introduction

Microplastics are micron-size pieces of plastic, formed by combining chains of simple molecular building blocks and can have very different chemical compositions (polymer types) and morphology (such as fibers, fragments, or films). Their shape, size, and weight can further help us identify where the plastic particles may come from. Microplastics have reached most places of the planet, including the remote areas of the Ocean and Rivers, even in areas with little human activity, water masses transport microplastics that become part of the food web and threaten marine ecosystems. Pollution resulting from plastic has become a foremost menace to livelihoods, biodiversity, and public/environmental health, [as millions of megatonnes of the stuff](#) drifts into global waterways yearly. What seems amazing about plastic pollution is limited knowledge of its distribution. Plastics use up petroleum resources and persist in the environment and are spilling into natural environments at an overwhelming rate and they have become incredible, invaluable materials, cheap, lightweight and outrageously functional; a bunch of unique characteristics allowing them to flourish across economies around the world. Our food systems are responsible for a sizeable portion of this global plastic diet. Plastic wraps our meals and streamlines our cars. It transports sewage and delivers human blood. Beyond the packaging and the pill boxes, the bags and baby bottles, is a realm of invisible plastic: tiny fibers, fragments, as well as chemical byproducts that permeate every facet of everyday life. Floating correspondingly in the sunlight like pollen. It is found in seafood, salt, as well as in millions of wildlife and is contaminated by samples from tap water from around the globe. In fact three multinational food giants such as Coca-Cola, Pepsi and Nestlé reign supreme as [the world's top plastic polluters](#). Each year, over 300 million tons of plastic are crank out in company with other world's factories: That is the weight of 46 Great Pyramids of Giza per year. Above 40% of bags used for shopping, mass containers, and straws remain used once as well as discarded. These are 18 Great Pyramids pitched that are littered down the river. While, they are responsible for some of the most visible food system plastics; the crisp packets infused into soft sandy beaches, the chocolate wrappers clogging urban sanitation systems, the soda bottles bobbing gently along coastlines, carrying a scrawled message for future generations, there's more bad news, as evidence suggests a [third of fish in the water bodies contain microplastics](#). Despite Big Food's heroic contribution to plastic pollution, it's undeniably an issue at smaller scales, too, where trade-offs exist. The storage sacks used by farmers to safely preserve produce and prevent aflatoxins; the crates used by market traders to protect fruit; the floats and nets used by fisherfolk to support healthy diets and sustainable livelihoods; all provide benefits while simultaneously contributing to harmful pollution. So, while consumer food and drink plastics are obviously a huge issue, this is just part of the problem. Only by taking a food systems approach can we understand the widespread use of plastics across value chains, from 'farm to flush'. And only with this broader view can we understand the horizontal impacts of food system plastics for human health, the environment, and food security, both beneficial and harmful. Without this cross-cutting evidence base, efforts to rapidly remove or replace plastics could cause unforeseen problems. The unintended consequences of well-intended policies could do more harm than good.

With increased reliance on plastic for packaging coupled with the quest for durability of plastics, global plastic production will not only continue to increase but will also create an unpleasant and unhealthy environment for all if appropriate mitigation approaches are not painstakingly and inclusively implemented (Duis and Coors, 2016). About 8 million metric tons of plastics enter the oceans annually in various ways as industrial discharge, trash, or litter from inland waterways, wastewater outflows, as well as transport from winds or tides (Smith *et al*, 2018). Recently, there has been an increased awareness of microplastics and their potential health hazards among the global scientific community. Microplastics are generally described as plastic debris or synthetic polymer particles (< 5mm) found in marine environment worldwide with their distribution assuming a heterogeneous pattern (different molecules, diverse shapes, structures, sizes, colours as well as an assembly of sources) (Hartmann *et al*, 2019). When plastics find their way into the ocean, the degradation rate

as well as plastics persistence varies depending on the polymer, density, shape as well as the plastic purpose itself (Eriksen *et al.*, 2014). Plastics otherwise larger than 5mm are macroplastics. Microplastics may originate from a variety of sources but when they are ingested by aquatic organism, their bio-accumulation or bio-magnification may distort the food chain and hence, affect the survival of the organism involved. Due to the persistence and vast mobility, microplastics are widely found in the marine milieu. Due to their low size, they can easily be consumed by the diversity of biological species oscillating from protozoans toward other marine mammals. Their uptake or bioaccumulation may depend on properties, for instance, shape, size, intensify as well as colour (Lusher *et al.*, 2017). The damaging social, economic and environmental consequences of these businesses seep uncontrollably into the built and natural world via the conduit of increasingly unhealthy and unsustainable consumption patterns. Even efficient and well-funded recycling systems in high-income economies cannot keep up with the volume, hence much of this 'recycling' has been shipped to poorer countries where waste management systems can often barely manage domestic flows. [Estimates from The Gambia](#) indicate that some systems capture just 10% of waste, with toxic open burning of plastics inevitably commonplace. As so often is the case, the global poor are disproportionately affected but also highly industrious around this issue. In South Africa for instance, informal waste pickers largely working in unsafe and unhygienic conditions are the true environmental stewards, plugging a waste management gap and [recovering 80-90%](#) of the country's used packaging and paper. Unsurprisingly, this unsustainable state of affairs has led to a long-overdue global outcry. Nigeria like every other nation is not left out in the global issue of plastic pollution on water bodies (Ebere *et al.*, 2019), as this is evident in a publication by Jambeck *et al.*, (2015) that stated Nigeria is ranked globally as the 9th largest source of plastic pollution in the ocean after some Asia countries and Egypt, this is due to the nation's poor waste management culture, thereby exposing the water bodies to both microplastic and macroplastic debris. Evidences of microplastic pollution in Nigeria has been reportedly found in the freshwater gastropods of River Osun (a major river that drains into the lagoon) (Akindele, Ehlers, and Koop, 2019), and some major rivers in the South-Eastern part of the country (Ebere *et al.*, 2019). Given these concerns and how more sustainable plastics might be created has become one of the biggest and most urgent questions in environmental chemistry today, both researchers from many branches of the field and policymakers are now working on ways to reduce plastics waste and to improve the chances that it can be recycled. Thus, this study is poised to evaluate public knowledge and perception about microplastic pollution and its effects in Lagos, Nigeria with a view to creating an implementation action plan that is focuses on prevention as well as microplastic pollution mitigation.

Significance of the Study

This study also adds to the knowledge of how the greater population segment comprehends microplastic pollution sources as well as what could be done toward reducing its destructive effects. The results of the study provide the potential for giving decision-makers additional policy knowledge toward formulating and developing regulatory policies for consumers geared in the direction of environmental as well as ecosystem protection. New innovative pollution control protocols may well lead to cleaner as well as better drinking supplies of water in Lagos Lagoon (Raimi *et al.*, 2017; Premoboere & Raimi, 2018; Olalekan *et al.*, 2018; Raimi, 2019; Henry *et al.*, 2019; Raimi *et al.*, 2019; Olalekan *et al.*, 2019; Raimi *et al.*, 2019; Suleiman *et al.*, 2019; Gift & Olalekan, 2020; Olalekan *et al.*, 2020; Gift *et al.*, 2020). Zellner *et al.*, (2008) stated that a better comprehending of the dynamics of environmental stress factors (like plastic pollution) is required toward addressing policies regarding the location as well as the strength of urban activities. Eventually, the sustainability as well as local communities' growth at large, particularly in urban areas, will have a significant impact on the quality of environmental policies. The study results will have a significant positive impact on social change by raising public awareness of the phenomenon of microplastic pollution as well as help stakeholders and development partners collaborate toward creating a sustainable and collaborative urban environment (Olalekan *et al.*, 2019). According to Romero-Lankao *et al.* (2016), examining the ecosystem interaction as well as the social dynamics can increase knowledge about how population growth can survive or improve in a degrading ecosystem. Expectantly, the study results should increase knowledge about the risk of perceived impact of plastic pollutants on food vulnerability as well as supplies of water, while increasing the usage of plastic products in contemporary societies.

Literature Review

Recently, anthropogenic (human-induced) debris of plastic pollutants has increased the pollution of the aquatic milieu. This environmental degradation level is a result of the increased usage of plastic products. Mason *et al.*, (2010), McCormick *et al.*, (2014), and Baldwin *et al.*, (2016) found that plastics breakdown in its microplastic form (less than 5 mm in diameter) constitutes the core danger toward water pollution. A significant stage toward plastic pollution mitigating of the aquatic milieu is toward increasing public awareness of how pollutants enter the waterways. One of the challenges in finding solutions to microplastic pollution is the possible conflict of interests between varied stakeholders with a keen curiosity about plastic products. Plastics are everywhere: in the atmosphere around you, it is currently the most enduring, insidious, as well as friendly product in the universe as well as have become a vital component of practically every technology today. Though their production activities consume substantial feedstock resources, plastics are principally disposed of after their service life.

Plastics are a staple ingredient in product design and manufacture, and their use, especially as single-use items such as water bottles and food wrappings, is expanding. The total weight of plastics produced per year currently stands at more than 380 million tonnes and is set to top 900 million tonnes by 2050. But, like the fossil fuels from which they are made, plastics can have negative environmental consequences. By 2050, an estimated 12 billion tonnes of plastic waste will be sitting in landfills or polluting the natural environment. For comparison, this number stood at around 4.9 billion tonnes in 2015. Used plastics also form a large proportion of the fuel fed into energy-generating waste incinerators, which are a source of carbon emissions. Documentary films such as those narrated by David Attenborough have drawn attention to the environmental hazards posed by waste plastics. Footage of discarded water bottles suffocating marine life has also helped to trigger a public outcry and propelled plastics pollution up global agendas. Although many plastics now carry the recycling symbol, in practice plastics recycling is crude and energy-intensive.

Plastics recycled are much of lesser quality; they pose lower strength, than recently manufactured plastics. Progressively, consumers consume products made with biodegradable plastics, extracted through plant sources or spiked through oxygen as well as other chemicals toward allowing them to decompose in the milieu. However, this is complicating recycling efforts, because biodegradable plastics have a detrimental effect on the quality of recycled plastics, and there is no reliable way for recycling plants to separate these plastics from other forms. "Now it is evident that this plastic is coming back to us through our food

chain. Now we see it is coming back to us through our drinking water. Do we have a way out?" This previously unknown contamination defies wealth and geography: Studies have shown that, people who drink two liters of water per day, or beverages such as tea, coffee, as well as soda, might likely ingest roughly eight (8) plastic fibers, in excess of 2,900 yearly. Hence, Invisible plastic is inside our bodies. Inside our babies. Thus, the problem is that plastic dominates our world. While we keep making more, and we keep disposing of it badly. The findings come as polls indicate hefty distrust in the safety of drinking water by consumers around the world, and as microplastic pollution is gaining prominence among the public and policymakers. While, scientists and researchers suspect that toxins from plastics can enter the body of a human. In animal studies, "it became clear very early on that the plastic would release those chemicals and that actually, the conditions in the gut would facilitate really quite rapid release." This ample evidence suggests that plastic qualifies as hazardous waste, and that it's a threat to wildlife. Used chemicals in plastic have remained associated with some illnesses, together with cancer.

Plastic fibers join a disturbing list of pollutants threatening the world's water supplies, including [endocrine-disrupting chemicals](#). But governments haven't examined what plastic in drinking water, food, and the air might mean for human wellness. "There are various routes that one could be exposed to plastics or plastics-associated chemicals." "The main route would be through food or water." "What we don't know is what implication that might have for human health." The only concession acceptable with plastics is that they breaks down into tiny particles of microscopic size, a pollutant that tends to last for thousands of years. It is this perniciousness, and ubiquity, that has led some experts to view plastic pollution as a challenge on par with that of climate change (Raimi *et al.*, 2018; Raimi, 2019; Morufu *et al.*, 2021). Researchers approximate that trillions of plastic pieces are stuck in the melting Arctic icecap, as well as another trillion more are floating on the surface of the ocean. Although the dimensions of less-buoyant plastic hiding under the waves were unidentified, a survey conducted in 2015 discovered plastic in the intestines of 28% of fish in the Indonesian market. While, in California, 25% of fish as well as 33% of mollusks sampled contained plastics. Scientists at Cornell University collected atmospheric microplastic data from the western U.S. from December 2017 to January 2019, it was discovered that 84% of the microscopic shards originated from road dust, approximately 11% came from atmospheric sea spray as well as 5% came from agricultural soil dust. The scientists emphasized that this 11% from sea spray is especially shocking. The scientists discovered action of oceanic activities grinds ocean plastic waste into micron-size particles, where wind formerly transports **microplastics** into the atmosphere, hence **polluting our air**. As **atmospheric** pollution resulting from car tyres could remain up to 1,000 times worse than from an exhaust, including sawmill related activities (Raimi *et al.*, 2018; Raimi *et al.*, 2020; Morufu *et al.*, 2021). **Thus**, it's astonishing that this much plastic is in the air at such level, as well as regrettably accumulating in the oceans and on land as well as recirculating and moving all over the place, including remote places. Microplastics are as dense in some Great Lakes waters and tangled inside Great Lakes fish as in the oceans. Lake Victoria, in east Africa, also has plastic suspended in its waters. Particles and fibers of polyethylene, polyurethane, polyester, and silicone rubber were found inside 20 percent of Lake Victoria fish in a recent study. "It's not just that you're exposed to plastic," from the instant a child is born these days, it has also remained exposed to about 300 synthetic chemicals. Whatever human health side effects an individual will experience as one get older, to find out what the ultimate origin of these is, there is no means of teasing it out." Hence, a [current article](#) published in the journal of Lancet Diabetes & Endocrinology projected that endocrine-disruptors could cost the U.S. about \$340 billion or 2.33% of gross domestic product, in 2010 over factors such as the intellectual disabilities of above 43,000 children exposed toward these chemicals; 33,000 cases of juvenile obesity; as well as 3,600 cases of testicular cancer. They cost the European Union \$217 billion, or 1.28 percent of GDP. While, plastic is fantastic at preserving food and drink, increasing fuel efficiency in cars, and saving lives and easing suffering in the form of sterile medical equipment. Plastic can also have a hard time keeping its chemicals to itself. "Since the problem of plastic was created exclusively by human beings through our indifference, it can be solved by human beings by paying attention to it,"

Annually, humans produce about 400 million tons of plastic globally and a remarkable percentage of this plastic is depleted in the milieu as litter (TUM, 2009). In 2010, approximately 4.8 - 12.7 million metric tons of plastic was reported to have entered into the ocean from the coastal countries (Jambeck *et al.*, 2015). Recent study posits that with the overwhelming sanitary consciousness due to COVID-19 safety guidelines, environment will now face more threat of plastic pollution as big companies that generates bulks of plastic waste relaxed their existing corporate environmental responsibilities and were unable to practice the 4R's of waste management (i.e. reduce, reuse, recycle, and recover) (Omoyajowo and Ogunyebi, 2020). In this report, companies that generate tremendous plastic waste were interviewed on their choices to reduce, reuse, recycle and recover plastics during COVID; majority agreed that the risk of COVID-19 spread hinders their chances of managing plastic waste in an environmental friendly way. Scholars have reasoned that these plastic materials could travel extended distances on ocean currents as well as resist biodegradation, breaking up into tiny and tiny "microplastic" pieces, which in turn allows them to accrue over time causing pollution and consequently hampering biodiversity (Law and Thompson, 2014; Geyer *et al.*, 2017; Premoboere & Raimi, 2018; Raimi, 2019; Olalekan *et al.*, 2019; Raimi *et al.*, 2019; Suleiman *et al.*, 2019; Okoyen *et al.*, 2020). However, public health knowledge about its degradation and human health impact especially how it rapidly breaks down into smaller particles called microplastic is gradually seeking global consensus. Microplastics are very small plastic particles generally less than 5 mm in size (TUM, 2009). They are found everywhere including air, soil, sediment, oceans, plants, animals and are usually formed from breakdown of larger pieces of plastics (WHO, 2019; Henderson & Green, 2020). Human anthropogenic activities such as microwaving food in plastic containers and the irresponsible disposal of plastic by-products (e.g., toys, cosmetics, grocery bags and candy wrappers), wear and tear of car tires, washing of microfiber clothing are some of the many ways microplastics could be formed. Studies have reported implicitly that increased public knowledge could lead to changes in behaviour (Steel *et al.*, 2005; McKinley & Fletcher, 2012). As human behaviour is well-thought-out to be a major marine litter source, meaning that changes in perceptions as well as behaviour is vital toward addressing litter in the natural milieu (Pahl *et al.*, 2017). Public health knowledge about microplastic pollution may be crucial in promoting sustainable healthy lifestyles or choices that people often as an effort towards preventing pollution threats, overexploitation, habitat destruction as well as climate change that could possibly be caused by microplastics (Raimi *et al.*, 2018; Suleiman *et al.*, 2019; Ebuete *et al.*, 2019; Raimi *et al.*, 2019; Henderson and Green, 2020; Morufu *et al.*, 2021). Hence, sustainable management as well as policy from decision makers toward curbing the inhumane marine pollution and adequate public sensitization about microplastic pollution is a dire necessity (Raimi *et al.*, 2019; Omidiji & Raimi, 2019; Raimi *et al.*, 2020; Adedoyin *et al.*, 2020; Ajayi *et al.*, 2020). However, there is dearth of information on public health knowledge and microplastic pollution in Nigeria and Africa. Nonetheless, understanding public perception about microplastic pollution could equally help to mind the gap towards proper management of the marine environment especially in developing suitable priorities toward decreasing the influx of plastic waste into the ocean. For instance, a decrease in the usage of single use plastics along with design as well as manufacture through end of product life are environmentally sound interventions that has great and tremendous impact (UNEP, 2016). An earlier perception study on marine litter observed that majority of individuals

reported being displeased seeing litter from marine on each visit to the coast whereas manufacturing and retail stakeholders in the public were less concerned compared to other groups (Hartley, 2013). Few descriptive studies have been shown into public understandings of microplastics risks (Anderson *et al.*, 2016; GESAMP, 2015). Thus, the objectives of this study include: to determine the relationship among demographic variables and awareness of micro-plastic pollution; to determine the knowledge and perception about microplastics among the respondents.

Materials And Method

Research design

The research adopts a survey research design that is descriptive. The descriptive survey design is a type of research design in which researcher collects information from a cross section of the study population in relation to a target variable (Gift and Obindah, 2020). This model is considered relevant for the research since it requires data through a target group. The design includes collection as well as analyzing collected data. Funmilayo *et al.* (2019) defined the descriptive survey design as a form of design that would be used in a study involving the use of questionnaire to collect respondent's opinion (Funmilayo *et al.*, 2019). These scholars further added that the type of descriptive survey design is the most effective technique toward obtaining real facts as well as figures where analytical results are used for policy making or generalization. This type of research design is seen as relevant to this study, considering the main aim of this study's is to focus on primary objective centers by exploring public health knowledge as well as Lagos Lagoon perception on microplastics pollution. The choice of a descriptive survey design was premised on its value as well as facility in proffering research solution to the study problem raised.

Research Population

The population in this study refers to the average number of individuals who often utilize the aesthetic value of the Lagos lagoon on a daily basis. It is suffice to mention that research population may connote a large collection of individuals or objects having similar characteristics which could form the fulcrum of a scientific query. It is for the benefit of the population that researches are done. Gift & Obindah, (2020) opines that population of study signifies the entire class of people, object, events or elements to which generalizations are to be inferred. In all, a total of 120 questionnaires were administered and retrieved from students and residents around University of Lagos (UNILAG) community. UNILAG community includes well-known areas such as Akoka, Ilaje/Bariga, Oworonshoki and Ogudu who often utilize the aesthetic value of the Lagos lagoon. Thus, the population of this study comprised of one hundred and forty (140) consisting of government officials, academia, student, business personnel and other individuals (see table 1 below).

Table 1: Population Distribution

S/N	Government	Academia,	Students	Business	Others	Total
1.	29	16	61	21	13	140

Source: Author Compilation (2019)

Study Area

Location

Lagos, located in the South-Western part of Nigeria is the largest city in African continent. Based on the 2006 National Census, Lagos State has a population of 9,013,534. However, according to the New York Times publication of 7 January 2014, Lagos population is reported to be over 21 million, comprising of a very diverse population due to heavy migration from other parts of Nigeria and surrounding countries. The Yoruba are the dominant ethnic group. Lagos is Nigeria's major commercial centre and the megacity would be the fifth biggest economy in Africa, if it were a country (Ekundayo, 2013). The tremendous economic growth coupled with the rapidly growing population in Lagos has not only promoted consumption growth but have also led to a surge in domestic waste. This is exacerbated by poor waste management practice. Hence, allowing plastic wastes and other debris into the city's waterbodies. Lagos lagoon is a water body in the heart of Lagos metropolis; with a surface area of approximately 6,354.7 sq.km. It is more than 50 km long and 3 to 13 km wide (Badejo *et al.*, 2014). Moreover, it is separated from the Atlantic Ocean by a long sand spit and flanked by swampy margins on the side (Badejo *et al.*, 2014). The Lagos lagoon is fed by a number of rivers and empties into the Atlantic Ocean via Lagos Harbour. Notably among these rivers are the Ogun, Ona/Ibu, Oshun, Shasha and Oni. The lagoon is fairly shallow; hence, it is not plied by ocean-going ships, but rather by canoes and smaller boats. Lagos lagoon is an important water body of socio-economic importance as it provides Lagosians (inhabitants of Lagos metropolis) a means of livelihood and transport, places of abode and recreation, dumpsite for residential and industrial discharges, and a natural shock absorber to balance forces within the natural ecological system (Okusipe, 2000).

Population and sample size

The population for this study comprised of residents around the Lagos Lagoon. Lagos lagoon is a water body about 6354.708 sq.km in area and 285km in perimeter in the heart of the metropolis linking the Atlantic Ocean and Lekki lagoon providing places of abode and recreation, means of livelihood and transport, dumpsite for residential and industrial discharges and a natural shock absorber to balance forces within the natural ecological system (Okusipe, 2004).

Sample size

The sample size of 104 was estimated using Taro Yamane formula (1967) as shown below:

$$n = \frac{N}{1} + N(e)^2$$

n = Sample size to be determined, e = Level of significance and N = Population size.

$$n = \frac{N}{1} + N(e)^2$$

n = 140, e = 0.05

n = 140/1+140 (0.05)²

n = 140/1+140 (0.0025) = 140/1+0.35

n = 140/1.35 = 103.7037037

n = 104.

However, out of the one hundred and four (104) questionnaires distributed to participants, only one hundred and two (102) was found useable.

Sampling techniques

The study adopted a purposive simple random sampling technique in the selection of the sample. Basically, residents and students going out of their way to utilize the aesthetic value and local fishermen in search of a living on the Lagos lagoon coast were thoroughly sampled.

Research Instrument

The tool adopted for this study was according to Deng *et al.*, (2020) using simple random sampling. Basic information for the assessment was obtained from primary data collected with the aid of a pre-tested questionnaire. Guided dialogue was basically used to capture information on trends, awareness and perception towards microplastic pollution; as well as public attitude/life style towards plastic use. Likewise, translation of questionnaire to Yoruba language being the native language in study area was done for inclusivity. At the beginning of the questionnaire, we briefly introduced what microplastics are and their characteristics so that people who had not heard of them before could complete the questionnaire. In all, a total of 120 questionnaires were administered and retrieved from students and residents around University of Lagos (UNILAG) community. UNILAG community includes well-known areas such as Akoka, Ilaje/Bariga, Oworonshoki and Ogudu who often utilize the aesthetic value of the Lagos lagoon. All the areas are predominantly characterized by residential buildings lining the coastline, natural fish ponds, boat transport, fishing and sand mining activities. Ilaje/Bariga has surroundings littered by plastics cans, water sachets and debris. The questionnaire contains related to the socio-demographic information of respondents such as gender, age, education level, occupation, and marital status. The other section contains questions related to knowledge and perception of microplastic. Out of 120 questionnaires administered, 102 were counted valid for analysis.

Validity of instrument

The research instrument was submitted to experts for review validation. Copies of the questionnaire were given to experts in Environmental Health Science as well as expert in research as well as statistics (statistician). These experts rated the validity of the research instrument (questionnaire) in terms of clarity, language as well as content in line with the study purpose.

Methods of data analysis/Statistical Analysis

Data collected from questionnaires were rechecked to ensure quality assurance on Excel spreadsheet prior to analysis. All submission requests through the semi-structured as well as comprehensive questions remained summarized from all respondents via statistics that are analyzed qualitatively like simple percentages as well as frequency distribution remained used toward analyzing the demographics of the respondents as well as to answer the research questions. More so, other important analyzed results are presented by means of a graphical representation such as pie chart. To enhance data analysis as well as results computation, version 20.0 of the SPSS was used.

Results

Table 2: Demographics of the Respondents

Demographics variables	No. of Respondents	Percentage (%)
Categories of workers		
Government	19	18.6
Academia	9	8.8
Student	53	52.0
Business	13	12.7
Others	8	7.8
Total	102	100.0
Age (years)		
18-25 years	63	61.8
26-35 years	31	30.4
36-45 years	8	7.8
Total	102	100.0
Gender		
Male	62	60.8
Female	40	39.2
Total	102	100.0
Marital status		
Single	70	68.6
Married	26	25.5
Divorced	6	5.9
Total	102	100.0
Education		
PhD	12	11.8
Masters or equivalent	16	15.7
Bachelors or equivalent	34	33.3
OND/NCE	4	3.9
SSCE	34	33.3
Others	2	2.0

Source: Field Survey, 2021

Table 2 reveals that 18.6% of the respondents were government workers while 8.8%, 52.0%, 12.7% and 7.8% of the respondents belong to the academia, students, business and others. Result shows that more than half of the respondents were students (52.2%). The sample was biased towards younger people as the age distribution follows this pattern; 61.8%, 30.4% and 7.8% of the respondents were between ages 18-25 years, 26-35 years and 36-45 years respectively. In terms of gender, the majority of the respondents were male (60.8%) while 68.6% were single, 25.5% were married and 5.9% were divorced. The distribution of education shows that respondents were generally well educated, with 11.8% of the respondents obtaining PhD while 15.7%, 33.3%, 3.9%, 33.3% and 2.0% of the respondents were holders of Mphil/M.Sc, B.Sc/HND, OND/NCE, SSCE and other qualifications respectively.

Table 3: Univariate relationship between demographics variables and awareness of micro plastic pollution

Demographics variables	Awareness of microplastic pollution			P-value
	Not aware (n= 43)	Aware (n= 59)	Total	
Categories of workers				
Government	10(23.3%)	9(15.3%)	19(18.6%)	0.004**
Academia	0(0.0%)	9(15.3%)	9(8.8%)	
Student	29(67.4%)	24(40.7%)	53(53.0%)	
Business	2(4.7%)	11(18.6%)	13(12.7%)	
Others	2(2.7%)	6(10.2%)	8(7.8%)	
Age (years)				
18-25 years	29(64.7%)	34(57.6%)	63(61.8%)	0.599
26-35 years	11(25.6%)	20(33.9%)	31(30.4%)	
36-45 years	3(7.0%)	5(8.5%)	8(7.8%)	
Gender				
Male	22(51.2%)	40(67.8%)	62(60.8%)	0.089
Female	21(48.8%)	19(32.2%)	40(39.2%)	
Marital status				
Single	28(65.1%)	42(71.2%)	70(68.6%)	0.447
Married	11(25.6%)	15(25.4%)	26(25.5%)	
Divorced	4(9.3%)	2(3.4%)	6(5.9%)	
Education				
PhD	4(9.3%)	8(13.6%)	12(11.8%)	0.561
Master's degree or equivalent	6(14.0%)	10(16.9%)	16(15.7%)	
Bachelors or equivalent	13(30.2%)	21(35.6%)	34(33.3%)	
OND/NCE	2(4.7%)	2(3.4%)	4(3.9%)	
SSCE	18(41.9%)	16(27.1%)	2(2.0%)	
Others	0(0.0%)	2(3.4%)	0(0.0%)	

Source: Field Survey, 2021

Values in the parenthesis are the percentages, **significant at 1% (p<0.01).

SSCE = Secondary School Certificate/High School Diploma; OND = Ordinary National Diploma; Others = Technical/Vocational skill certification or no education, PhD= Doctoral degree.

Result in Table 3 and figure 2 reveals that out of the 102 respondents that participated in the study, 59 respondents representing 57.8% are aware of microplastic pollution of which the majority were students (40.7%), age brackets 18-25 years (57.6%), male (67.8%), single (71.2%) and Bachelor's degree or equivalent holders (35.6%). Result also reveals significant association between awareness of microplastic pollution and category of workers (p =0.004, p<0.05) which other demographic factors show insignificant association (p>0.05).

Table 4: Knowledge and perception about microplastics among the respondents

Items	n	Mean score	Standard deviation	Rank
Knowledge of microplastics				
1 I never throw plastic waste into common waste bins.	102	2.25	1.47	8
2 I often recycle plastic food containers, pet bottles etc.	102	2.50	1.49	7
3 All plastic marine debris will eventually become microplastics	102	3.79	1.37	4
4 Microplastic pollution is a serious global problem	102	3.97	1.35	1
5 Microplastics are not toxic	102	1.99	1.35	
6 I do not know a lot about microplastics	102	3.03	1.55	5
7 My lifestyle may contribute to microplastic pollution	102	3.01	1.69	6
8 Microplastics pollution is not a serious problem in Lagos lagoon	102	2.14	1.48	10
9 Microplastics do not affect human's health	102	1.87	1.23	11
10 Microplastics do not have a profound impact to sustainable development in Nigeria	102	2.23	1.40	9
11 People in my neighborhood do not know about microplastic pollution	102	3.91	1.38	2
I want to learn more about microplastics	102	3.82	1.49	3
Overall	102	2.88	1.44	
Perception of microplastic				
2 I am less concern about where plastic waste I generated ends	102	2.43	1.52	6
3 Marine animals will not consume microplastics as food	102	2.63	1.59	5
4 I think it is the responsibility of my community authority to reduce plastic pollution	102	3.71	1.54	3
5 I am not willing to tell my family and friends about the issue of microplastics in Nigeria	102	2.75	1.61	4
6 I am willing to participate in the cleanup efforts of microplastics in Lagos	102	4.00	1.45	2
7 I am willing to encourage the government to work on the issue of microplastics in Lagos	102	4.39	1.14	1
Overall	102	3.32	1.48	

Source: Field Survey, 2021

Table 4 presents the mean scores obtained by the respondents on knowledge and perception of microplastic pollution. The overall mean scores of 2.88 and 3.32 were obtained. The mean score on knowledge of microplastic is less than the expected weighted mean of 3.00 for 5 points rating scale which implies that the respondents have poor knowledge of microplastic pollution though they show better knowledge of the serious global problem of microplastic pollution than other knowledge items. Result also indicates that the mean score on perception is greater than 3.00 (3.32) which indicate that the respondents have good perception on microplastic pollution and are more prepared toward encouraging the government to work on microplastics issue in Lagos.

Table 5: Source of Information about the awareness of microplastic pollution

	Information Sources (n=59)	Frequency	Percentages
i.	Internet (Search engine sites, Journals, blogs etc.)	14	23.73
ii.	Newspapers/Magazine	-	-
iii.	Social Media (e.g., Facebook, Instagram)	32	54.24
iv.	Word of mouth by family, friends and acquaintance	4	6.78
v.	Workshop, Trade fairs and Conferences	9	15.25
	Total	59	100

Source: Field Survey, 2021

Table 5 shows the various source of information about microplastic pollution among the proportion of respondents that had awareness on this subject. It was clear that majority (54.24%) acquire information on social platforms, 23.73% through internet sources, and 15.25% through workshop, trade fairs and conferences and 6.78% through word of mouth by family, friends and acquaintance.

Discussion And Policy Implications

Socioeconomic characteristics of the respondents

Before the statistical analysis's outcomes were observed, the reviewed samples needed to be ascertained through the specific population the outcomes were generated. The socio-demographic characteristic, including categories of workers, age gender, marital status and education concerning public health knowledge and perception on microplastic pollution is revealed in Table 2. Result reveals that 18.6% of the respondents were government workers while 8.8%, 52.0%, 12.7% and 7.8% of the respondents belong to the academia, students, business and others. Additionally, more than half of the respondents were students (52.2%). The sample was biased towards younger people as the age distribution follows this pattern; 61.8%, 30.4% and 7.8% of the respondents were between ages 18-25 years, 26-35 years and 36-45 years respectively. This view is supported through Lingzhi *et al.*, who indicates that there was biased towards younger people, with 48.97% of respondents aged between 18 and 30, 34.1% between 31 and 50 and only 16.93% over 50. This view is also similar to the study conducted by O'Brien & Thondhlana, who found that the average age of the respondents was 33 ± 16 years, ranging from 18 to 85 years. The sample was heavily skewed towards the younger age group, with more than half (54%) of the respondents between the ages of 18 and 35, followed by 36 and 65 (39%) and 66 and 85 (6%) age groups. Also, Sujitha *et al.*, found that the study participants belonged to age group 19 to 64 years. The mean age of the

study participants was calculated to be 41 ± 13.4 years. About 52% of the respondents belonged to age group 19-39 years and nearly 20% belonged to age group 40-49 years. In terms of gender, the majority of the respondents were male (60.8%) somewhat larger than the number of female respondents. This view is supported through Manuel & Maria, who found that most heads of households are men (72.67%) and Lingzhi *et al.*, who indicates that there were slightly more males (54.69%) than females (45.31%); this proportion is similar to the proportion of males in Shanghai (Shanghai Statistical Yearbook, 2018). This view is contrary to the study conducted by O'Brien & Thondhlana, (2018) who found that female respondents (69%) outnumbered males (29%) resulting in an overrepresentation of women who represent about 52% of the population at the national level. While 68.6% were single, 25.5% were married and 5.9% were divorced. This view is contrary to the study conducted by Sujitha *et al.*, who found that the majority of the respondents were married (56%) and belonged to nuclear (62%) type of family. The distribution of education shows that respondents were generally well educated, with 11.8% of the respondents obtaining PhD while 15.7%, 33.3%, 3.9%, 33.3% and 2.0% of the respondents were holders of Mphil/M.Sc, B.Sc/HND, OND/NCE, SSCE and other qualifications respectively. As education revolutionize human attitudes. It supports people to know their environment to solve numerous snags. Meanwhile, these results are similar to those of O'Brien & Thondhlana, (2018) who found that the respondents had a generally high education level, with nearly all the respondents (97%) indicating having completed matric (the highest secondary qualification in South Africa, before entering University) or higher and Sujitha *et al.*, who estimated that around 56% of the study participants were graduates. This view is supported through Lingzhi *et al.*, who indicates that respondents were generally well educated, with 61.09% of the respondents obtaining a vocational college or higher education. Also, this view is contrary to the study conducted by Manuel & Maria, who found that a large percentage of the respondents have elementary school as the maximum level of education (42.65%).

Relationship between demographics variables and awareness of micro plastic pollution

Microplastics are ubiquitous and their potential harm to human health and the environment has received increasing attention from the public and scientific community (Deng *et al.*, 2020, Olarinmoye *et al.*, 2020). With unabated proliferation of plastic waste in the environment, public awareness and public understanding of how microplastics could evolve and how they are impacting the environment especially the Lagos Lagoon which is an hotspot for diverse seafood cannot be overemphasized. As the discovery of microplastics in the marine food chain has led to concerns for human consumption of seafood because various animals, ranging in size from tiny creatures like zooplankton to sharks and whales consumes microplastics and the likelihood of microplastics being eaten is influenced by the amount in the environment and how closely they resemble food (Henderson and Green, 2020). Effects vary between species and by the types of plastic and the concentration of microplastics. As researchers fear plastic particles in seafood might contribute to human illness by releasing toxins absorbed from polluted water, and by secreting their own chemical ingredients. Plastic fibers might contribute to inflammation, migrate to other organs, or leach toxins in ways that burden your health. For some whose livelihoods depend on marine life, the notion of plastic fish inspires dread and denial. The relatively high public awareness about microplastic pollution as noted in this present study (Table 3) literally implies that residents of the Lagos lagoon environment understand what microplastics are, and how it could logically hamper the environment. However, it was evident the people in this area generally have relatively poor knowledge of microplastics inspite of the fact that majority were informed that issues of microplastic pollution is a serious global problem. A recent study not only detected microplastics (mostly polypropylene and polyethylene) in the Lagos lagoon but also underscore the necessity of precisely evaluating the exact concentrations of these microplastics in the environment in a bid to evaluate the impact in the food chain and consequently human health effects (Olarinmoye *et al.* 2020). As majority reveals that 57.8% are aware of microplastic pollution of which the majority were students (40.7%), age brackets 18-25 years (57.6%), male (67.8%), single (71.2%) and B.Sc/HND holders (35.6%). Result also reveals significant association between awareness of microplastic pollution and category of workers ($p = 0.004$, $p < 0.05$) which other demographic factors show insignificant association ($p > 0.05$). This view is supported through Sujitha *et al.*, who indicates that majority of respondents (80%) were familiar with the health hazard generated due to use of plastic which was also similar when compared to a study done in Mangalore where 86% of the respondents knew about health threats as a result of using plastics (Joseph *et al.*, 2016). These results are better when compared to different studies conducted in other parts of the world where only 50% to 70% of the respondents knew about the harmful health hazards on using plastic (Sanghi, 2008; Sung, 2010; Adane & Muleta, 2011; Brittany & Jessica, 2019). In this study nearly 78% were familiar with the ill effects of plastic over the environment which was less when compared to a study done in California were 93% of the respondents had adequate knowledge on the harmful effects of plastic use over environment (Brittany & Jessica, 2019). This might probably be due to lack of knowledge about the negative effects of plastic use over environment which can be strengthened by conducting awareness campaigns through teach to reach accelerator. Availability of posters and banners with ill effects of plastic use printed on them can be used to intensify their awareness of micro plastic pollution. Interestingly, the people of Lagos lagoon environment incredibly expressed a good perception about how the menace of microplastic pollution could be addressed especially how they are willing to encourage the government to work on the issue of microplastics pollution in Lagos Lagoon.

While those interviewed indicated other known awareness regarding plastic pollution impact, it is also of concern that most population are unaware of this problem. Such ignorance leads to inconsistencies in information, which can only be filled from leaning as well as improvement and strengthening of public education. Such uncertainties as well as knowledge inconsistencies weaken the full understanding of toxicological, ecological as well as environmental effects of plastics. Hence, there is need to address the need for further research as well as public teaching on plastic related pollution, which might help to advance stakeholder cooperation through informing and educating the public around microplastic pollution problem. In general, public interest would be better and effective if they were supported through governmental agencies, which are usually well funded. In order to reduce the toxicity of plastic waste of any kind, entails a plethora of solutions, which must be met voluntarily as well as legislatively. Preferably, production, use as well as plastics disposal ought to be maintained globally, as prevailing supply chains crossed as well as re-cross continents, borders as well as oceans. "Stick and carrot" legislative approaches are required, designed at rewarding producers, consumers as well as suppliers working in the direction of a zero-waste strategy, even though highly punitive actions are imposed on offenders. Hence, educating the general populace on plastic pollution can open everyone's minds toward understanding all of the numerous methods in which we pollute our milieu, as well as how individuals can actually realize the garbage, they can realize the pollution from plastic, they get their hands on it as well as identify it is there due to us. The key to solving any snag is a good magnitude understanding. The current microplastic pollution problem is no exception. In order for the public to perceive the problem of plastic pollution that needs to be tackled urgently entails public awareness using education supported through scientific information towards the devastating effects of the plastic pollution.

Knowledge and perception about microplastics among the respondents

The mean score on knowledge of microplastic is less than the expected weighted mean of 3.00 for 5 points rating scale which implies that the respondents have poor knowledge of microplastic pollution though they show better knowledge of the serious global problem of microplastic pollution than other knowledge items. Result also indicates that the mean score on perception is greater than 3.00 (3.32) which indicate that the respondents have good perception on microplastic pollution and are more prepared toward encouraging the government on working on the project of microplastics in Lagos. While, plastics are a contemporary miracle, society across all sectors have benefited, together with health as well as food sectors, saving many lives. Since the inception of plastics industrial production began in the 50s, the plastics volumes produced has almost surpassed any further material. Nevertheless, the same features that render plastics extremely desirable are also those that tend to render them abundant in the milieu, particularly as a huge segment of plastics is designed to be thrown away practically instantly subsequent to their use. Hence, the burden of plastic poses a great threat to health and environment. Society's capacity toward coping by the sheer quantities of plastic produced as well as discarded is massively overwhelmed, as only 9% of entirely synthetic plastic ever manufactured are recycled. Majority of the wasted plastic ends up in landfills as well as eventually, end up in the milieu. Majority of plastics hardly degrade. Instead, they gradually split into tiny particles, called microplastics, as well as, perhaps, nano-plastics. These particles, either in form of large or small plastics, have devastating detrimental effects on biota, ecosystems, as well as the milieu, but likewise aimed at the economy as well as human health. Plastics is found inside the stomach contents of many organisms, including whales, birds, earthworms, dolphins as well as turtles. Smaller particles size might remain more persistent, as these might remain consumed through bacteria that are at the foundation of diverse food webs. Additionally, chemicals commonly used toward improving the properties of plastics - referred to as plasticisers - could percolate into the milieu as well as constitute new exposure routes to organisms, hypothetically causing bioaccumulation phenomena. Respondents regarded pollution resulting from microplastic as a modern-day problem that presently lacks sufficient monitoring instruments. The principal impediment is the lack of detailed information required to determine the problem extent as well as most individuals are ignorant that plastic is a huge problem since it is such a common material used in our day-to-day lives. While there are echoed sentiments, it's important to note that the public don't always have access to the acquisition of basic information. However, without such basic information, individuals tend toward having a sense of denial around the problems except such issues are brought to their consideration in graphical terms. Also, there is need for research role and education in raising awareness that will help resolve and enlighten policy development on plastic pollution problem. Although participants thought there is need for policy guidelines aimed at monitoring floatable plastic materials. Nevertheless, more significant remained supporting effective program development through collecting data on the nature as well as the exact plastic pollution sources occurring in Lagos Lagoon which remain most predominant to help promote better policies.

Sources of Information about Microplastic pollution

As human behaviour is considered the sole source of marine litters, which is in special consensus with the formation of microplastics, then equipping the public domain with relevant and adequate information about microplastics would be considered a key to tackling microplastic pollution. This study succinctly brought to our attention that a good number of respondents that were aware about microplastics and its associated risks had the knowledge through social media campaigns, followed by internet sources. Knowledge about sources, contamination, fate and effects of microplastics may be an ultimate guide in enhancing public motivation and sense of environmental responsibility (Raab and Bogner, 2020). Previous studies have appraised the significant role of media in not only increasing public participation and awareness, but serving as an instrument for many socio-psychological incentives, all of which could be geared towards mitigating environmental pollution (McAllister, 2015; Raab and Bogner, 2020; Henderson and Green, 2020). A previous study gave an account of where public sought information regarding environmental news and updates: 52% (websites), 48% (Television shows) and Newspaper (24%) were reported implying that majority gets environmental information via websites. The findings in this present study have pointed clearly that government and civil society actors should consider utilizing other available sources of information (such as Radio/TV show, newspapers/magazines, workshop/seminars etc.) especially in sponsoring environmental awareness campaigns for all, without leaving anyone behind.

Conclusion

This study shows relatively good awareness (58%) about the plastic pollution. Satisfactory awareness level about the ill effects of plastic was observed. Enforcement of prohibition of plastic waste dumping would lead to reduction in the current stress levels of wild animals in the Lagoon and rejuvenation of fish populations. These findings highlight the need to improve the awareness, knowledge and perception level of micro plastic pollution among the respondents towards eco-friendly sound alternatives. Information, education as well as communication (IEC) services should be intensified and encouraged toward bringing about attitudinal changes in practice. Many of the respondents in these situations had health hazards awareness from plastic pollution. The notion of the 5 R's, i.e., reduce, reuse, recycle, rethink, restrain, might assist as an administrative instrument aimed at adaptive procedures in addressing human as well as environmental health problems posed through plastics. While, this study provides the preliminary information on public health knowledge and perception on the fate and impact of microplastic pollution in Lagos. The study did not only confirm a relatively huge gap in public awareness on microplastic pollution and its health impacts but also confirm public willingness to encourage government to work on the issue of microplastic pollution. The gaps identified in this study clearly shows that it is imperative that proper knowledge-based training, orientation, and sensitization of the public on microplastic pollution and the potential health risks of exposure be developed. Global concern about microplastic pollution with its threat to food safety and public health has increased over time. However, there is no effective technical method to tackle and remove microplastics from the environment (Deng *et al.*, 2020). Therefore, public attitudes towards plastic use and integrated waste management principles are sustainable paths to reducing microplastic pollution. Increasing public health knowledge and awareness about microplastic pollution would greatly help to increase risk perception and thus, encourage everyone to be more active actors for reducing microplastics pollution. Therefore, science communicators, civil society actors, industry and policy makers should take into consideration the crucial media role in establishing perceptions as well as socio-cultural solutions to dimensions toward reducing single usage of plastics and microplastic emission.

Policy considerations and recommendations

Plastic pollution challenges and its environmental impacts entails burning attention. Since the COVID-19 pandemic attack of 2020 has changed several aspects of our day-to-day life as well as is likely to forever change the pattern of our living (Gift & Olalekan, 2020; Samson *et al.*, 2020; Raimi & Raimi, 2020; Gift *et al.*, 2020; Raimi *et al.*, 2020; Morufu *et al.*, 2021). The future undoubtedly seems to be less urban as well as less universal; efforts are required toward recognizing the vital problems where special attention desires to be given. While, efforts ought to be made at diverse levels as well as must comprehend scientific-based or science-informed solutions where possible. Further research is required, not only at the level of new materials as well as technologies toward dealing with plastic waste nevertheless to increase the already (limited) prevailing knowledge concerning presence, fate as well as effects in terms of micro, meso, macro as well as nano-plastics once in the aquatic milieu. As such, initiatives must remain carried out with a holistic viewpoint, with a sight toward:

- i. recognising the underlying root causes of plastic wastes as well as a critical analysis of pro-environmental behaviours towards solid-waste management, not excising human spirituality;
- ii. promoting stakeholders and citizenry's involvement, which may remain guaranteed through calls aimed at initial inputs, policy discussion as well as awareness campaigns on ways to control microplastic pollution and its associated risk;
- iii. reducing the usage of single-use plastics as well as set reduction targets through incentivizing public vendors that complies with the 4R's of plastic waste management strategies (reduce, reuse, and recycle)
- iv. designing appropriate environmental friendly policies such that supports implementation of reusable packaging as well as toward regulating packaging practices through the diverse sectors, with a focus on food supply chain as well as the cosmetic industry, along with considering measures that are stricter toward tackling single-dose or monodose packaging;
- v. Behavior change and plastic waste prevention policy needs to be properly designed with right perspective based on the needs and reality of today's households and industries;
- vi. Creating information about environmentally responsible behaviors, such as recycling and plastic waste minimization, as well as the clear picture of how microplastics are formed and their associated risks needs to be presented in a culturally and emotionally appropriate context;
- vii. creating customers right toward returning plastic packaging to retailers, hence encouraging improved collection efficacies as well as improved recycling separation;
- viii. establishing clear as well as appropriate regulations for biodegradable labelling as well as bio-based plastics, by means of associated investments in research, education as well as dissemination efforts aimed at creating public awareness as well as educational standards towards helping to formulate policy development on plastic pollution problem;
- ix. fostering and improving activities as well as actions that inspire reusable packaging strategies or zero-waste. This can be accomplished through harmonizing the regulatory framework schemes all over Nigeria and promoting the 5 R's, thus, reducing, reusing, recycling, rethinking and restraining. This must remain accompanied through severe restrictions and discouraging penalties aimed at single-use of plastics;
- x. ring-fencing returns originating through tax as well as levies aimed at actions accompanying zero plastic waste, together with awareness programs, supporting specific environmental projects or financing the recycling industry;
- xi. financing as well as investing in up-to-date infrastructures aimed at the collection, separation as well as plastic waste processing, as well as in rural areas, which remain often left out of such operations. This must comprise efforts to reduce downstream processes or generation of waste (e.g., landfilling as opposite toward waste generation);
- xii. companies should be more responsible for the full life cycle of their various plastic products. Besides, for this to happen, governments will need to introduce more regulations, and a proposed United Nations plastics treaty needs to succeed. Also, society must also demand that manufacturers provide equivalent life-cycle assessments and evaluations of all the environmental impacts of currently used plastics, so that the priorities for replacements become clear.
- xiii. strengthening enforcement and monitoring bodies such as NESREA, SON, with clear definition of roles as well as responsibilities toward ensuring total compliance; for instance, SON should develop a comprehensive regulatory system that seeks to standardize the manufacturing of quality durable plastics, enhance its re-usability while minimizing their hazards to public health and the environment.
- xiv. create adjustment tools toward monitoring ongoing progress as well as implemented policies effectiveness while adjusting them where required.

Declarations

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Competing interests

We affirm that we have no conflict of interest that may be alleged as prejudicing the impartiality of the study reported. We did not receive special assistance from government, not-for-profit sectors or commercial institutions.

Consent

All the authors announced that they had received written notice from the participants.

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Data Availability Statement

The data that support the findings of this study are summarized in the various tables and are available from the corresponding author while they are in preparation by Raimi Morufu Olalekan for online submission to a web portal.

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Figures

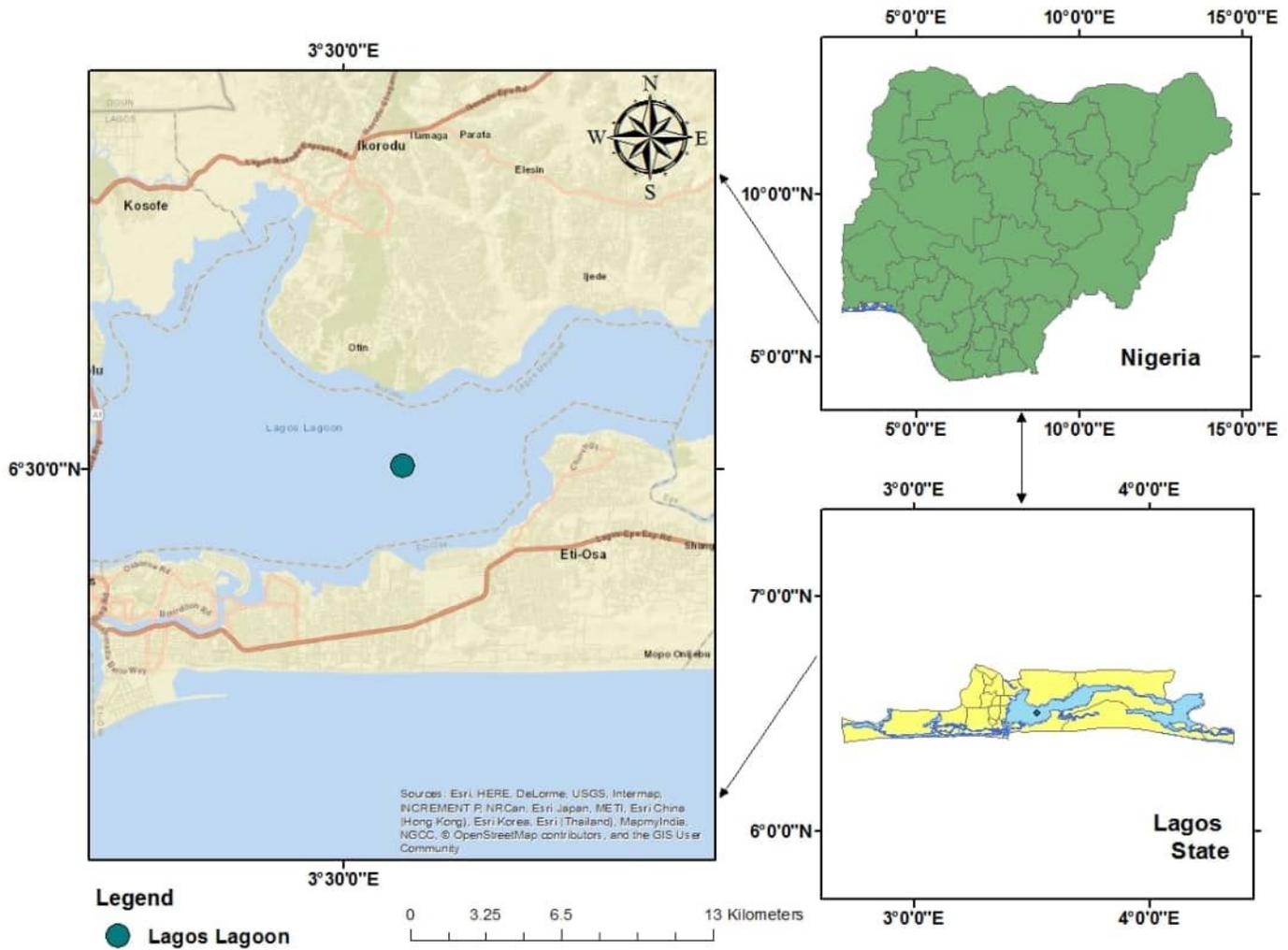


Figure 1

Map showing the study location

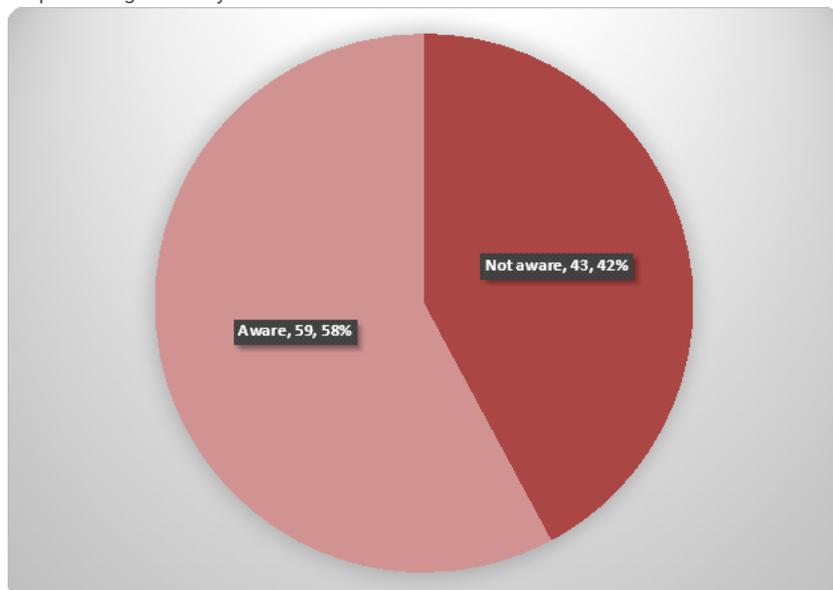


Figure 2

Pie chart showing awareness of microplastic pollution in the study area.