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Assessment of Public Awareness, Knowledge, Attitude and Perception on Microplastics Pollution in Kaduna Metropolis, Kaduna.

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abstract

This study aims to assess public awareness, knowledge, attitude, and perception of microplastic pollution in the Kaduna Metropolis, Kaduna. Three hundred and eighty-four (384) copies of structured questionnaires were distributed to respondents using random sampling. Descriptive and inferential statistics, and Relative Importance Index were applied using Microsoft Excel and Statistical Packages for Social Sciences (SPSS v28). The results revealed that 37.1% of the respondents are students, 28.25% of the respondents are traders, 17.51% are civil servants, and 17.23% are from academia. The study revealed that 68.4% of the respondents are aware of microplastic pollution. For the knowledge of plastic pollution, 48% believe plastic aquatic debris eventually becomes microplastics. The majority of the respondents 45.87% got information about plastic pollution from seminars and workshops. For the relationship between education and awareness of microplastic pollution, the correlation coefficient revealed a moderate positive relationship (r = 0.467), while linear regression revealed low influence of education of awareness of microplastic pollution (R^2 = 0.218). Regarding the attitudes of the respondents about microplastic pollution, the majority of the residents were willing to take part in community efforts to clean up microplastics (RII=0.80), and they are mostly curious to find out more about microplastics. The study concluded that most of the respondents are aware of microplastic pollution, even though the awareness varies with level of education and occupation. The study therefore recommends that there is a need for more public education about the dangers of microplastic pollution and illegal dumping of plastics should be discouraged.

Introduction

The ubiquitousness of plastics in all facets of our lives means that humans are inevitably exposed to microplastics (MPs) on a daily basis (Kirstein et al., 2021). Recently, microplastic pollution has been in the public domain as an emerging issue of global concern (Henderson & Green, 2020). Furthermore, as the world population continues to experience a growth rate of 1.68% per annum from 1955 to 2015 (Verla et al., 2019), there is an increase in the production of plastics because it is cheap, versatile, and suitable for the on-the-go lifestyle of millions of people around the world (Enyoh et al., 2019), earning the title plastic age (Lehmann et al., 2019).

As of 2017, the world was producing 348 million metric tons of plastics, with an approximate annual increase of 9%. By 2020, the number has reached 367 million metric tons (Shanmugam et al., 2020). It has been estimated that five trillion plastic items pollute the world's waters, endangering a variety of aquatic habitats (Plastic Europe, 2020). An interesting fact is that 58% of generated plastic waste ends up in dumpsites, and only about 18% is recycled based on the data available in 2015 (Geyer et al., 2017). Although the distribution and gravity of microplastic pollution in a region are determined by several factors such as the climate, environmental and geomorphological factors, in addition to urbanization, industrialization, law enforcement capacity, environmental education and the behaviour of the population (Veettil et al., 2024).

The term ‘microplastics’ was proposed in 2004 to describe the tiny plastic particles recorded; however, no comprehensive description exists that fully captures all the possible characteristics that could be used to define what a microplastic is. However, microplastics have been identified as synthetic polymeric matrices or solid particles whose shape can be regular or irregular (Frias & Nash, 2019). They are microscopic particles less than five millimetres in length, and are known to be found in freshwaters, seas, oceans, air, soil, and vegetation. They are mostly derived from plastic items, textiles, industry, agriculture, and general garbage (Enyoh et al., 2021). These definitions excluded other materials such as rubber derivatives or inorganic polymers, polyvinyl chlorides (PVC) containing >50% additives, and crystalline fibres, even though they share the same characteristics as other types of microplastics (Nohara et al., 2024).

Microplastics exist in different forms such as bits, sheets, flakes, pellets, fibres, or foams, and are found in every nook and cranny of the environment (Mamun et al., 2023). Various amounts of microplastics have been found in increasing numbers of ecosystem compartments (Lehmann et al., 2019). Because of their abundance, microplastics have been found in table salts and potable water (Verla et al., 2019), and because of their dimensions, they are easily swallowed by aquatic animals at trophic levels, including fish, invertebrates, turtles and whales, dolphins and porpoises (Deng et al., 2020). Several studies have revealed that microplastics have been ingested by soil organisms and plants from polluted soils across different land uses (Enyoh et al., 2021). Most recently, they have been detected in agricultural soils, urban centers and soils industrial areas (Kumar et al., 2020). In humans, microplastics have been found in different human tissues and biological samples such as blood, faeces, lungs, kidneys, liver, placenta, sputum and spleen (Kutralam-Muniasamy et al., 2023). Microplastics have been found in infants ingested through plastic feeding bottles and plastic toys (Mišľanová et al., 2024), playing with plastic teethers (Dibia et al., 2023), and through breastmilk and infant formula (Liu et al., 2023).

Within our oceans, there is documented evidence that 693 wildlife species have encountered microplastic debris through ingestion, entrapment, transportation and alteration of marine habitat (Gall & Thompson, 2015). The primary sources of microplastics are daily cosmetics, capsules for drugs and direct resin pellets (Brennecke et al., 2016), while degradation of large

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plastics and fragmentation under high temperatures, waves and solar radiation are the main secondary sources. And although there is no certainty about the health risks posed by microplastics, there is a consensus among scientists that plastic waste should be reduced to avoid a greater disaster in the future (Ashrafy et al., 2023). Furthermore, anthropogenic activities, chiefly human behaviours such as warming food in the microwave using plastic boxes and inadequate disposal of plastics, wearing and tearing of automobile tyres are increasing the formation of microplastics globally (Omoyajowo et al., 2021). Furthermore, the use of menstrual cups by women has been identified as a significant contributor to plastic pollution (Patrick et al., 2023).

Some environmental impacts of microplastic pollution include increasing the toxicity of the ecosystem, thereby altering biogeochemical cycles (Behera & Das, 2023), blockage of drains, and reducing percolation thereby causing floods and erosion, and consequently leading to the waning of Nigerian roads (Kehinde et al., 2020). Microplastics also negatively impact water quality, causing the acidification of marine habitats and initiating the release of the surfactants and formation of the sea-slicks and microbial bio-films (Wu et al., 2023). From an environmental angle, plastic pollution negatively affects tourism by distorting the aesthetics and causing a physical hazard (Henderson & Green, 2020).

At the international level, the United Nations (UN) has made commitments to cut plastic pollution into the environment, especially the oceans. These commitments include Addressing Single-Use Plastic Product Pollution, the UN Environment Assembly Resolutions on Marine Litter and Microplastics, and the UN Sustainable Development Goals (SDGs) (Walker, 2021). Specifically, goal 14 of the UN-SDG, on life below water, calls on governments to prevent and considerably decrease marine pollution of all types, particularly from land-based activities like as marine debris, by 2025 (United Nations, 2023). In Nigeria, despite the existence of legislation that addresses these issues, the problem of plastic pollution persists and may even get worse (NESREA, 2009). According to data from the UN, Nigeria is one of the five (5) African nations included in the top 20 global contributors of plastic garbage in marine ecosystems (Okeke et al., 2022). To lessen the effects of plastic pollution in the country, the Nigerian government passed the Plastic Prohibition Bill in May 2019, which proposes the prohibition of the use, manufacturing and importation of plastic bags for business and domestic use (Nwafor & Walker, 2020).

However, the menace of plastic pollution continues to grow. There is an increasing concern about the presence of microplastics in Nigeria's freshwaters, and in Nigeria, there is a poor culture of plastic waste recycling, hence, the majority end up in landfills where it further constitutes environmental damage (Enyoh et al., 2019). A recent study even discovered the occurrence of microplastics in borehole water and sediments (Aliyu et al., 2023). They have been discovered in all types of ecosystems, making it a very dangerous trend (Dowarah et al., 2022); microplastics have been reported as potential carriers of Coronavirus (Enyoh et al., 2020) and research has shown that they affect the food chain by inducing nutrients and environmental stress in ecosystems (Ugya et al., 2022).

Literature Review

Studies on microplastic pollution mainly focus on marine environments (Ashrafy et al., 2023; Omoyajowo et al., 2021). However, researchers have recently focused on terrestrial ones (Balestra et al., 2024). In Kaduna Metropolis, several studies have been conducted on pollution and waste management. For example, Aliyu et al. (2023) assessed microplastic contamination in river water, bottled water, sachet water and branded table salt samples in the Kaduna Metropolis, Nigeria. The study found that microplastics in bottled water pose a medium pollution risk, according to pollution risk indices. The study also revealed that children consume more microplastics than adults do. It was however, further showed that the estimated daily intake was generally low, suggesting little harm from daily use. However, the study only focused on quantification of microplastics.

Additionally, AbdulKadir et al. (2023) assessed household plastic waste generation and composition in selected locations Within Kaduna Metropolis. They collected and analyzed a total of 6052.45 Kg of household plastic waste generated by 1516 residents from 100 household. They revealed that household plastic waste stream in the Kaduna metropolis comprise of PET (15.73%), HDPE (10.47%), PVC (1.26%), LDPE (27.51%), PP (8.95%), PS (8.93%) and others plastics (27.15%). The study also found that plastic waste generation varies seasonally between the two seasons, with the wet season producing the most garbage per capita (0.067 kg/cap/day) compared to the dry season's 0.060 kg/cap/day.

Furthermore, Ishaq et al. (2023) examined the Modes of disposal of household plastic waste in Kaduna Metropolis, Kaduna, Nigeria. The study revealed that the residents of Kaduna Metropolis usually adopt an informal mode of disposing their waste, with about 33% of waste disposed by wheel-barrow boys, other methods include open-dumping (26%), collection by government agencies (16%), private agencies (12%), burning (6%), open-drain (5%) and by burying (2%). The study concluded that there was a high level of awareness (77%) among the residents. Yusuff and Sonibare (2004) characterised textile industries' effluents in Kaduna Metropolis, Nigeria and the pollution implications. The study focused on the pollution implications of these effluents from textile operations in the city; important because of the risk of human exposure to them.

Anake et al. (2009) assessed heavy metals pollution at municipal solid waste dumpsites in the Kano and Kaduna states in Nigeria. The study revealed that paper and food scraps were the major composition of generated waste. Butu (2015) assessed electronic waste management and the environmental impact in Kaduna using field observation and oral interviews. The study identified different forms of plastic in the generated waste such as battery parts, electrical cables, televisions, cell phones, computer parts and accessories among others. The study found that waste characterization is not usually carried out at household levels. They recommended strong legislation enforcement on importation of obsolete electronic products and a good e-waste handling and recycling strategies that are environmentally friendly.

However, despite the environmental impacts of microplastics, there is a paucity of literature in the Kaduna Metropolis on the knowledge, awareness, attitude and practice of people concerning microplastics. Therefore, this study aims to assess the citizens' attitudes, knowledge, and awareness of microplastic pollution. Thus, it is critical to understand the level of public awareness, knowledge and attitude towards microplastic pollution. This will help the authorities understand the challenges to sustainable waste management practices in the Kaduna Metropolis.

Materials and methods

Study Area

The Kaduna Metropolis is composed of Kaduna North and Kaduna South Local Government Areas and parts of Chikun and Igabi Local government areas of Kaduna State. Kaduna Metropolis lies between Latitudes 10º23´00″ and 10º39´00″ north of the Equator and Longitude 7º20´16″ and 7º35´00″ east of the Greenwich Meridian (Figure 1) with an area of 3,156 km^2 (Baba et al., 2020). The climate of Kaduna Metropolis is characterized by two distinct wet and the dry seasons (Abdussalam, 2020). The wet season runs for about six to seven months, mostly between April and October, with an average rainfall of 1400mm. The dry season (harmattan) has severe dust haze, with northerly winds flowing from the desert (Abubakar et al., 2024). The maximum temperature in Kaduna Metropolis can be over 30ºC, with the hottest months being March, April and May. Relative humidity typically ranges between 25% and 90% depending on the month of the year (Ahmed et al., 2024).

As an urban area, the Kaduna Metropolis is experiencing rapid settlement expansion, driven by population growth and urbanization (Goje & Dogo, 2019). The area had about 14,000 people in 1929, but the population kept growing and was projected to have up to 2,031,742 in 2017 (Daful et al., 2020). Additionally, the Kaduna Metropolis has experienced a rise in industrialization, having at least three industrial zones. The Kakuri industrial zone is the most famous because it is the home to companies like Peugeot Automobile Nigeria (PAN), United Nigerian Textiles Plc, Kaduna Textile (KTL), Nigerian Brewery, and Defence Industries Corporation (DIC) (Mukhtar et al., 2019). This has exacerbated the environmental challenges such as land and water pollution, land degradation and soil contamination (Ahmed et al., 2017).

The study area lies on the Kaduna Plain. Much of the area lies between 547 and 840m with scattered hills rising 50-200m above the surrounding land (Musa & Abubakar, 2024). The river and stream networks in Kaduna Metropolis are part of the middle Kaduna River Catchment Area, with River Kaduna as the main channel, and other smaller rivers, such as the Romi River as tributaries (Musa & Abubakar, 2024). The areas have a typical Guinea Savannah vegetation. In terms of agriculture, the Kaduna Metropolis is blessed with rich agricultural lands, with many crops produced along the Kaduna River and its tributaries cutting through Kaduna (Musa & Abubakar, 2024). Historically, migrating farmers were encouraged to settle in Kaduna Metropolis during the colonial periods to curb food shortages (Bununu et al., 2015).

From the post-colonial periods, the Kaduna Metropolis became the hub of textile industries in Nigeria (Saleh, 2015). This is because of its proximity to cotton-growing areas around Zaria. Apart from the textile, the Kaduna Metropolis also has plenty of commercial and manufacturing industries such as automobile, iron works, fertilizers, furniture, and cable industries among others (Saleh, 2015). Recently, the metropolis witnessed an increase in companies producing bottled and sachet water (Mukhtar et al., 2019). These industries increase the chances of microplastic pollution. These microplastics have been found in both raw and treated water, fragments were clearly more prevalent. In sampled bottled water and table salt, fragments and fibers were predominant (Aliyu et al., 2023).

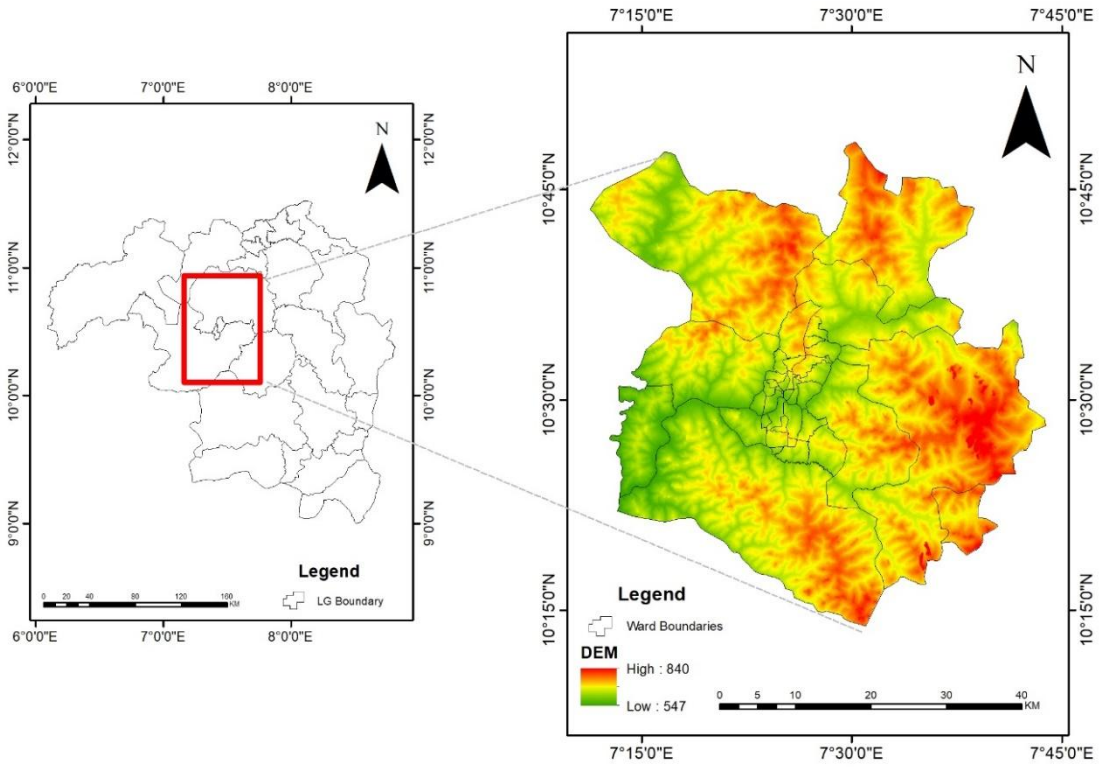

Figure 1: Map of Kaduna State showing Kaduna Metropolis
Source: Modified from GRID3 - Nigeria (2024)

Materials

Questionnaire Design

The purpose of the survey was to assess public awareness, knowledge, attitude and perception on microplastics pollution in Kaduna Metropolis, Kaduna. Prior to data collection, an iterative process of survey conceptualization, questionnaire design, pilot interviews, and modifications were conducted.

To create a comprehensive questionnaire, a preliminary survey was conducted on the 16th of June, 2023, with the aim of examining the current reports and surveys pertaining to microplastic pollution in Kaduna Metropolis. In line with this, talking with academics, administrators of municipal solid waste management, and independent specialists greatly aided in understanding the infrastructure of plastic pollution in the research region. A preliminary survey consisting of questions was created and categorized into four sections: 1) residents' demographics and background; 2) residents' awareness of microplastic pollution; 3) residents' understanding of the implications of microplastic pollution; and 4) residents' impression of microplastic pollution.

We examined residents' knowledge and practices concerning microplastic pollution. The knowledge and practices were measured using 5 items. Residents selected their level of knowledge using a 5-point Likert scale ranging from 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree. The population of this study comprises of civil servants, students of higher institutions, traders and people working in the academia. The total population of the selected wards is 657,221. According to Krejcie and Morgan (1970) sample size determination table, a population of more than 100,000 will have 384 number of questionnaire.

Two (2) wards with the highest population were selected from the local governments that made up the Kaduna Metropolis using purposive sampling. Considering the population of the selected wards in 657,22, this study distributed 384 questionnaires to respondents selected randomly. The number for each ward is shown in Table 1.

Reliability Test

Reliability test was carried out to measure the degree to which the questionnaire would yield consistent results. Statistical Package for Social Sciences (SPSS v28) was used to test the validity and reliability of the questionnaires. The Cronbach's alpha coefficient ranged from 0.79 to 0.95, as indicated in Table 2. As a result, the Cronbach's alpha coefficient was greater than the 0.70 cutoff point.

However, after the field survey conducted by the research team, only 354 questionnaires were usable, as some couldn't be retrieved, while others were not usable. This yielded 92.18% response rate.

Table 1: Proportion of Questionnaire Distributed to Selected Wards

S/N	Location	LGA	Population	Number of Questionnaire
1	Sabon Tasha Ward	Chikun	99,579	58
2	Narayi Ward	Chikun	51,102	30
3	Rigasa Ward	Igabi	119,798	70
4	Rigachikun Ward	Igabi	79,163	46
5	Kabala Ward	Kaduna North	45,312	26
6	Kawo Ward	Kaduna North	103,039	60
7	Makera Ward	Kaduna South	92,513	54
8	Badiko Ward	Kaduna South	66,715	39
	Total		**657,221**	**384**

Source: Authors' Compilation, 2023

Methods

Descriptive statistics and crosstabulation were used to characterize the respondents based on their sociodemographic variables. Cross tabulation is the process of combining categorical data into a table, with each cell providing the frequency (raw or proportional) of observations that fit the categories indicated by that cell (Momeni et al., 2018). This study used crosstabulation to explore the relationship between categorical variables.

Furthermore, to understand the relationship between the residents' level of education and their awareness of microplastic pollution in the Kaduna Metropolis, Pearson's product-moment correlation coefficient and linear regression were applied.

Table 2: Cronbach's Alpha for the Questionnaire

Attribute	Factor	Cronbach's alpha
1. Awareness (Awareness 1-2)	1.1 Level of Awareness 1.2 Source of Awareness	0.84
2. Knowledge of Microplastic Pollution (Knowledge 1-)	2.1 I often don't dispose plastic waste in the designated bin 2.2 I often reuse and/or recycle household plastic food containers, pet bottles etc 2.3 Plastic aquatic debris eventually become microplastics 2.4 Plastic pollution is a serious environmental problem 2.5 I don't know much about microplastics especially how it could get into the food chain or impact human health	0.92
3. Attitude (Attitude 1-6)	3.1 I am less concerned where plastic waste is disposed 3.2 I am not willing to tell my friends, family or colleagues about plastic pollution 3.3 I am willing to participate in the clean-up efforts to microplastics in my community 3.4 I am willing to encourage government to work on the issue of microplastics in Kaduna Metropolis 3.5 I want to learn more about microplastics 3.6 I live a lifestyle that may contribute to microplastic pollution	0.83
4. Perception (Perception 1-7)	4.1 Microplastics are not toxic 4.2 Microplastic pollution is not a serious problem in Kaduna Metropolis 4.3 Microplastics do not affect human health 4.4 Microplastics do not have any influence on sustainable development in Nigeria 4.5 People in my neighborhood do not know about microplastic pollution 4.6 It is individual's responsibility to reduce plastic pollution 4.7 Aquatic animals will not ingest microplastics	0.95

Source: Authors' Compilation, 2023

The term correlation refers to a group of techniques used to summarize the direction and intensity of the link between two variables, X and Y. Only when two variables are regularly distributed can it be used to measure their connection, and it is usually denoted by *r* and it can only take values between − 1 and 1.
It is calculated using equation (i) (Whitford, 2005).

$$r = \frac{\sum_i (x_i - x_m)(y_i - y_m)}{\sqrt{\sum_i (x_i - x_m)^2}\sqrt{\sum_i (y_i - y_m)^2}} \qquad (i)$$

Where r = correlation coefficient, x_i= values of the x-variable in a sample, x_m= mean of the values of the x-variable, y_i= values of the y-variable in a sample, and y_m= mean of the values of the y-variable
Linear regression is the primary regression procedure utilized to predict the output *y* coordinate based on the input *x*. The linear model was selected to assess the influence of the predictor variable (level of education) on awareness of microplastic pollution (dependent) and by fitting them into the linear regression. This was computed using equation (ii) (Montgomery et al., 2021).

$$E(Y) = \beta_0 + \beta_1 X + \varepsilon \qquad (ii)$$

where Y is the dependent variable, E(Y) is the expected value of Y, β_0 is the intercept, β_1 is the coefficient of X (predictor), and ε is the residual.
However, to determine public attitude towards plastic pollution, examine the environmental impacts of plastic pollution and analyse peoples' perception of microplastic pollution in the Kaduna Metropolis, Likert Scale and Relative Importance Index (RII) were used to analyze the responses.
According to Kassem et al. (2020), the Relative Importance Index (RII) is used to assess the relative importance of specific causes and consequences based on their likelihood of occurrence and impact on the project, using a five-point Likert scale. It is one of the most often utilized and has a highly accurate value when rating variables using a questionnaire (Genc, 2023). However, the limitation of the RII does not establish causality; it merely ranks factors based on perceived importance (Kinemo, 2024). The larger the value of the RII, the higher the agreement of the respondents on its cause or critical component. The RII is calculated using equation (iii) as used by (Kinemo, 2024).

$$RII = \frac{\sum W}{(A * N)} \qquad (iii)$$

Where, RII – Relative Importance Index (RII)
W - is the weight given to each factor by the respondents from 1, 2, 3, 4 and 5 for strongly disagree, disagree, undecided, agree and strongly agree, respectively;
A – is the highest weight (i.e., 5 in this case), and;
N – is the total number of respondents.

Results

Awareness of Microplastic Pollution

Table 4 presents the results of the level of awareness of microplastic pollution in Kaduna Metropolis. Among the respondents with primary school education, 80% are not aware of microplastic pollution, while only 20% of respondents are knowledgeable about microplastic pollution. Out of the respondents with secondary education, 74.7% of the respondents are aware, while 25.3% said they are not aware. Among the respondents with tertiary education, 82.4% said they were aware of microplastic pollution, while only 17.6% said they were not aware. However, among the respondents with informal education, 76.2% said they were not aware, while only 23.8% respondents said they were aware of microplastic pollution.

Table 4: Awareness of Microplastic Pollution Based on Education and Occupation

		Awareness of Microplastic Pollution		
		Yes	No	Total (N)
Level of Education	Primary	20.0	80.0	40
	Secondary	74.7	25.3	162
	Tertiary	82.4	17.6	131
	Informal	23.8	76.2	21

		Awareness of Microplastic Pollution		
		Yes	No	Total (N)
Job Category	Civil Servant	77.4	22.6	62
	Trader	61.0	39.0	100
	Academia	72.1	27.9	61
	Student	67.9	32.1	131

Source: Authors' Analysis, 2023

For the level of awareness based on occupation, Table 4 revealed that out with civil servants, 77.4% said they were aware of microplastic pollution, while 22.6% said they were not aware. Among the traders, 61% said they were aware, while 39% said they were not aware of microplastic pollution.

Among the students sampled, 67.9% said they were aware, while 32.1% said they were not aware of microplastic pollution. Among the respondents from the academia, 72.1% said they were aware, while only 27.9% said they were not aware of microplastic pollution. This indicated that civil servants and employees working in academia have the highest level of awareness of microplastic pollution. These findings are similar to those of Premarathna et al. (2023) which found that the level of awareness of microplastics is linked to their level of education and their occupation.

Relationship Between Level of Education and Awareness of Microplastic Pollution

This section analyzes the relationship between level of education and level of awareness of microplastic pollution in Kaduna Metropolis using the Pearson Product-Moment Correlation Coefficient.

Table 5: Relationship Between Education and Level of Awareness of Microplastic Pollution in Kaduna Metropolis

Correlations

		Education	Level of Awareness of Microplastic pollution
Education	Pearson Correlation	1	.467
	Sig. (2-tailed)		.000
	N	354	354
Level of Awareness of Microplastic pollution	Pearson Correlation	.467	1
	Sig. (2-tailed)	.000	
	N	354	354

Source: Authors' Analysis, 2023

From Table 5, Pearson's product-moment correlation coefficient (r) is 0.467, which indicates a moderate positive correlation between educational qualification and level of awareness of microplastic pollution in Kaduna Metropolis. Given that the p-value is lower than the alpha (0.05), this indicates that the correlation is statistically significant. This result is similar to the findings of Ishaq et al. (2023) that level of education influences awareness and methods of waste disposal.
waste disposal.

Influence of Education on Awareness of Microplastic Pollution

This section analyzes the influence of level of education on the level of awareness of microplastic pollution in the Kaduna Metropolis using the linear regression.

Table 6: Influence of Education on Awareness of Microplastic Pollution

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.467[a]	.218	.000	.84883

a. Predictors: (Constant), Level of Education

From Table 6, the model summary revealed the coefficient of determination (R^2) is 0.218 which suggests that 21.8% of the variation in the level of awareness can be explained by the level of education. This suggests that the model accounts for minimal variability, indicating the presence of additional factors affecting the level of awareness that remain unaddressed by this model.

Knowledge of Microplastic Pollution

The knowledge of microplastic pollution in Kaduna Metropolis was assessed. The results are given in Table 7. From Table 7, majority of the respondents claim they dispose plastic waste properly, with 70% saying they strongly disagree with the statement saying "I often don't dispose plastic waste in the designated bin", 20% were in agreement, while only 10% expressed indecision. Only 27% of the respondents reuse or recycle plastic materials in their households, 20% expressed indecision, but majority (54%) do not. Majority of the respondents (59%) believe plastic debris in water body would eventually lead to microplastic pollution, 23% are undecided, while 19% do not believe that plastic debris in water bodies would lead to microplastic pollution.

On the challenges posed by plastic pollution, majority of the respondents (65%) believe plastic pollution is a serious environmental problem, 9% expressed indecision, while 14% disagree. Interestingly, 43% claim to have knowledge of microplastic in food chain, 37% claim they do not know how microplastic can affect the food chain, while only 21% expressed indecision. These findings are in harmony with the account of Duru et al. (2019), which revealed that most Nigerians do not recycle the plastic materials they use in their households.

Sources of Information About Awareness of Microplastic Pollution

This study examined respondents' source of information on awareness of microplastic pollution. The result is shown in Table 8. A majority of the respondents learnt about microplastic pollution from workshop/seminars, followed by word of mouth 39%, the internet with 38%, school curriculum with 33% and social media with 21%. This shows that there is still a lack of adequate coverage of microplastic pollution in our school curriculums.

Table 8: Source of Information About Awareness of Microplastic Pollution

Source of Information	Frequency	Percentage
Internet	38	15.70
Social Media	21	8.68
School Curriculum	33	13.64
Word of Mouth	39	16.12
Workshop / Conference / Road Shows	111	45.87
Total	**242**	**100**

Source: Authors' Analysis, 2023

The result also shows that there are a lot of workshops on microplastic pollution which would be good for public education. This is in contrast with the findings of Omoyajowo et al. (2021), which found that majority of people in Lagos know about microplastic pollution from social media. Another interesting thing about this result is that majority of the respondents (45.87%) learned about microplastic pollution through workshops (including seminars and road shows). This indicates that there is a significant level of public enlightenment on the effects of microplastic pollution in Kaduna Metropolis.

Table 7: Knowledge of microplastic pollution in the Kaduna Metropolis

S/N	Knowledge of Microplastic Pollution	SD	D	U	A	SA	Total	Mean
1	I often don't dispose plastic waste in the designated bin	153 (43%)	94 (27%)	35 (10%)	14 (4%)	58 (16%)	354	2.237
2	I often reuse and/or recycle household plastic food containers, pet bottles etc	135 (38%)	56 (16%)	70 (20%)	38 (11%)	55 (16%)	354	2.497
3	Plastic aquatic debris eventually become microplastics	31 (9%)	34 (10%)	80 (23%)	38 (11%)	171 (48%)	354	3.802
4	Plastic pollution is a serious environmental problem	35 (10%)	14 (4%)	76 (21%)	31 (9%)	198 (56%)	354	3.969
5	I don't know much about microplastics especially how it could get into food chain or impact human health	101 (29%)	28 (8%)	73 (21%)	66 (19%)	86 (24%)	354	3.023

Source: Authors' Analysis, 2023

Table 9: Respondents' Attitude Towards Microplastic Pollution in Kaduna Metropolis

S/N	Attitude	SD	D	U	A	SA	Total	Weighted Total	RII
1	I am not concerned where plastic waste is dumped	156	31	87	17	63	354	862	**0.4870**
2	I am not interested in telling my friends, family or colleagues about microplastic pollution	135	21	76	38	84	354	977	**0.5520**
3	I am willing to take part in the community's microplastics cleanup initiatives.	42	24	45	24	219	354	1416	**0.8000**
4	I'm willing to push the government to address microplastic problems in Kaduna Metropolis.	17	21	21	41	254	354	1556	**0.8791**
5	I'm curious to find out more about microplastics.	52	21	52	42	187	354	1353	**0.7644**
6	I live a lifestyle that may contribute to microplastic pollution	118	31	49	42	114	354	1065	**0.6017**

Source: Authors' Analysis, 2023

Table 10: Respondents' Perception of Microplastic Pollution in Kaduna Metropolis

S/N	Perception	SD	D	U	A	SA	Total	Mean
1	Microplastics are not toxic	198 (56%)	49 (14%)	59 (17%)	10 (3%)	38 (11%)	354	1.99
2	Microplastic pollution is not a significant environmental issue in Kaduna Metropolis	194 (55%)	38 (11%)	45 (13%)	31 (9%)	46 (13%)	354	2.14
3	Microplastics do not affect human health	205 (58%)	49 (14%)	70 (20%)	3 (1%)	27 (8%)	354	1.86
4	Microplastics do not have any influence on sustainable development in Nigeria	160 (45%)	62 (18%)	70 (20%)	17 (5%)	45 (13%)	354	2.22
5	People in my neighborhood do not know about microplastic pollution	31 (9%)	35 (10%)	59 (17%)	38 (11%)	191 (54%)	354	3.91
6	It is individual's responsibility to reduced plastic pollution	56 (16%)	38 (11%)	35 (10%)	52 (15%)	173 (49%)	354	3.70
7	Aquatic animals will not ingest microplastics	132 (37%)	52 (15%)	69 (19%)	17 (5%)	84 (24%)	354	2.63

Source: Authors' Analysis, 2023

Attitude to Microplastic Pollution

To analyse the attitude of respondents on microplastic pollution, Relative Importance Index (RII) was used. Results are shown in Table 9. With RII value of 0.879, most of the respondents are willing to encourage the government in curbing microplastic pollution. Secondly, the respondents expressed willingness to participate in clean-up efforts by communities with RII value of 0.8000. Ranking 3rd is people expressing interest to learn more microplastics, with RII value of 0.7644.

Table 9 further revealed that the respondents are sharply divided when asked about their contribution to plastic pollution. The variable ranked 4th with RII value of 0.6017. this is followed by respondents' willingness to tell their friends and families about microplastic pollution with RII value of 0.5520 and lastly, respondents' saying they are less concerned where plastic waste ends ranked 6th with RII value of 0.4870.

Perception of Respondents on Microplastic Pollution

The perception of respondents concerning microplastic pollution in Kaduna Metropolis was assessed. The results are shown on Table 10.

Findings from Table 10 reveals that the majority of the respondents (70%) believe that microplastics are toxic, 17% are undecided, while only 14% believe that microplastics are not toxic. This finding is similar to that of Hoang (2024) which found that human health will be under significant threat from exposure to microplastics and their negative impacts. In Kaduna Metropolis, 21% of the respondents agree that microplastic pollution is not a significant environmental issue, 13% are undecided, while 66% disagree with the statement that 'microplastic pollution is not a significant environmental issue in Kaduna Metropolis.' Responding to the statement that 'microplastics do not affect human health', majority of the respondents (72%) strongly disagree, 20% are undecided, while 9% agree that it has no effect on human health.

For the influence of microplastics on sustainable development, the majority of the respondents (63%) disagree with the statement that 'Microplastics do not have any influence on sustainable development in Nigeria', 20% are undecided, while only 18% of the respondents responded positively to the statement. However, 64% of the respondents responded positively to the statement that 'people in my neighborhoods do not know about microplastic pollution', 17% expressed indecision, while 19% of the respondents disagreed with the statement. For the role of individuals in curbing microplastic pollution, 27% of the respondents rejected the statement that 'it is individual's responsibility to reduce plastic pollution', 10% expressed indecision, 15% affirmed the statement, and 49% strongly affirmed. On the statement that 'aquatic animals will not ingest microplastics', 52% of the respondents rejected the statement, 19% were undecided, 5% affirmed the statement, while 24% strongly affirmed. These findings agree with the studies of Dumbili and Henderson (2020) and Kehinde et al. (2020) which revealed that microplastics are toxic and have the capacity to cause harm to human health.

Conclusion

This study assessed the knowledge, attitude and perception of residents in Kaduna Metropolis concerning microplastic pollution. Descriptive statistics, Relative Importance Index and Pearson product-moment correlation coefficient were used to analyze the questionnaires administered to the respondents using random sampling. The results from the study revealed that the respondents are significantly aware of microplastic pollution with 68.4%, and workshops/conferences were the major source of information about microplastic pollution with 45.87%. The study also showed that respondents generally showed a positive attitude towards microplastic pollution. On the respondents' perception of microplastic pollution in Kaduna Metropolis, most of the respondents believe microplastics they are harmful for human health and pose danger to aquatic animals. On the relationship between education and awareness of microplastic pollution, the Pearson correlation coefficient revealed moderate positive relationship (r = 0.467), while for the influence of education on level of awareness, the linear regression model revealed (R^2 = 0.218), showing a low influence. Regarding the respondents' knowledge of microplastics, 48% believe that plastic aquatic debris eventually become microplastics and 56% of the respondents believe plastic pollution is a serious environmental problem.

For the attitudes of the respondents about microplastic pollutions, majority of the residents were willing to take part in community efforts to clean up microplastics (RII=0.80), they are also curious to find out more about the microplastics. Finally, 56% of the residents believe microplastics are toxic, and pose serious environmental issue in the Kaduna Metropolis. Furthermore, residents believe that reducing microplastic pollution is an individual responsibility.

Generally, a reduction in microplastic pollution requires increasing the capacity of communities to recycle, and most importantly, reduce the quantities disposed into the environment, and providing sustainable and enhanced waste management practices (Dettling et al., 2024). Thus, enhancing the level of awareness of microplastics is critical at the individual and community levels. For the analysis of the level of awareness, it can be concluded that most of the respondents are aware of microplastic pollution, although the awareness is more among civil servants and students of tertiary institutions.

Based on the findings of this study, the study recommends that there is a need for more public education about the dangers of microplastic pollution in

Kaduna Metropolis. Also, authorities should formulate policies that will encourage the recycling of plastic materials and discourage production of plastics. Finally, open dumping and illegal dumping of plastic waste, especially in drainage channels should be discouraged.

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