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Microplastics pollution understanding of beachgoers in Cape Town: South Africa

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Abstract

Plastic pollution is a global issue, with microplastics gaining international attention from Non-governmental organizations (NGOs), the government, the public, media and academia; microplastics are a growing source of concern. This research article aims to explore the Cape Town beachgoers' general knowledge and understanding of microplastic pollution in terms of its potential effects on the environment and human health. Using a questionnaire, the study was conducted at Muizenberg and Lagoon Beach, and involved participants belonging to the age group of <18–64 years. A sampling technique known as convenience sampling was used. This technique allowed individuals to be selected based on their willingness to be part of the sample and their availability; it allowed participants with no obvious knowledge of microplastics to take part. The data were recorded in Excel and analysed with the Statistical Package Social Sciences. Although the public was relatively familiar with microplastics at the time of the study, 40% of the participants from Muizenberg Beach did not know what microplastics are, while 60% knew. In Lagoon Beach, 26.67% did not know what microplastics are, while 73.33% did. Environmental education and the prohibition of microplastics were identified by the majority of respondents as necessary measures for reducing microplastic pollution and further research was suggested, with some of the respondents believing that the lack of strict regulations on plastic use was the greatest difficulty in reducing the pollution from microplastics.

Impact statement

Microplastics are emerging contaminants posing significant threats to the environment and human health, with nanoplastics being even smaller and potentially impacting biological systems. These non-biodegradable particles can build up in the digestive tracts of living things, with diverse effects on both biology and physics throughout the food chain. Inflammation, metabolic problems, oxidative stress and decreased enzyme activity in animals are among the effects. Microplastics have drawn interest from researchers worldwide and have been considered a major problem related to global plastic pollution that has existed for some time, including in South Africa. Since recent scientific evidence has increased the urgency of the issue of microplastics, the public has become increasingly concerned about them as an environmental issue. Several natural science studies have investigated microplastics from perspectives, such as the basic knowledge of microplastics.

Introduction

Plastic pollution is a global environmental issue that has impacts on livelihoods, biodiversity and public health due to its non-biodegradable nature, making it persistent in the environment. Plastics are a wide variety of combinations of properties when viewed as a whole; they are used for rubber, fibre and asphalt. Plastics are formed by elongated chains of polymeric molecules that are created from organic and inorganic raw materials, such as chloride, silicon, oxygen, hydrogen and carbon (Shah et al., 2008; Robinson, 2024). Nevertheless, plastic pollution is growing at an exponential rate and has become an area of concern due to its potential to cause serious environmental consequences. The discarded plastic wastes accumulate in landfills and natural environments (Heller, 2022; Wojnowska-Baryła et al., 2022). The increased use of plastic for its various purposes worldwide and the waste mismanagement of plastic in societies have caused the prevalence of microplastics across the globe. The issue of microplastics has gained significant attention from the global scientific communities (Yuan et al., 2020; Fortunov, 2024), with

microplastic pollution gaining more international attention as it poses environmental and health risks. Muthuvairavasamy (2022) reported that plastic debris can be classified according to their sizes, namely mega, macro, meso, micro and nano plastics. Microplastics are smaller pieces of plastics that are ~5 mm and smaller (Khan, et al., 2018; Sharma and Kaushik, 2021; Arif et al., 2024). These Microplastics (MPs) are present in two forms, either primary or secondary form (Soares et al., 2021). The primary forms are those produced in their original size and are commonly found in cosmetic products, such as face scrubs, body wash, toothpaste and ointments (Bouwman et al., 2018; Giustra et al., 2024; Patil et al., 2024), while secondary MPs are associated with the plastic fragments as a result of plastic pollution from grocery bags, garbage bags and other plastics as they break down into smaller particles (An et al., 2020; Yuan et al., 2022; Kurniawan et al., 2023).

Over the past few years, research on microplastic pollution has gained significant attention all around the globe (Omoyajowo et al., 2022; Akande, 2023; Hossain, 2024), some mainly focusing on the coastal environment (Harris, 2020; Ryan et al., 2020; Van Ryan Kristopher et al., 2021), estuaries (Govender et al., 2020; Boshoff et al., 2023; Samuels et al., 2024) and microplastic impacts on human health (Blackburn and Green, 2022; Ghosh et al., 2023) and public awareness levels of microplastic pollution (Henderson and Green, 2020) to name a few. Although microplastics have been extensively researched in the scientific community, there is a large gap between academic studies and public awareness, especially in Africa where environmental awareness is lower compared to other continents and is slowly increasing due to NGOs and international aid. South Africa is no exception, where the population and the environment are highly susceptible to MP pollution due to the country's poor waste management techniques (Julius et al., 2023; Malematja et al., 2023), lack of waste management services in some areas (informal settlements), heavy reliance on plastic among the populace (Khangale et al., 2020; Fortunov, 2024) and insufficient environmental awareness/education. Several literatures have shown that understanding public knowledge, attitude and perception about microplastic pollution could help to mind the gap towards proper management of inland waste and beachgoers' behaviours towards the marine environment (Omoyajowo et al., 2022; Ghosh et al., 2023), and further lead to the mitigation of microplastics.

Although there are policies and initiatives in place at national and international levels, such as public campaigns to raise awareness and address the knowledge gap, for instance, the United Nations has taken action to address microplastic pollution through its Clean Seas campaign (Usman et al., 2022; Ghosh et al., 2023), there are also challenges that need to be overcome, such as the lack of awareness, ineffective regulations and the lack of public willingness to participate. A study in Shanghai by Deng et al. (2020) showed that only 26% of the respondents had heard of microplastics before the survey and the majority were relatively unfamiliar with microplastics. However, studies have shown that some regions like Japan and China have high awareness, while others are less informed. The public's understanding of plastics is not comprehensive enough in some Asian countries; for instance, another study conducted in Bangladesh by Hossain (2024) on people's attitudes regarding plastic and microplastic pollution showed that only a small percentage of participants (22%) had prior knowledge of the term microplastics, while a large proportion of them (66%) had never heard of them and 12% were not sure. Therefore, such evidence supports studies stating that there is a need to understand public perceptions of plastics in society and their environmental impacts if we are to develop appropriate interventions to reduce the input of plastic waste into the ocean (Pahl and Wyles, 2017; Dilkes-Hoffman et al., 2019; Soares et al., 2021), which is why countries in Europe and Asia have pushed on campaigns focusing on promoting the reduction and elimination of single-use plastics, improving waste management and increasing public awareness (Borg et al., 2022; Akande, 2023). Nevertheless, the discovery of microplastics in the marine food chain has led to concerns for human consumption of seafood (Lehel and Murphy, 2021; Unuofin and Igwaran, 2023), although adverse effects on human health is 'limited, difficult to assess and still controversial' (Barboza et al., 2018; Henderson and Green, 2020). Nations like Canada and the United States have also proposed or implemented bans on microbeads in personal care products (Deng et al., 2022), while in Europe, the European Union has also banned it and proposed a ban on single-use plastics, use of plastic straws and cutlery as well (Grosso, 2022; Lee and Kim, 2022; Guzik et al., 2023). With all these regulations and policies, it is understood that the public is still relatively unfamiliar with microplastics. A study conducted by Deng et al (2020) revealed that most respondents believe that the lack of knowledge and environmental awareness of microplastics is the greatest difficulty in reducing the pollution from microplastics. Therefore, it is imperative and crucial that human behaviour is considered the sole source of marine litter and changing perceptions and behaviour is the key to tackling litter in the natural environment (Pahl and Wyles, 2017). In a study on community awareness and perceptions of microplastics, the majority of respondents (67%) were aware of MPs, and their responses were closely linked to their level of education, although their knowledge of regulatory measures was insufficient (Premarathna et al., 2023), meaning there was still a lack of regulation understanding used to mitigate the impacts of plastic usage in Sri Lanka.

Microplastics pose a severe threat to natural ecosystems, more especially the aquatic ecosystem. Therefore, exploring public opinion and knowledge about plastic litter is essential for the successful implementation of policies targeting plastic pollution (Forleo and Romagnoli, 2021). Several studies carried out in other countries noted that the young generation is more mindful of environmental issues than the older generation, and their use of social media is crucial, as it helps to shape public and policy discourses with implications for public awareness and political action (Lassen et al., 2018; Laskar and Kumar, 2019). Therefore, media coverage plays a vital part in spreading awareness. Literature suggests that attitudes and knowledge about microplastics can predict various behaviours that contribute to the mitigation of related emissions (Deng et al., 2020). At the individual level, human behaviour is associated with awareness, perception, attitude and level of concern about this environmental issue, therefore causing them to engage in solutions that are key elements for policymakers to introduce and implement effective pollution control measures. Environmental aware consumers are a typical example, as they have the power to reject products and decrease the demand, leading the manufacturer to listen to their demands and government intervention. Additionally, societal-level behaviour is influenced by policies and legislations (Beeharry et al., 2017). According to Bouwman et al. (2018), producers, consumers, government and other affected parties can address the plastic issues in South Africa and the world with an intensive effort. However, the knowledge gap between the government and society in developing countries such as South Africa is huge. South Africa is one of the countries that is on its way to put more effort into microplastic research (Boucher and Friot, 2017; Bonthuys, 2018).

Microplastic pollution is a growing study and receives worldwide attention. Although microplastics have been extensively

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researched in the scientific community, public perceptions, attitudes and behavioural preferences towards microplastics remain underexplored. In the research on microplastics, this study will serve as a baseline study in South Africa to understand the issues, distribution and fate of microplastics. The research provides knowledge and understanding of microplastic pollution and its pathways, to academics and non-academics. Plastic waste is problematic, as this pertains to mismanagement and lack of knowledge from the local communities. With that in mind, this study seeks to widen the understanding of the impact of microplastics and get a view from the people.

Materials and methods

Study area

This study was conducted at two different locations, namely Muizenberg Beach and Lagoon Beach. These two sites differ in coastal dynamics as well as in beach activities. Also, the industrial activities found in these two selected sites differ and the study area is further explained in Figures 1 and 2.

The two locations where the survey took place are Muizenberg and Lagoon Beaches. Muizenberg Beach with coordinates (34.1087° S, 18.4702°E) is a side suburb of Cape Town located on the coast of False Bay. It is on the east side of the coast, on the curve of the Cape Peninsula. The place is known for its popular surfing activities and kiting. The area is one of the Cape Town's tourist attraction points and it is about 35 km away from Cape Town. Fishing and angling are also common activities that one would find in Muizenberg Beach. Muizenberg has an estimated population size of 36,857 with English as the first dominant language (Stats SA, 2011; Lehohla, 2015).

The second site is Lagoon Beach (33.8922°S, 18.4834°E) that is located in Milnerton and is a prime site of Rietvlei estuary. The lagoon is a sandy beach on the West Coast of Cape Town and is in proximity to hotels and commercial apartments. Milnerton has an approximate population size of 95,630 (Stats SA, 2011; Lehohla, 2015).

Data collection method

According to Taherdoost (2022), the advantage of a qualitative approach is that it considers the big picture in a way that quantitative methods cannot. Rather than assessing a list of potential challenges facing research participants, it was determined that a qualitative approach would be more appropriate for this study, which sought to gain an understanding of microplastic pollution. The research was conducted using a qualitative technique, in the form of a questionnaire, which was used as an instrument for data collection. According to Shamsudin et al. (2024) and Whitehead and Whitehead (2020), questionnaires are a cost-effective research tool for data collection. A sampling technique known as convenience sampling was used; this type of procedure is non-probability. This technique allowed individuals to be selected based on their willingness to be part of the sample and their availability (Kumar, 2019; Whitehead and Whitehead, 2020). This technique was employed to ensure that every group of the population is eligible to be part of the sample. The convenience sampling was achieved through walking around the sites and stopping people or, in some cases, disturbing them and asking if they are willing to take part in the research. Convenience sampling is cost-effective, requires fewer resources, is fast and saves time. Small-scale quantitative surveys have been undertaken to explore public perceptions and understanding of marine litter. The research design was meticulously selected to meet the study's research aims, objectives and research questions. The section that follows provides additional information about the case study methodology, data collection instrument and data collection procedure. The study was conducted at Muizenberg Beach and Lagoon Beach, and the survey focused on the people who were around the beach, either the beachgoers, residents or people who work around the two beaches. This includes recreational water sports participants and lifesavers. Random questioning did not cover other areas beyond the specified areas in these two sites. Before participating in the study, the participants were informed of its nature, and that their participation was voluntary. During the introduction, they were also informed that they could withdraw from the study at any time. Participants were assured of anonymity and confidentiality.

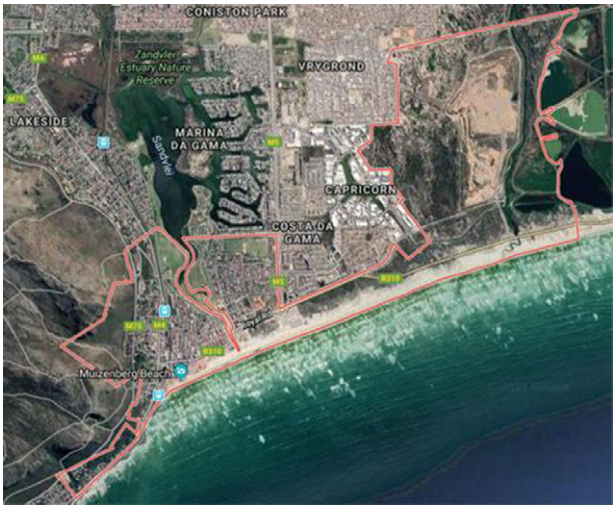

Figure 1. Satellite image of Muizenberg Beach demarcated by a red line.

Figure 2. Lagoon Beach demarcated by a red line.

Validity and reliability

Through questionnaires, the data collection method has been outlined according to the study's well-defined objectives. Experts (co-

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authors, such as Siyabonga Madonsela) within the specific field dealing with bush encroachment management and pre-field administration validated and endorsed these structured interviews and questionnaires. As part of the pretest, questionnaires were given to participants to determine how they would respond to questionnaires before heading to the field. After the pilot phase, feedback provided a useful basis for adjusting the questionnaires and structured interviews. Following the pilot study, Cronbach's α was 0.76, which was acceptable and satisfactory.

Data analysis

Using IBM Statistical Package for the Social Sciences version 26, a programme for editing and analysing data (Verma, 2012) that ensures the meaningful and symbolic content of qualitative data, we analysed questionnaire data such as demographic information (Creswell et al., 2007). The significance of the significant statements and phrases regarding the studied phenomenon was then formulated into significant statements.

Results and discussion

Demographic profile of Muizenberg and Lagoon Beaches

The majority of the participants from Muizenberg Beach were male, with a percentage of 66.67%, while 33.33% were female, as shown in Figure 3. This is supported by the 2011 data from Stats SA, which showed that Muizenberg Beach had more males than females, with 19,012 (51.58%) males and 17,845 (48.42%) females in 2011. However, the Western Cape was recorded to have ~5.8 million people and more than half of the population, ~51% of the population, was females (Stats SA, 2011).

In Lagoon Beach, the minority were male participants with a percentage of 46.67% of the sample size. Female participants in Lagoon Beach contributed about 53.33% of the total sample size. Stats SA of 2011 contradicts the above information; they state that there were ~48,258 (50.46%) males and 47,371 (49.54%) females in Lagoon Beach (Figure 4). However, findings by the Western Cape population profile (2017) states that Cape Town has 51.5% females.

The majority of the participants in Lagoon Beach were in the age groups of 25–34 and 45–54 years, with 23.33% of the total sample size, as shown in Figure 5. Participants at the age group of 35–44 years and those below 18 years were the second most participants in the survey with 13.33%. The lowest percentage was observed for the age group of 55–64 years, with 10%. The majority of the Lagoon participants were in their early 20s to late 30s, referred to as youth, and there was also a high number of middle-aged participants. The

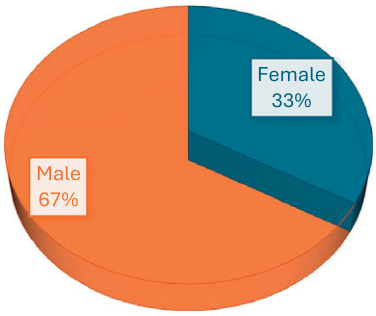

Figure 3. The gender distribution of the beachgoers who participated in this study in Muizenberg Beach.

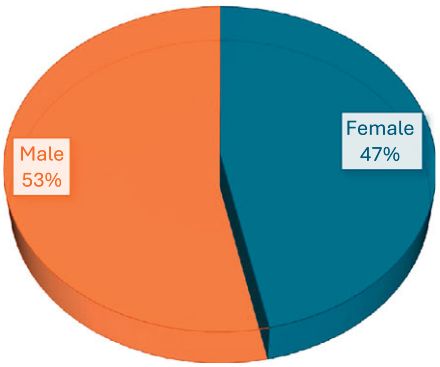

Figure 4. The gender distribution of the beachgoers who participated in this study in Lagoon Beach.

fewest participants were teenagers (<18) and older-aged adults (>55) (Figure 5). While at the Muizenberg Beach, it was found that the majority of the participants were in the age groups of 25–34 and 18–24 years, both age groups having 30% of the sample size, are shown in Figure 6. Furthermore, this meant that the population is predominantly young adults (youth). The remaining 40% was split into the age group of 35–44 years, who accounted for 23.33%, while the participants younger than 18 years and those in the age groups of 55–64 years represented 6.67% of the sample size (Figure 6). The fewest participants were found in the age group of 45–54 years with 3.33% of the population (Figure 6). This shows that the representative population is composed of young adults (18–34) and has few middle-aged adults (36–55 years), while it also has older adults that are twice the number of middle-aged adults (Figure 6).

There were a couple of similarities and differences between the two sites. Here is a comparison of demographics between the two sites. Young adults, aged 18–35 years, were the dominating participants from both sites. However, Lagoon Beach had a high number of older adults compared to Muizenberg, with an age range above 55 years. In terms of the employment status of the participants, there were more employed participants in the survey in both areas. Although South Africa suffers from a high unemployment rate, the selected sample size was merely affected by this issue. With the increasing number of tertiary students in South Africa, students were the second dominant group in the survey's employment status. According to Stats SA of 2011, there were more females than males in South Africa. This was further published by Stats SA of 2019, showing that there are still more females than males.

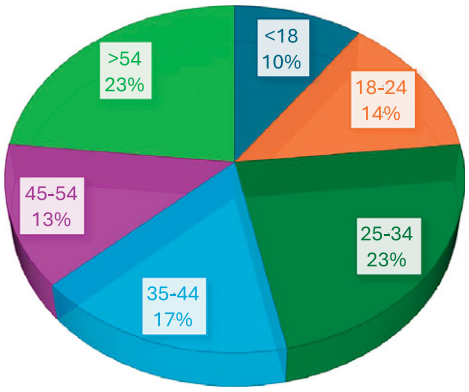

Figure 5. The age distribution of the beachgoers who participated in this study in Lagoon Beach.

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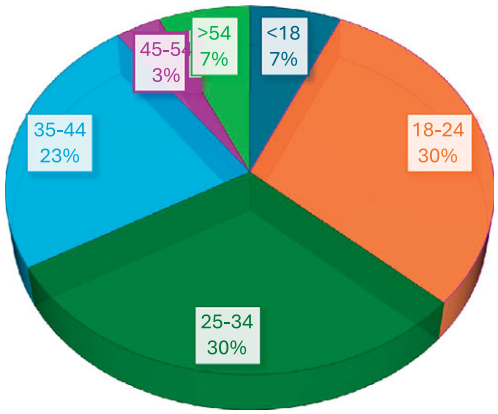

Figure 6. The age distribution of the beachgoers who participated in this study in Lagoon Beach.

Although Stats SA provided such information, Muizenberg had more males in the survey than females compared to Lagoon Beach, which was dominated by females.

The knowledge of microplastics and the sources of information, from Muizenberg Beach respondents

The participants were asked if they had an idea of what microplastics are and where they heard about it; options were given for them to choose from. About 40% of the respondents did not know what microplastics are, while 60% did know, as shown in Figure 7. Sixty percent of the participants who have knowledge of microplastics were further asked from where they learnt about microplastics. Approximately 16.67% of the participants identified radio/TVs as their source of information about microplastics (Figure 7). Approximately 44.44% of the participants responded that they knew microplastics and learned about them on social media. It is evident that the rises in the use of social media platforms have an educational contribution. About 5.56% of the participants who know microplastics have indicated that they obtained their knowledge via lecture. Over 33.33% of the participants below 18 years, who know microplastics, have indicated 'other' as their source of information, which could be friends, newspapers or other sources of information. The above results are in line with Kapoor's (2011) study that showed how mass media plays an important role in creating environmental awareness and distributing information. During Kapoor's (2011) study, it was shown that a majority of people were gaining environmental education through radios and most of them were found to be illiterate; community radio stations have been playing a key role in promoting environmental issues and raising awareness (Mbangati, 2020).

Many studies, including this one, have shown that, in general, media plays a vital role in educating people about environmental issues, particularly social media and radio. Some people use social media and other media channels as their sources of self-education, so the high numbers of social media users may be linked with the interest of self-education. However, this is not surprising because the world has become more digital as figures are on social media. Several studies found that major media channels were found to be effective for educational purpose and that was in line with the results found in this study (Kapoor, 2011; Kushwaha, 2015; Chen and Wang, 2021). Although majority of people indicated that people must be educated more on microplastics, and they have human health impacts. A smaller percentage have stated that microplastics have no human health impacts and there is no necessity for education. However, Hammami et al. (2017) contradicted the results by stating that the use of education to reduce microplastic pollution is an effective method. Those who indicated that microplastics have human health impacts may have been guessing the response or their sources of information about microplastics may have highlighted human health impacts. The above results are not a true reflection of the entire population and there were missing aspects during the study.

The knowledge of microplastics and the sources of information, from Lagoon Beach respondents

Figure 8 is the correlation between whether people know microplastics or not and where they learned about microplastics. The graph shows that out of all the people that participated in the study

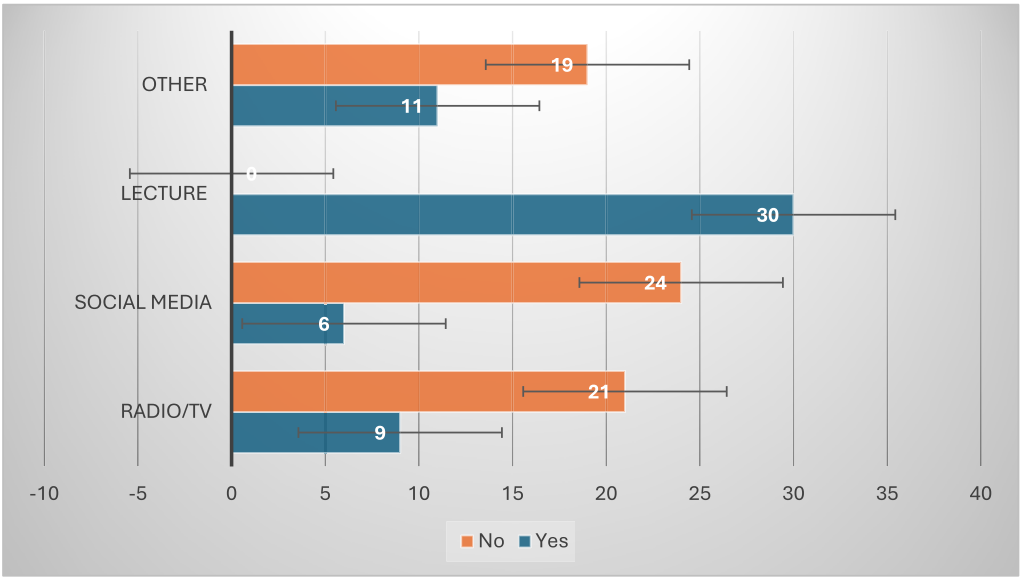

Figure 7. The knowledge of microplastics and the respondent's sources of information about microplastics, from Muizenberg Beach respondents.

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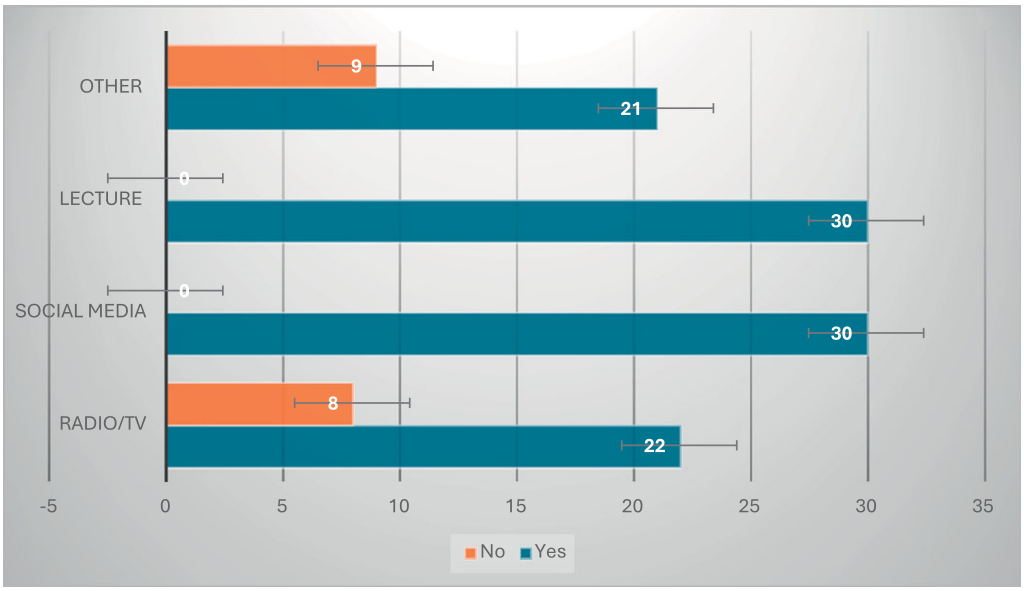

Figure 8. The knowledge of microplastics and the respondent's sources of information about microplastics, from Lagoon Beach respondents.

in Lagoon Beach, 26.67% do not know what microplastics are, while 73.33% know the subject. Those who had knowledge of microplastic pollution were then asked to identify their source of knowledge. Roughly, about 36.36% of them identified radio/TVs as their source of information about microplastics. Furthermore, another 36.36% of people from those who indicated that they know microplastics selected social media as their source of knowledge, while 18.18% of the participants in the sample indicated that they learned about microplastics during lectures, and only a few (9.09%) participants have indicated that they have learned about microplastics from other sources. In support of the above results, Kushwaha (2015) states that the approach to using different media sources to address environmental issues is a promising development. Targeting social media and radio/TV was suggested to be a better way of reaching a larger part of society than using flyers and websites (Kushwaha, 2015). The issue with websites and flyers was the fact that not everyone has access to websites and some people are illiterate to read on flyers. Völker et al. (2022) conducted an empirical analysis of media framings and concluded that three main narratives are used in media reports: (i) that microplastics are abundant in the environment; (ii) that microplastics are present in food and beverages; and (iii) that microplastics contain toxic chemicals that animals may ingest. Many respondents associated microplastics with their presence in the environment, primarily in marine habitats, as well as environmental pollution and animal distress, according to our findings.

Education about microplastic pollution and its impacts on the environment

The majority of respondents associated microplastics with potential consequences, frequently in relation to environmental impacts and less frequently with personal impacts as shown in Figure 9. Although it was also mentioned where microplastics can be found, such as in aquatic environments and the ocean, opinions regarding potential causes/sources appeared to be somewhat hazy. This is consistent with previous research, indicating that the public may not be aware of the origins of microplastics (Anderson et al., 2016; Deng et al., 2020; Henderson and Green, 2020).

While some responses to the close-end question on microplastics define the issue rather explicitly, others suggest merely a hazy grasp. This current study assumed that a higher understanding of microplastics leads to decreased levels of fear based on respondents' familiarity with various media narratives about microplastic consequences (Fiene, 2013: 41; Renn, 1998). Subsequently, in this study, they did not examine the accuracy of the public's knowledge of microplastics, but rather inquired about self-assessed knowledge and understanding of microplastics information. Based on the

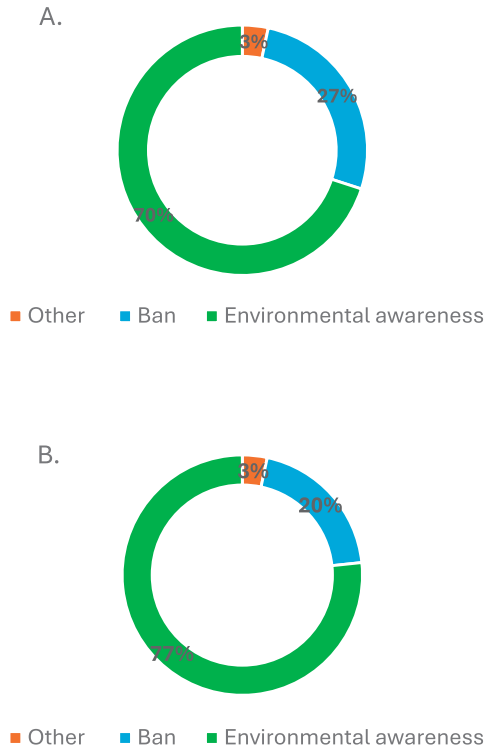

Figure 9. Relationship between the need for more education on microplastics and human health impacts, based on respondents at (a) Muizenberg Beach and (b) Lagoon Beach.

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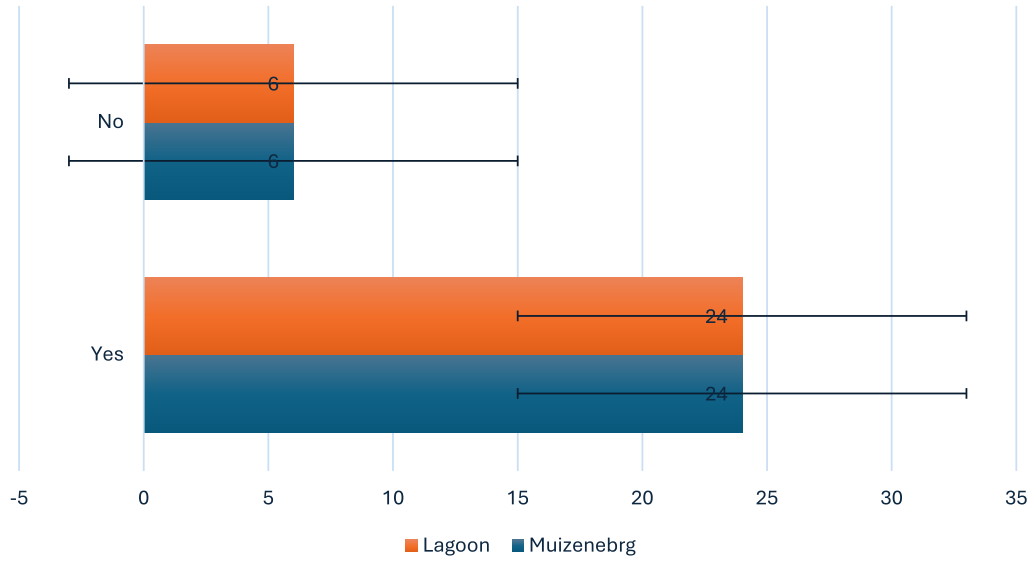

Figure 10. Participants' response on whether microplastics have an impact on human health.

results obtained from the data analysed from the Muizenberg data, 20% of respondents indicated that there is no need for education, while 80% of the participants indicated that there is a need for education on the subject, as shown in Figure 10. The need for more education on microplastics and plastic disposal is supported in a study by Hammami et al. (2017). Several scientists (Choy and Drazen, 2013; Wright and Kelly, 2017) conducted studies that are in line with the results obtained in this research. The studies state that the knowledge on the impacts of microplastics on human health is limited (Choy and Drazen, 2013; Wright and Kelly, 2017). In support of the results, Smith et al. (2018) stated that they have the potential of causing lung cancer in humans depending on the quantity of consumption.

In Figure 10 representing Lagoon Beach data, 27.27% of respondents indicated that microplastics have no impact on human health and 72.73% of the participants said there is an impact on human health (Figure 9 left). A maximum of 84.21% of the participants of the total sample have indicated that people need to be educated more on the subject, while 36.67% of the participants of the total sample indicated that there is no need for education about microplastics. Approximately 66.67% of participants (16 out of 24 participants) who indicated that microplastics have an impact on human health were those who indicated that there is a need for education on the subject. About 33.33% (8 out of 24 participants) of those indicated that microplastics have human health impacts were those who indicated that there is no need for education about microplastics. Wals et al. (2014) indicated that urgent issues such as environmental pollution and climate change should be addressed through science education by sharing teaching knowledge and skills through various media. The majority of Lagoon Beach participants have agreed to the need for more education on microplastics. This is supported by Hammami et al. (2017) who also marked environmental education and awareness campaign as better methods of educating the public about environmental issues of concern. The studies indicate that human health impacts depend on the dosage (Smith et al., 2018). Similar findings have been reported by other researchers (Anderson et al., 2016; Henderson and Green, 2020), for example, even though people frequently associated evaluations with our research, the types of evaluations they made primarily concentrated on attributing a negative affective valence to microplastics and, to a lesser extent, on the viability of resolving the problem. As a result, only a few respondents mentioned or were unaware of the possibility of other forms of evaluation, which may explain the lack of a wider range of evaluations. Providing participants with more comprehensive knowledge about effective strategies to decrease microplastic contamination could lead to a wider range of opinions on different aspects of microplastics, such as the importance of the issue and the effectiveness of the suggested solutions. This adds to the existing corpus of research that calls for increased communication efforts focusing on both the risks and solutions associated with microplastics (Veiga et al., 2016).

Conclusion

If they were well-versed in media narratives, women, middle-aged individuals and the elderly exhibited relatively elevated risk perception. Environmental consciousness and media literacy strongly predicted the perceptions of the dangers that microplastics pose to the environment and human health. Media messages and established social norms influence the public's perceptions of plastic pollution and the newly discussed issue of microplastics. Rather than focusing primarily on potential negative effects, information campaigns may benefit from combining data about specific sources of microplastics with practical advice on how people can take everyday steps to help mitigate the problem. This is consistent with the theory that knowledge of behavioural options and prospective action methods is one of the most important categories of information associated with pro-environmental behaviours (e.g., Kollmuss and Agyeman, 2002). The findings of this study highlight the need for increased scientific literacy that utilises media in compelling and accurate ways to engage diverse audiences in innovative and creative ways. The issue of microplastics must be presented with consideration for cultural specificity, media preferences, scientific comprehension and perceptions of plastics.

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