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The degree of awareness of the risk of microplastic particles/people's perception in taking preventive measures for this type of risk

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Abstract. Microplastic particle (Mps) pollution is and will continue to be threatening to the entire planet. There is still no clear and complete information about the effects of Mps. In the field of research, the data held so far is enough to have reasons for concern about this global phenomenon that shows an upward trend in global plastic production. The persistence in all four environmental factors and the extreme diversity of Mps lead to high levels of uncertainty in hazard and exposure estimates for this type of risk. Why do we produce plastic? Due to its durability, rigidity, and even abrasion. Currently, few studies have examined how individuals perceive these particles. Our research is based on how Romanians perceive risk Mps and how such risk perception affects people's pro-environmental behavioral intention. The research method is based on a survey (questionnaire) of 409 people from all over Romania, sent online through different platforms. GDPR rules were taken into account when preparing the questionnaire so that respondents are not asked for their personal data. One of the questions in the questionnaire measures the following statements on a scale from 1 to 7, where 1 represents total disagreement and 7, total agreement. Affirmations: R1 - Taking measures against Mps pollution in your household will cost too much money;/R 2 - Mitigating Mps pollution will cost too much time;/ R 3 - Lack of space, hard-to-change habits, and physical effort required are inconveniences for taking de-pollution measures or to mitigate Mps pollution. The results of our study show that in Romania, the perception of individuals in the decision to take measures against Mps pollution costs too much money, obtaining a percentage of 13.30% (total agreement - 7). Time is not a variable obtained in the survey that creates problems for respondents in helping to mitigate Mps pollution. The lack of space in

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Romanian households is a variable where a percentage of 18.76% was obtained (total agreement-7), this being an inconvenience to take depollution measures with Mps. A closer examination of people's perceptions supports the design of appropriate interventions that can reduce plastic consumption, promote proper disposal, and thus decrease Mps pollution risks with benefits to human health and the environment.

Keywords: microplastic particles, perception, awareness, risk.

1. Introduction

Plastic materials are composed of synthetic polymers and occupy all spheres of modern day-to-day life. From the total production of plastic, at the end of 2018, Asia represented 51%, China, 30%, Japan: 4%, and other Asian nations: 17% [1]. The aquatic environment is polluted with plastic materials worldwide [2], [3] because the use of plastic materials is ubiquitous, bringing benefits and advantages to society and not least to the world economy [4].

Human exposure to pollution is believed to be more intense now than at any other time in human existence [5]. Among the causes of environmental pollution with microplastics are a number of activities such as industry, transport, agricultural and commercial activities, residential areas, etc. However, the demand for plastic is growing exponentially and production trends are expected to quadruple by 2050 [6]. Inadequate management of plastic waste has caused the accumulation of contaminants in the environment, resulting in 20 million tons of plastic litter entering the ocean annually [7].

The production and use of plastics have followed an upward trend over the past two decades and reached a record high with the COVID-19 pandemic [8]. During the COVID-19 pandemic, 1.6 million tonnes of plastic waste was generated worldwide per day, mainly due to high market demand in the production of single-use personal protective equipment. This means that there was an annual plastic waste generation of 75 kg per capita [9].

Mps waste present in a landfill, not properly treated and without sufficient protection, can leak into the environment. Mps pollution from landfills should receive more attention [10]. Due to the increase in plastic production, import, use of products, and last but not least plastic waste, Mps pollution is a ubiquitous and emerging environmental and public health problem worldwide, but with an increased risk in underdeveloped states. A good example would be related to Mps pollution in Africa where Deme [11], proposed a bottom-up hybrid regulatory approach to manage this type of pollution. By 2025, more than 55% of municipal waste must be recycled, with the percentage rising to 60% by 2030 and 65% by 2035. EU countries are legally obliged to establish a separate collection of textiles and hazardous waste by 1 January 2025 generated by households and until December 31, 2023, bio-waste must be collected separately or recycled (compost) at source [12].

1.1. Background and aims

These newly formed small particles are called microplastics (Mps) and nanoplastics (NPs). Mps are plastic particles with a diameter of less than 5 mm [13]. Due to sources and different types of weathering, different forms of Mps result, including fragments, fibers, spheres, films, and foams [14], [15], [16]. The chemical composition of Mps mainly includes polyethylene (PE), polyvinyl chloride (PVC), polystyrene (PS), polypropylene (PP), and other common plastics according to various plastic sources [17].

A major risk affecting all four environmental factors is pollution related to Mps particles. One of the important environmental factors that is polluted with Mps particles is the air. If it is clean then we can call it an important and indispensable resource, especially for the modern world. Air is an environmental factor that continues to deteriorate year by year, but many people are still indifferent to this seriousness of pollution [18]. The alarming increase in particulate air pollution (Mps) in many cities of the world greatly affects human health [19] and also leads to an increase in respiratory diseases [20], cancers [21], etc. The degradation of the environment is also reflected in the water resources that the planet has which, like the air, are greatly affected by this danger Mps.

A main cause of water pollution is the improper treatment of wastewater that ends up back in the circuit without being passed through a decontamination process [22]. For the improvement of gray water treatment, the technological process plays an important role, becoming the determining factor that can lead to a decrease in water pollution [23]. Last but not least, the effects of the soil pollution phenomenon have a direct link with the quality of life, because both the population and the entire biodiversity are seriously affected by the consequences of the contamination of this important environmental factor and its exposure to the Mps pollutant [24].

1.2. Aim of the study

This increasing presence over the years of Mps particles in many components of the environment is a cause of concern for humanity due to their small size and potential risk to health and the environment. Rose [25] through its study reviews about 380 articles that have been evaluated, to discover the extent of the fate of Mps particles, their transport in air, soil, freshwater, and marine, as well as their effect on different ecosystems.

The perception of individuals plays an important role in reducing this type of pollution that is still growing. According to Guan [26], even a short environmental video can effectively involve the population, NGOs, and last but not least governments, in combating the overproduction of single-use plastic products, as a prime example.

Following this principle, in our study, we focused on three hypotheses, namely: R 1) Taking measures against Mps particle pollution costs too much money for

individuals; R 2) Pollution mitigation costs too much time; R 3) Lack of space, hard-to-change habits, too much physical effort, are inconveniences to make decisions and de-pollution measures or to mitigate Mps pollution.

2. Materials and methods

The project was carried out based on an online survey in 2022, interviewing 409 people in Romania, where we tracked the perception, attitude, and behavior regarding Mps particles.

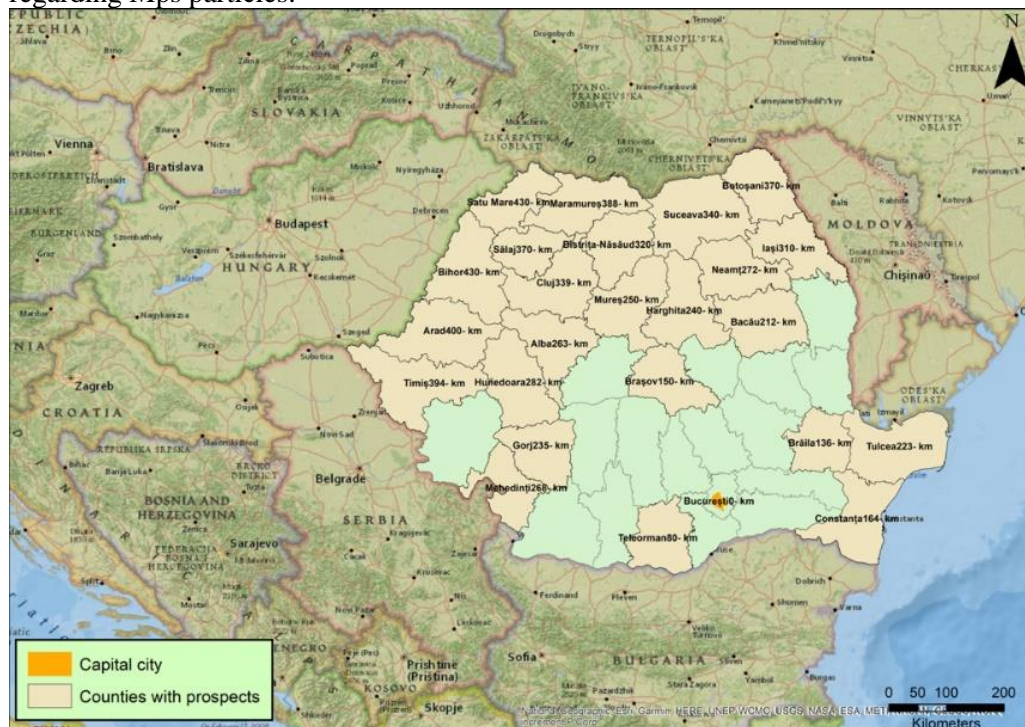


Fig. 1. Map data: Created by authors using Arc maps

The location of the interviewed persons on the map of Romania with the 25 counties where the interviews were conducted is represented in (Fig.1). The numerical values represent the distance between each county and the capital, Bucharest. The questionnaire had 17 questions, including an optional question about other information that the respondents received from the press, TV, etc., about Mps. The questions in the survey were related to the degree of awareness, the risk perceived by the respondents for the environment and health, perception, behavior, and awareness.

Profile of respondents

The average age of the people who participated in the survey was 38,5 years, of which 33,5% were men and 66,5% were women. The human environment

predominated with a percentage of over 80% and the percentage of people with university education was 66%.

3. Results

On a scale from 1 to 7, we analyzed the answers of the respondents for the three statements: R 1) Taking measures against Mps particle pollution costs too much money for individuals; R 2) Pollution mitigation costs too much time; R 3) Lack of space, hard-to-change habits, and too much physical effort, are inconveniences to making decisions and de-pollution measures or mitigating Mps pollution. The number 1 represents total disagreement and 7 represents total agreement. Bigger differences were obtained in hypothesis number 3 (R 3), where the Romanians surveyed stated that “Mitigating Mps particle pollution costs too much time for them”. Only 17.77%, a small percentage, stated that it is not a matter of time to mitigate Mps pollution (Table 1). In the hypotheses R 1 and R 3, the percentages are similar. A little over 18.00% of the percentage of those interviewed say that money is a problem for them to take measures against Mps pollution, respectively 22.46% of the Romanians interviewed say that the lack of space in their households is a problem that hinders them in the mitigation and de-pollution process with Mps.

Table 1. Three variables tested on a scale from 1-7, against Mps pollution and mitigating this type of risk

	1- total disagreement	7- total agreement
R 1. Taking measures against Mps pollution in your household will cost too much money	18,00%	13,30%
R 2. Mitigating Mps pollution will cost too much time	17,77%	44,93%
R 3. Lack of space, hard-to-change habits, and physical effort required are inconveniences for taking de-pollution measures or to mitigate Mps pollution.	22,46%	18,78%

3.1. Hypotheses

R1 - Taking measures against Mps pollution in your household will cost too much money

For R 1. “Taking measures against Mps pollution in your household will cost too much money”, the percentage results are similar. We do not have a large percentage of interviewed Romanians who state that taking measures to mitigate Mps pollution costs too much money for them. The percentage is 18.00%, but for 7 (totally agree) we also have a not very high percentage of respondents who claim that they totally agree that the Mps risk reduction action would cost a lot of money for them (Fig. 2). The result is gratifying.

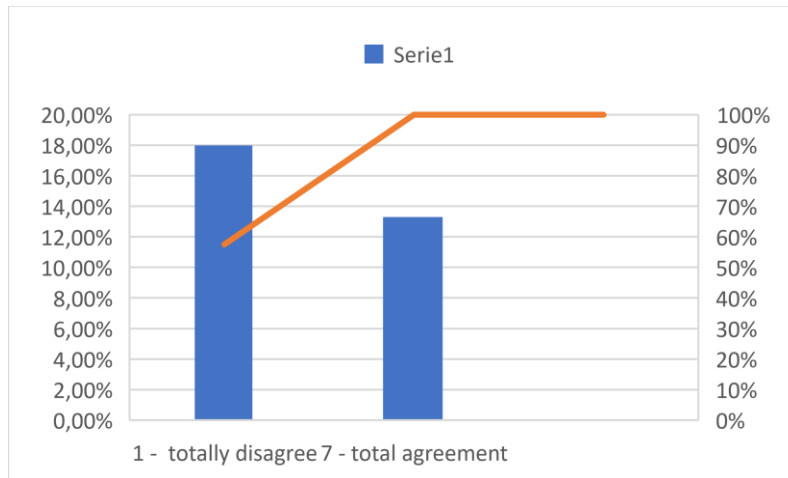


Fig. 2 . R 1- Taking measures against Mps pollution in your household will cost too much money

R 2 - Mitigating Mps pollution will cost too much time

In the question related to R 2 “Pollution mitigation costs too much time for you”, the participants in the online survey expressed their opinions on a scale from 1 to 7. And here for this question, the number 1 represents total disagreement, and 7, total agreement. From the answers of the respondents, it can be seen that for the Romanians participating in the survey, time is a big problem, because a percentage of over 44% said that the "time" variable is an impediment in mitigating Mps pollution (Fig.3).

More than 17% of the respondents expressed their opinion by answering with the number 1- (totally disagree), for them "Mitigating Mps particle pollution" does not cost too much time.

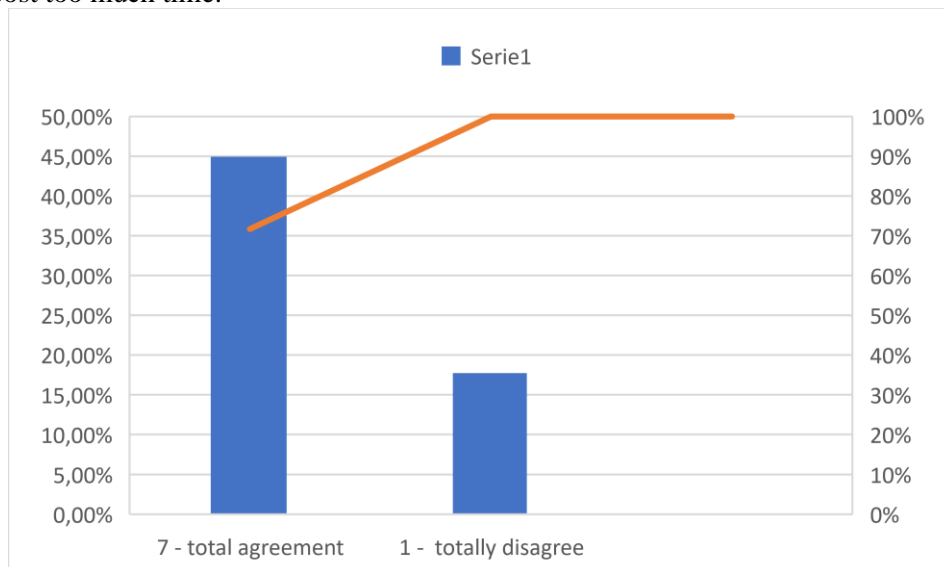


Fig. 3. R 2 - Mitigating Mps pollution will cost too much time.

R 3 - Lack of space, hard-to-change habits, and physical effort required are inconveniences for taking de-pollution measures or mitigating Mps pollution

The answer of the survey participants for hypothesis R 3 “Lack of space, habits difficult to change, increased physical effort, are inconveniences to take depollution measures or to mitigate Mps pollution”, can be seen in figure number 5. More than 22% of the respondents answered that the lack of space in their households is not a problem for them (Fig. 4). Neither physical effort nor hard-to-change habits prevent them from trying to mitigate pollution by trying to take measures in this regard. More than 18% of the people interviewed say that habits that are difficult to change, and the lack of space are inconveniences for them to take the necessary measures, against Mps pollution.

The risk created by Mps particles has a slow action and it is necessary that the results obtained from various actions to raise awareness of the degree of risk worldwide, from governments, from NGOs, and last but not least from each individual, are put into practice in the future to change the perception of individuals, what this type of risk has to do with it.

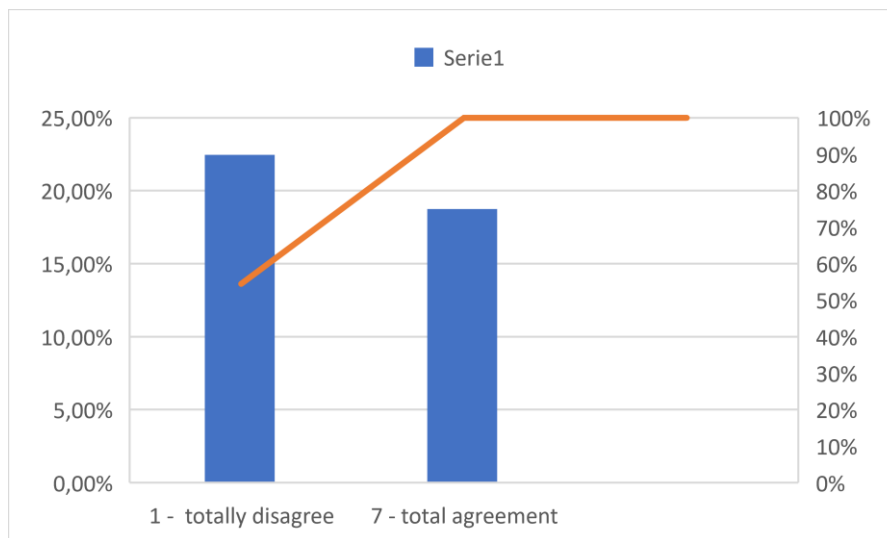


Fig. 4. R 3- Lack of space, hard-to-change habits, and physical effort required are inconveniences for taking de-pollution measures or mitigating Mps pollution.

4. Discussion

Environmental pollution and its potential to influence human health and the environment, in recent times, is high, being at the same time a problem of universal interest all over the globe. This pollution reaches its worst proportions, of course, in the urban-industrial centers that are densely settled, and densely populated, in the more developed countries. The industry, grouped in urban and semi-urban areas, surrounded by densely populated localities, continues to pollute the

environment and affect human health over time. Over the past three decades, there has been a growing global concern about the public health impacts of environmental pollution. Human exposure to pollution is believed to be more intense now than at any other time in human existence [5].

As the circular economy is a rapidly growing “young” field according to Zhang [27], which makes the transition from trash to treasure (chemical recycling and up-cycling of plastic waste into fuels, high-value chemicals, and advanced materials), are points that could reduce Mps pollution, but at the same time, the behavior and perception of this type of risk are very important when they come from the population. Based on the data obtained from the survey, we analyzed through the hypotheses listed above, if the Romanian population is concerned about this area (Reduction, Recycling, Reuse, Refusal, Replacement, Single-use replacement), and if taking measures in this area.

For hypothesis number 2 “Mitigation of Mps pollution costs too much time for individuals”, the highest percentage was obtained for number 7 (total agreement), being over 44% of the respondents affirming this.

Time is an important resource and precisely for this reason, there is a need for a change in the prioritization of everyday activities. Advertisements, mass media with repeated activities, pro-environment, anti-plastic pollution, NGOs, and governments through legislation help to change the behavior of individuals and the perception related to this type of risk.

Taking measures in your own households to reduce Mps pollution starts with recycling, reuse, etc., but this needs to happen on a national level. Municipalities at the local level through the specific European legislation, transposed at the national level, could help to increase the percentage of recycling [12], [28], [29], [30]. Recycling points must be in close proximity to households, something that is not yet happening throughout the country.

The lack of space for Romanians is a problem that prevents the mitigation of pollution related to the Mps risk, and precisely for this reason, even in Romania, the percentage in the recycling area is low, placing us at the end of the European ranking [31].

5. Conclusion

The growing demand for plastic warrants further research to reduce the persistence and increase the biomineralization of plastic pollutants globally. Considering the toxicity and health effects of Mps particles, there is a global need to search for better alternatives to efficiently isolate and degrade Mps, present in various environments.

The pro-environmental behavior of employees and consumers in general demonstrates that in recent decades their concerns for a healthier lifestyle and environmental care are driving forces for reducing and mitigating this type of risk. Every year, approximately 42,000 tons of Mps end up in the environment following the use of products containing them. It is estimated that approximately

176,000 tonnes of Mps produced unintentionally as a result of wear and tear from large pieces of plastic reach the surface waters of the European continent annually [32].

Mitigation of pollution and, last but not least, its reduction starts from each individual, but specific legislation applied at all levels is needed. The population must be helped to be able to take measures in this regard, with recycling points as I specified above that should be near the households, because as it results from the survey together with physical effort and habits that are difficult to change, we still have to also consider the lack of space for storage before a proper recycling of the plastic.

6. Limitation

In the case of our survey, we have some limitations related to the distribution of the questionnaire to the participants. The dissemination was done online, through different channels, which can lead to a lower degree of attention from the participants than if it had been done face to face.

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