

A survey on knowledge and awareness on the issue “microplastics”: a pilot study on a sample of future public health professionals

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Parole chiave: Microplastiche, ambiente, salute pubblica, studenti universitari, operatori di sanità pubblica

Abstract

Background. Microplastics pollution represents a global public health concern. Since the greatest amount of microplastics are of anthropogenic origin, one of the most relevant strategies to reduce microplastics pollution is to raise awareness among the population and this is even more important for all those involved in public health prevention interventions. The aim of this study was to assess the level of knowledge and awareness on microplastics of a samples of future healthcare workers.

Study Design. A cross-sectional study was performed on 151 university students in the field of Public Health, both pre- and post-graduate, attending the Sapienza University of Rome courses.

Methods. A questionnaire consisting of three sections was administered to the participants. The first section assessed knowledge and awareness on microplastics, the second consisted of an informative brochure on microplastics, the third evaluated the awareness after reading the brochure, and interventions considered useful to manage microplastics pollution.

Results. About 25% of participants had never heard of microplastics. The scores on knowledge about microplastics were low, and differences between the investigated courses were not statistically significant (p -Value=0.134). Internet was the main source of information on microplastics, while the scores describing concern about the investigated issue resulted always higher after reading the informative brochure respect to before reading.

Conclusions. The lack of knowledge about microplastics pollution highlights that future public health workers should be better informed and, therefore, able to transfer essential information to the population. Increasing general population's knowledge and awareness would increase risk perception and make all individuals more active actors for reducing microplastics pollution.

Introduction

Microplastics pollution and its implications for environmental and human health are an issue of increasing concern for the scientific community. The term “microplastics” is used to define plastic particles sized 5 mm or

smaller (1), which are classified as primary or secondary according to their origin (2). *Primary* microplastics are any plastics manufactured to be less than 5 mm (3) and typically used in cosmetics (4), in moulding processes as plastic powders (5) and as drug vectors (6). *Secondary* microplastics are the

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result of fragmentation of plastic materials into smaller pieces both during their use and after disposal, whose final repository is the environment (7, 8).

Microplastics can enter the environment through different pathways: the release of fibers and particles into water during synthetic clothes washing (9, 10); the industrial production of plastic-based or plastic-containing products; mechanical factors such as friction, impact, disintegration, etc; incorrect disposal (11, 12); degradation processes, including biodegradation by living organisms, photodegradation by solar radiation, thermal and thermo-oxidative degradation induced by high temperature and oxygen, and hydrolysis (13). Furthermore, the use of cosmetics containing plastic microbeads determines an estimated environmental daily release equal to 2.4 mg per person (7).

Although humans may be exposed to microplastics by inhalation of contaminated air, the most alarming issue on microplastics pollution is their accumulation in environmental matrices such as soil and water and their consequent intake by plants and animals. As regards the soil, thousands of tonnes of plastic end up in cultivated areas every year (14-16) as a result of landfills leaching (17), fertilization by sewage sludge (16, 18), irrigation by wastewater (19, 20), or compost and organic fertilizers (21), atmospheric deposition (22, 23). This massive contamination poses risks for both environmental and human health because microplastics change the soil structure, its function and microbial constitution, determining negative consequences on plants and animals and reducing quality and safety of food (24). Additionally, also the hydraulic conductivity can be affected, influencing its fertility (25). As far as the aquatic environment is concerned, microplastics are mainly detected in oceans, seas, rivers, lakes and groundwater (26, 27), where many different marine species may

ingest and accumulate them (28). In this way, microplastics pass from the low trophic levels of the food chain to humans (29, 30). Thus, the ingestion of contaminated fruits and vegetables from polluted soils (31) and of marine fishes, bivalves and crustaceans (32) becomes the main source for the intake of microplastics.

After ingestion, microplastics may release monomers and other components or, when they are nanometer-sized, enter directly the bloodstream, in both cases posing a great concern for public health. In fact, plastics usually contain toxic chemicals such as Bisphenol A, phthalates and heavy metals (33) that may cause cytotoxicity, oxidative stress, genotoxicity and alterations of gene expression in human cells (34). Besides, both plastic-released compounds and nanosized microplastics may reach and damage others systems (35-37). Finally, microplastics assumption via inhalation can also lead to respiratory distress and inflammation (38-40).

Given the evidences on negative outcomes for human and environmental health due to microplastics exposure, in the last few years, the authorities have focalized their attention on this problem. For example, the 2030 Agenda for Sustainable Development, adopted by the United Nations on September 25th, 2015, includes strategies for marine pollution control and management, fixing a significant reduction by 2025 (41). Main interventions are addressed to amend bad practices and lack of infrastructure in solid waste management and many European Countries defined specific measures for implementing waste prevention programmes and waste management plans, as requested by the European Parliament with L 150/144. Despite these recommendations, a recent review reported that, even if current clean-up strategies have reduced plastic and microplastic pollution, they are not sufficient to resolve the problem due to the increasing amounts of plastics entering

the environment; for this reason, one of the most important approach to reduce the production is to raise awareness among the general population on this issue (42). A key part of the population who should be aware of the risks associated with microplastics pollution is represented by public health workers, who are fundamental in health education and prevention strategies devoted to inexperienced public. The aim of this pilot study was to assess the level of knowledge and awareness of medical students and residents in public health with regard to the theme “microplastics pollution”, in order to evaluate their competence in such a problem and to evidence possible needs for information, training and updating the future leading figures of Public Health.

Methods

Study design and population

This was a cross-sectional study carried out on 151 undergraduate or postgraduate students attending the Sapienza University of Rome. In particular, the study sample was made up of 83 students attending the “Environment and Workplace Prevention Techniques” (EWPT) Degree courses, 34 students attending the “Health Assistance” Degree courses and 34 Residents in Public Health (RPH), previously graduated as MDs. The research project was presented to the Presidents of the selected university Degree Courses, who organized the meetings with the students. The project was illustrated to all the students in the classroom, after clarifying the purposes and the reasons of the survey. Knowledge and awareness of participants were assessed through a self-administered, anonymous questionnaire elaborated “ad hoc” and validated before the beginning of the study. The questionnaire was administered to the students of the different Degree courses on different days of the same academic year.

Questionnaire and covariates

The questionnaire was elaborated on the basis of scientific evidences (3, 10, 17, 24) and of an educational project on microplastics performed by the non-governmental organization “A Rocha International” (43). The questionnaire consisting of three section: the first one assessed the knowledge and the awareness on microplastics pollution, the second consisted of an informative brochure on microplastics and the last evaluated again the awareness after reading the brochure and possible interventions considered useful to control microplastics pollution.

In particular, the participants were asked to respond to 13 questions. The first question “Have you ever heard of microplastics?” had three possible responses “no”, “yes, sometimes” and “yes, often”, then coded as follows: “no” and “yes” (the sum of “yes, sometimes” and “yes often”). The second question “From which source of information have you heard of microplastics?” had several responses (friends and relatives, conferences and seminars, internet, books, information brochures, radio, television, newspapers, environmental journals, women’s magazine, magazines, scientific journals, specialists and other). Participants could give more than one response, then coded to obtain a ranking. The third question “Have you ever directly searched information about microplastics?”, had three options: “never”, “sometimes” and “frequently”. The fourth question “Have you ever discussed about microplastics?” had several options (never discussed, with friends, colleagues, health workers, relatives and other), then coded with progressive numbers from 0 to 5. The response to the fifth question “How do you consider your knowledge about microplastics?” was in form of an ordinal scale from “1” corresponding to “no knowledge” to “10” designated “expert”. The next questions investigated the general knowledge on microplastics. In particular, the sixth, the seventh and the eighth questions “According to you, which shape microplastics

have?”, “In your opinion, what dimension microplastics have?” and “In your opinion, what is the main origin of microplastics?”, evaluated respectively participants’ knowledge about form, dimensions and origin. Possible responses for the sixth question were “fibers”, “spherical particles”, “irregular particles” and “fibers and particles”, while those for the seventh question were “plastic fragments visible at naked eye”, “a few cm”, “less than 1 mm” and “infinitesimal”. Possible options for the eighth question were “industrial production of plastic products”, “the release of fibers and particles to water”, “washing synthetic clothes”, “physical phenomena: friction and disintegration of plastic products”, “use of plastic products”. Each participant was asked to create a classification of the responses from the most to the less important source of microplastics. The ninth question “In your opinion, microplastics can affect human health?” had the following responses: “no”, “yes”, “I do not know”. The tenth and eleventh questions were asked to evaluate respondents’ concern about microplastics, respectively before and after reading the informative brochure, with an ordinal scale from “1” corresponding to “no concern” to “10” indicating “great concern”, with question “How much do you concern about microplastics?”.

After reading the informative brochure, if the concern changed, participants were asked to explain the reasons for. The last question was asked to draw up a personal ranking based on the following possible control interventions: “reduce use of plastic products”, “separate collection of waste”, “recycling”, “inform population about microplastics”, “more incinerators”, “reduce plastic packaging”, “penalties for those who do not properly dispose of waste”, “less synthetic clothes”.

Other requested information to each participant were gender (male or female) and age (continuous variable).

All the responses were coded and entered in a database created “ad hoc”.

Statistical elaboration

Statistical elaboration was performed using IBM SPSS Statistics 25 statistical software (IBM Corp., Armonk, NY, USA).

Possible differences in the percentages of the responses to the question “Have you ever heard about microplastics” of the students attending each investigated Degree course were compared through the chi-squared test. Median values of the responses to the question on knowledge given by the student of different Degree courses were compared by the use of Kruskal-Wallis test, while median values of the responses to the concern respectively before and after the reading of the informative brochure for each course were compared through the Mann-Whitney test.

Results

In Table 1 the characteristics of the study population are reported. The mean age was 22.5, with the youngest and the oldest participants aged, respectively, 19 and 54 years. Women were about 60% and more than 50% among the pupils attending the EWPT Degree course.

Table 1 - Characteristics of the study population

Variables		N	%
Age	22.5 [6.16]*		
Gender	Female	87	59.6
	Male	59	40.4
Course	Health Assistance	34	22.5
	EWTP**	83	55
	PH***	34	22.5
	Residents		

*arithmetic mean [standard deviation]

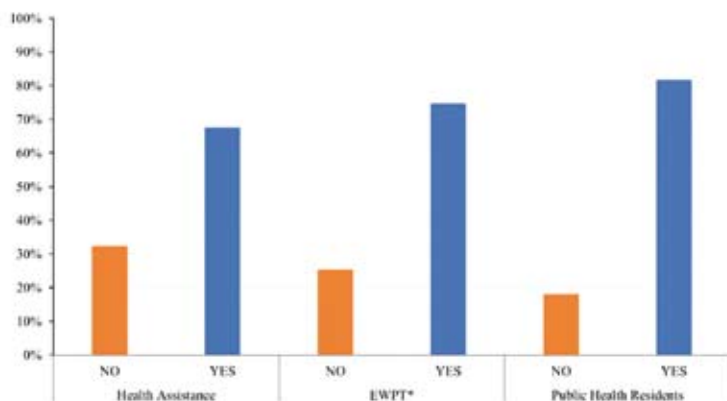
**EWTP= Environment and Workplace Prevention Techniques

***PH= Public Health

Figure 1 shows the distribution frequencies for the responses to the question: “Have you ever heard about microplastics?” More than 30% of Health Assistance students had never heard about microplastics, while almost 20% of the RPHs answered “Yes” to the same question. In any case, there is not a

significant difference between the answers given by the attending students of each university course (p -Value=0.411).

Table 2 reports the ranking of the information sources from which each student heard about microplastics. “Internet” was the most used source for all the university



*EWTP= Environment and Workplace Prevention Techniques

Figure 1 – Distribution frequencies for the responses to the question: “Have you ever heard about microplastics?”; results grouped according to each university course.

Table 2 - Ranking of the responses to the question “From which source of information have you heard of microplastics?”

Ranking	Source	N	%	Health Assistance % (N)	EWPT* % (N)	Public Health Residents % (N)
I	Internet	77	25.8	18.2 (14)	54.5 (42)	27.3 (21)
II	Television	62	20.8	19.4 (12)	59.7 (37)	21.0 (13)
III	Friends and Relatives	23	7.7	21.7 (5)	56.5 (13)	21.7 (5)
IV	Scientific Journals	22	7.4	4.5 (1)	40.9 (9)	54.5 (12)
V	Environmental Journals	19	6.4	26.3 (5)	26.3 (5)	47.4 (9)
VI	Newspapers	18	6.0	5.6 (1)	50.9 (9)	44.4 (8)
	Specialists	18	6.0	-	50 (9)	50 (9)
VII	Conferences and seminars	13	4.4	7.7 (1)	38.5 (5)	53.8 (7)
VIII	Books	11	3.7	-	45.5 (5)	54.5 (6)
	Magazines	11	3.7	9.1 (1)	27.3 (3)	63.6 (7)
IX	Other	10	3.4	-	90.0 (9)	10.0 (1)
X	Radio	8	2.7	25.0 (2)	25.0 (2)	50.0 (4)
XI	Information brochures	5	1.7	20.0 (1)	20.0 (1)	60 (3)
XII	Women’s Magazine	1	0.3	-	100.0 (1)	-

*EWTP= Environment and Workplace Prevention Technique

students, while “Scientific Journals” were only at the fourth position and they were mostly quoted by the RPHs. In addition, information gathered by questionnaires evidenced that more than two thirds of the participants from Health Assistance and EWPT and more than one third from RPHs had never searched for the issue “microplastics” and most of the study population never discussed about this issue.

Figure 2 shows the answers to the question “How do you consider your knowledge about microplastics?”, grouped according to each university course. The scores for knowledge resulted, on average, 2.70, 2.99 and 3.55 for Health Assistance, EWPT and RPHs, respectively. The difference between the percentages of the responses of the attending students of each university course resulted not statistically significant (p -Value=0.134).

Most of the participants believe that microplastics are in the form of fibres and particles (35.3%, 48.2% and 55.9% for Health Assistance, EWPT and RPHs, respectively) and of dimension less than 1 mm (58.8%,

55.4% and 61.8% for Health Assistance, EWPT and RPHs, respectively).

Almost all the participants suppose that microplastics can affect human health, while the remaining replied that they did not know about any possible related risks.

Table 3 reports the ranking generated from the answers to the question “In your opinion, what is the main origin of microplastics?”. “Industrial production of plastic products” and “Use of plastic products” ranked first on an equal footing.

In Figure 3 are reported the scores representing the concern of participants about microplastics, respectively before and after reading the informative brochure. The scores were always higher after reading the informative brochure. In the cases of Health Assistance and EWPT, the differences between the before and after scores were statistically significant (p -Value=0.001 and <0.001 , respectively). Differences in the scores, in the most of cases, were explained by the increase of awareness and knowledge about the issue “microplastics”.

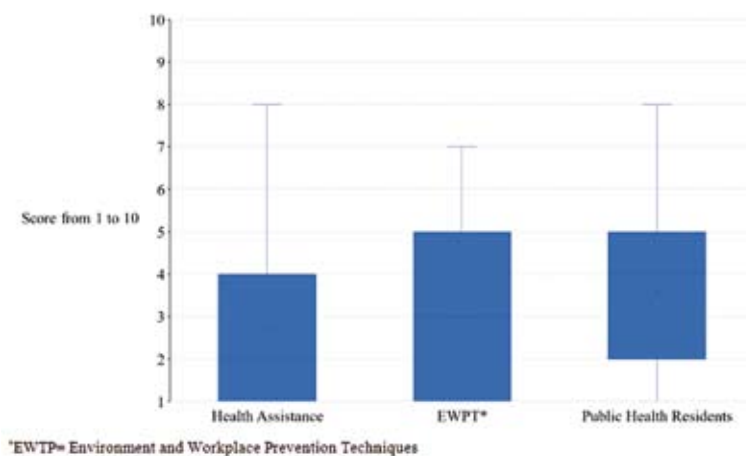


Figure 2. Boxplot and whisker plots illustrating the distribution of the percentage of the responses to the question “How do you consider your knowledge about microplastics?”; results grouped according to each university course.

Table 3 - Ranking of the responses to the question “In your opinion, what is the main origin of microplastics?”

Ranking	Origin	N	%	Health Assistance	EWPT*	Public Health
				% (N)	% (N)	Residents % (N)
I	Industrial production of plastic products	144	25.4	22.2 (32)	57.6 (83)	20.1 (29)
	Use of plastic products	144	25.4	22.2 (32)	56.3 (81)	21.5 (31)
II	The release of fibers and particles to water, washing synthetic clothes	140	24.6	22.9 (32)	56.4 (79)	20.7 (29)
	Physical phenomena: friction and disintegration of plastic products	140	24.6	22.9 (32)	55.7 (78)	21.4 (30)

*EWTP= Environment and Workplace Prevention Techniques

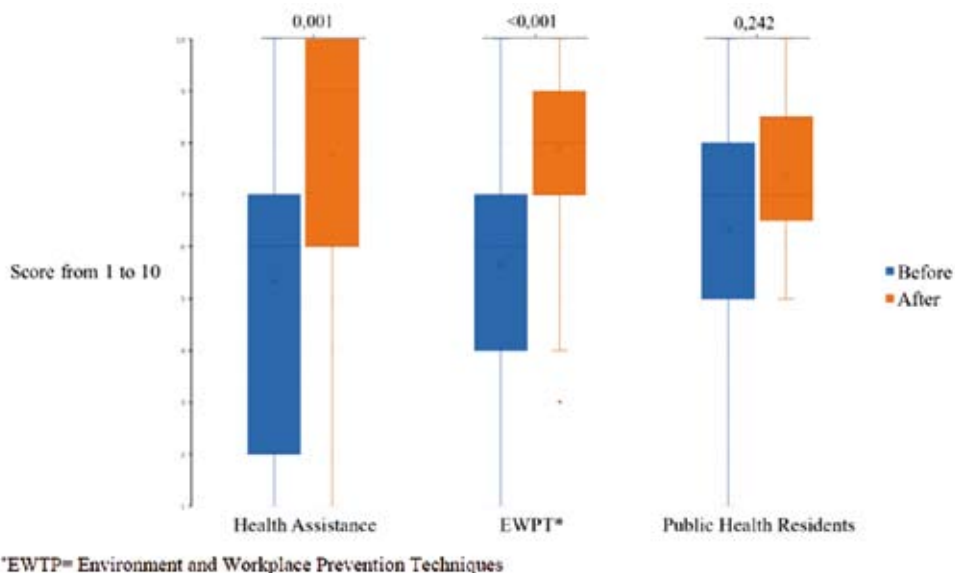


Figure 3 - Boxplot and whisker plots illustrating the distribution of the percentage of the responses to the question “How much do you concern about microplastics?”; results recorded before and after reading the information brochure, grouped according to university course.

Table 4 shows the ranking of the possible interventions to reduce microplastics according to the opinion of participants. “Reduce plastic packaging” and “Penalties for those who do

not properly dispose of waste” ranked first on an equal footing. The study population agreed that the last intervention should be the creation of “More incinerators”.

Table 4 - Ranking of the responses to the question “In your opinion, what is the main interventions to reduce microplastics?”

Ranking	Intervention	N	%			
				Health Assistance % (N)	EWPT* % (N)	Public Health Residents % (N)
I	Reduce plastic packaging	144	12.8	20.8 (30)	56.9 (82)	22.2 (32)
	Penalties for those who do not properly dispose of waste	144	12.8	21.5 (31)	57.6 (83)	20.8 (30)
II	Reduce use of plastic products	142	12.6	21.8 (31)	57.7 (82)	20.4 (29)
	Separate collection of waste	142	12.6	22.5 (32)	56.3 (80)	21.1 (30)
III	Recycling	140	12.4	22.1 (31)	57.1 (80)	20.7 (29)
IV	Inform population about microplastics	138	12.3	22.5 (32)	58.7 (81)	18.8 (26)
	Less synthetic clothes	138	12.3	23.2 (32)	57.2 (79)	19.6 (27)
V	More incinerators	137	12.2	23.4 (32)	58.4 (80)	18.2 (25)

*EWTP= Environment and Workplace Prevention Techniques

Discussion and conclusions

The first relevant result of the present study is related to the knowledge on the issue “microplastics” of the participants: a not negligible percentage of the study population has never heard of microplastics; this finding demonstrates a lack of knowledge also in students attending healthcare university courses. Besides, it is important to note that the participants who claim to have heard of microplastics, reported Internet as the main source of information. This is of concern because, even if currently Internet is the main source of all the search questions, data and evidences reported by Internet sites sometimes are unreliable and not scientifically supported. This result is backed by what has been reported by a review performed to evaluate the use of Internet as a source for health information: it seems that there is an increasing trend to search health information on websites (44). This evidence imposes to control websites reporting health information and, at the same time, involve

a great challenge for the creation and the dissemination of scientific websites reporting evidence-based health information. Notice that the gap of information on microplastics affects, with no significant differences, all the participants, both those attending the three-year courses and the RPHs, who are postgraduate students. Thus, the university students, at all levels, are in short supply of information on this issue.

In the present study, almost all the participants assume that microplastics can affect human health. There are still no clear scientific evidences about microplastics’ effects on human health and this is due to the complexity of being able to estimate microplastics’ toxicity and potential risks caused by ingestion of microplastics through food (45, 46). However, several studies have demonstrated that the accumulation of microplastic particles in the human body poses several potential threats due to cytotoxicity, hypersensitivity, unwanted immune response, acute responses such as hemolysis and respiratory distress

(36, 39, 47). These evidences, even if not strong, cannot be neglected considering the precautionary principle. This principle was developed as a result of the increase in environmental risks related to human activities that can damage the environment, and it focuses on situations where there is not a definite and demonstrated link between cause and effects. In these cases, the precautionary principle proposes to intervene on a possible environmental risk even when there are not (yet) scientifically evidences in order to prevent all possible damage (48).

Another important result is related to the score representing the participants' concern on microplastics, respectively before and after reading the informative brochure. The scores were always higher after reading the informative brochure and this difference in the most of cases were explained by participants with the increase of awareness and knowledge about the issue given by the information reported on the brochure. This finding is in line with those reported by a previous study (49) intended to evaluate the public perceptions and expectations to avoid endocrine disrupting surfactants, other important environmental risk factors. The authors demonstrated that the perception degree of a risk is related to multiple factors, including knowledge or insight knowledge, previous personal experience and self-control. In particular, knowledge of general population together with perception and attitudes seems to play an essential role in risk management process, as reported also by other studies (50, 51). Regarding the microplastics, knowledge and information can contribute to involve a reduction of the production of these products, a key concept to reduce the problem. Indeed, as well as for all the solid waste, once the microplastics have been produced, they enter the environment; thus, it should be essential to apply also to the microplastics the “Zero Waste”

approach, a set of principles that focus on redesigning resource lifecycles so that all products are reused (52). This approach is very important to reduce plastics' and microplastics' pollution because, according to the Organization for Economic Co-operation and Development (OECD), the majority of plastics (85%) is not recycled or reused, but sent to landfills or incinerators or ends up dispersed in the environment (53).

The present study has some limitations. First of all, the number of participants is limited to 151 students; in order to reinforce the results on knowledge and awareness of the future public health professionals, the sample size should be increased. Besides, the second section of the questionnaire was a very simple informative brochure on microplastics; it should be interesting to perform a study involving a more in-depth information and training session to better assess the chances in the knowledge and concern of participants. Finally, we compared students attending public health university courses; future studies should include also “not healthcare” university courses.

All the results demonstrate the importance of educational interventions on the general population about the issue “microplastics”. Indeed, increasing general population's knowledge about microplastics would increase their risk perception and probably convince all individuals to become active actors toward the elimination or at least to reduction of microplastics production, use and, consequently, pollution. Regarding the participants in the study presented here, in addition to be part of the general population, they will be part of the future public health professionals. Thus, it should be desirable to include a training on the microplastics' issue in pre- and post-graduate courses, in order to make aware of the problem all public health workers, who can transmit their knowledge to general population and play an active role

in the field of prevention and public health interventions.

Riassunto

Un'indagine su conoscenza e consapevolezza in tema di "microplastiche": studio pilota in un campione di futuri operatori di sanità pubblica

Introduzione. L'inquinamento da microplastiche rappresenta un argomento di preoccupazione globale per la Sanità Pubblica. Dato che una grande quantità di microplastiche deriva da attività antropiche, una delle più rilevanti strategie per ridurre l'inquinamento da microplastiche è quella di aumentare la consapevolezza della popolazione e questo è ancora più importante per coloro i quali sono coinvolti in interventi di prevenzione per la sanità pubblica. Lo scopo di questo studio è stato quello di valutare la conoscenza e la consapevolezza sulle microplastiche di un campione di futuri operatori sanitari.

Disegno dello Studio. Uno studio trasversale è stato condotto su 151 studenti universitari nel campo della Sanità Pubblica, sia laureandi che specializzandi di corsi sanitari della Sapienza Università di Roma.

Metodi. Un questionario costituito da tre sezioni è stato somministrato ai partecipanti. La prima sezione valutava la conoscenza e la consapevolezza sul problema dell'inquinamento da microplastiche, la seconda sezione consisteva in un dépliant informativo sulle microplastiche e la terza valutava la consapevolezza dopo aver letto il dépliant insieme ai possibili interventi considerati utili per gestire l'inquinamento da microplastiche.

Risultati. Circa il 25% dei partecipanti non aveva mai sentito parlare di microplastiche. I punteggi sulla conoscenza riguardo le microplastiche sono risultati bassi e le differenze tra i diversi corsi non statisticamente significative (p -Value = 0.134). I punteggi sulla preoccupazione sono sempre stati più alti dopo aver letto il dépliant informativo.

Conclusioni. La scarsa conoscenza riguardo al problema dell'inquinamento da microplastiche evidenzia che i futuri operatori di sanità pubblica siano meglio informati e, di conseguenza, capaci di trasmettere informazioni essenziali alla popolazione. Aumentando la conoscenza e la consapevolezza della popolazione generale, accrescerebbe la percezione del rischio tanto da rendere tutti soggetti più attivi nella riduzione dell'inquinamento da microplastiche.

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