Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 7
Open Access

A Bibliometric Analysis: The Developments Of Microplastics In Pregnant Women And The Placenta

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Cite this paper as: Nurul Amaliyah, Hasnawati Amqam, Hasanuddin Ishak, Syamsuar, Rahayu Indriasari, Wahiduddin (2024). A Bibliometric Analysis: The Developments Of Microplastics In Pregnant Women And The Placenta. *Frontiers in Health Informatics*, *13 (7) 839-849*

ABSTRACT

Background: Researchers have found microplastics in the placenta of pregnant women. The increasing presence of microplastics in the human body has motivated researchers to innovate and develop interventions related to microplastics. This bibliometric study aimed to analyze publication trends in the relationship between microplastics, pregnant women, and the placenta based on publications from 2022 to 2024. It also seeks to examine contributions from international collaborations across various journals, highlight the most influential authors and articles, and predict future developments in this topic.

Method: This study employed a bibliometric approach to analyze scientific output, covering 107 articles retrieved from the Scopus database, using VosViewer software and Tableau analysis.

Results: We found that the research on microplastics in pregnant women and the placenta, has increased in recent years. The number of publications peaked in 2023 with 42 publications, ndicating sustained interest in the topic. China produced the highest number of publications on this topic, totaling 39, with Xinyuan Liu as the most prolific author. Frequently used keywords included "microplastics AND pregnancy" and "placenta."

Conclusion: Research on microplastics in pregnant women and the placenta has shown a rising trend in publication numbers. ee workloads and provide rewards or incentives for those who work hard.

Keywords: Microplastics, Pregnancy, Placenta, Bibliometrics

INTRODUCTION

Plastic is a non-organic waste material with many benefits but also substantial negative impacts if not properly managed and used, particularly in daily life. It is lightweight, flexible, transparent, strong, durable, long-lasting, readily available, and affordable (1). Plastic are made from petrochemical substances that are highly hazardous if they re-enter the environment. These chemicals pose threat to life, especially to humans (2).

Microplastics, which are tiny plastic particles less than 5 mm in size, have been found to have significant negative impacts on human health and the environment. The term "microplastics" was first coined 19 years ago by Thompson et al. (2004), who studied marine plastic pollution in the UK. Microplastics contribute to pollution by entering natural

ecosystems through various sources, including cosmetics, clothing, food packaging, and industrial processes (3).

In marine environments, 35% of all microplastics originate from textile/clothing washing processes, mainly due to the erosion of polyester, acrylic, or nylon-based garments. Microplastics also accumulate in air and terrestrial ecosystems(4). Plastics degrade slowly, often over hundreds to thousands of years (5). Microplastics are highly likely to be ingested, assimilated, and accumulated within the body and in various tissues, including the placenta (3).

Over the past few decades, research has shown that pregnancy and infancy are particularly vulnerable to exposure to environmental toxins. Contamination in pregnant women affects both the mother and fetus. The direct effects of microplastics (MPs) on the health of pregnant women have not been extensively studied. Most knowledge about MPs' effects of MP's on maternal health and fetal development comes from animal studies (6).

Microplastics in the human body can lead to various disorders, including liver inflammation, weight loss, reduced mucin excretion in the colon, and disruption of amino acid and bile acid metabolism (7). In pregnant and breastfeeding mothers, microplastics may alter neural cell composition and brain histology in their offspring.

Microplastics can enter the bloodstream and reach the placenta from the mother's respiratory and gastrointestinal (GIT) systems through cells. Once MPs reach the maternal surface of the placenta, they may invade tissues via several transport mechanisms, both active and passive, which remain poorly understood. Transplacental microplastic passage (5–10 μm) may depend on varying physiological conditions and genetic characteristics (8).

Research (8) has identified 12 microplastic fragments isolated from four human placentas: five on the fetal side, four on the maternal side, and three in the chorionic membrane. This finding indicates that microplastics in the human body can reach placental tissue at all levels.

Based on this overview, it is crucial to evaluate the research scope of microplastic issues to provide insights into current data, trends, scientific collaboration, and impacts. One method to assess microplastic research developments is bibliometric analysis, which is popular among researchers as it helps map the focus and trends related to authors, institutions, and countries.

RESEARCH METHODS

Location and research design

This review focuses on research related to microplastics in pregnant women and the placenta, using data from international publications obtained through ScienceDirect, with data extracted from Scopus. Keywords such as "microplastics," "pregnant women," and "placenta" were used to support bibliometric analysis. The search was conducted using article titles, abstracts, and keywords from 2022 to 2024. The collected data included the number of publications per year, journals publishing articles on microplastics, and research subjects within the 2022–2024 period.

Population and sample

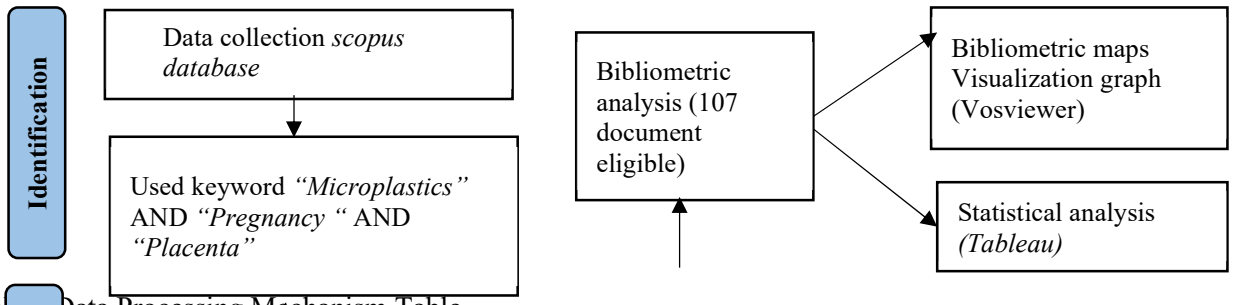
The curated dataset comprised 50 articles and 43 reviews from 93 publications. Data processing involved identifying relevant information in the Scopus database using the specified keywords, with 93 publications filtered and organized using Microsoft Excel. VosViewer software was used for data analysis to visualize trends in international publication development on the topic of microplastics, with bibliometric mapping and network visualization using various features.

Data analysis

Bibliometric analysis is an approach used to examine the evolution of a research domain, including topics and authors, based on the social, intellectual, and conceptual structure of a discipline. It is commonly used across scientific disciplines, focusing on quantitative studies of journal articles, books, and other forms of written communication (9). The results of the bibliometric analysis help researchers identify potential research areas and locate potential collaborators. A literature review was conducted after performing a bibliometric analysis. Initially, titles and abstracts from the search results were screened according to predefined eligibility criteria. The full texts of the selected articles were evaluated to ensure compliance with the eligibility criteria.

a. The Inclusion Criteria: Study period between 2022 and 2024; studies in the final publication stage; publications in English; and document types: articles and reviews.

b. The Exclusion Criteria: Publications in languages other than English; theses, dissertations, books, book chapters, conference papers; and literature.

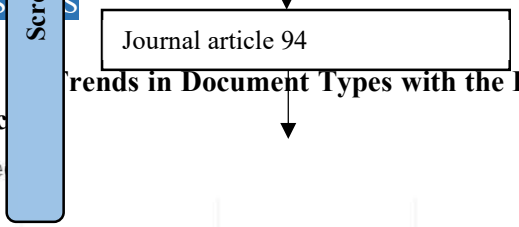


Tab Data Processing Mechanism Table

Rese Ethics

This y was conducted in accordance with the principles of research ethics. Prior to data collection, ethical approval was ned from the Ethics Committee of the Faculty of Public Health, Hasanuddin University The data collected were l only for research purposes and kept confidential.

RES S



1. Trends in Document Types with the Highest Publications on Microplastics in Pregnant Women and the Plac

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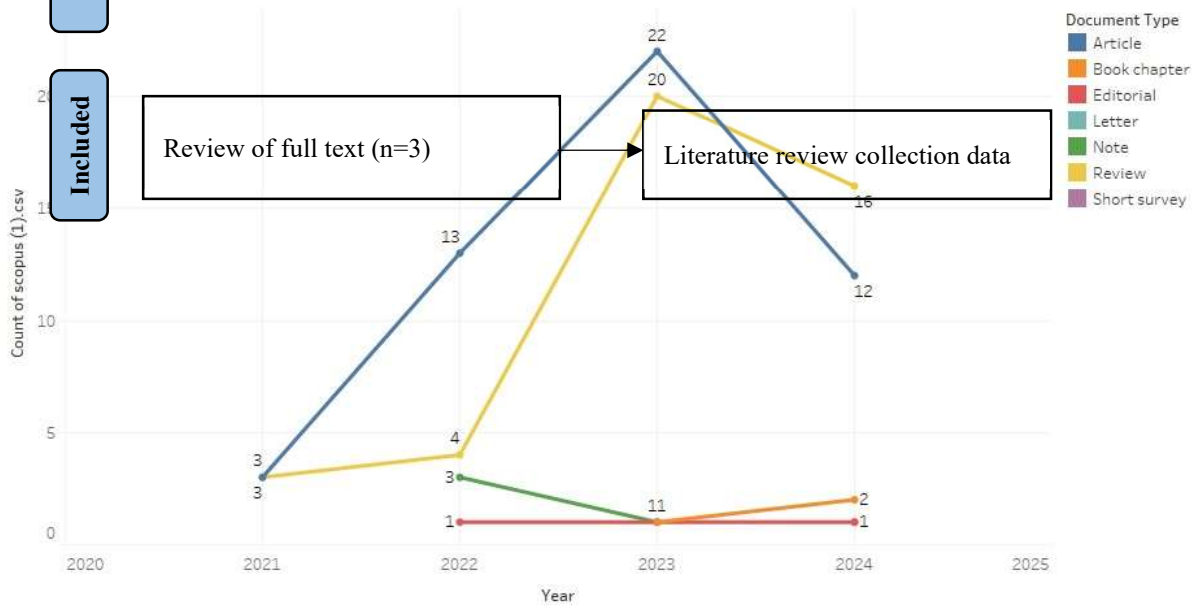

The trend of count of scopus (1).csv for Year. Color shows details about Document Type. The marks are labeled by count of scopus (1).csv. Details are shown for Document Type.

Figure 1 Annual Publication Trends in Microplastics

The bibliometric analysis visualization presented in Figure 2 shows a pattern of increasing yearly trends in the literature on microplastics in pregnant women and the placenta. Articles and reviews were the two primary publication categories that represented the evolution of this research. The number of published documents in this field rose in 2023, with 22

articles and 20 reviews, compared to only three articles and three reviews in 2021 and 13 articles and four reviews in 2022. However, by 2024, the number of publications declined to 12 articles and 16 reviews, resulting in a total of 107 documents (43 reviews and 50 articles). This four-year period (2021-2024) demonstrates significant fluctuations in publication trends within both categories. Articles and reviews have shown varying publication numbers, reflecting growing interest in this topic. Current work on this subject is gaining more attention, and the number of publications is expected to rise in the future, aligning with government programs that emphasize community-based interventions for microplastics. Thus, microplastics in pregnant women and the placenta remain an intriguing research area.

2. Contributions from Various Countries

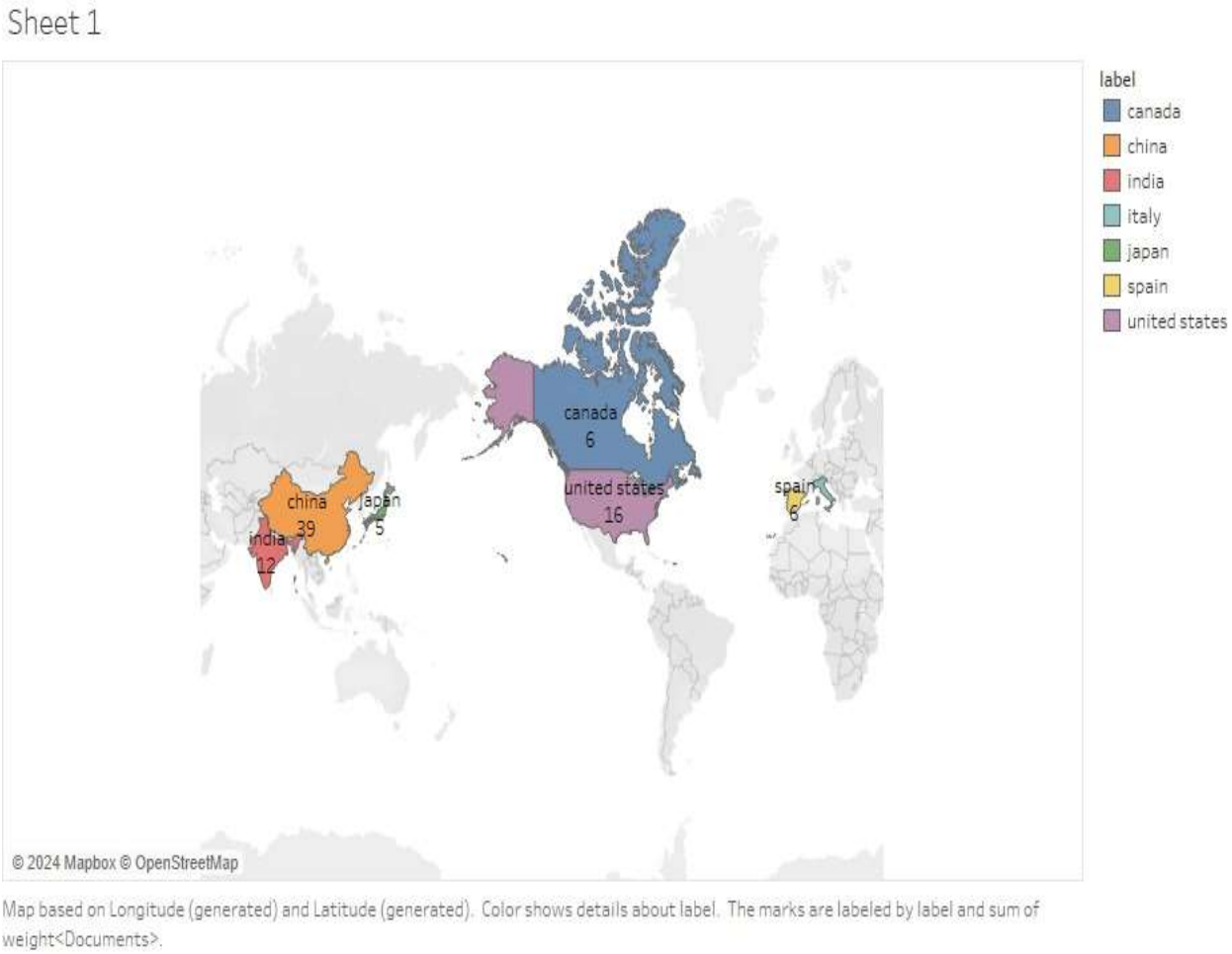

Figure 2 Contributions from Various Countries

The number of publications contributed by a country can indicate the intensity and distribution of research authorship on a given topic. Figure 2 shows that, among the seven contributing countries, each has reported at least five documents. China leads other nations in the number of articles on microplastics in pregnant women and the placenta, highlighting its prominent role in advancing research on this topic.

3. Co-occurrence Network Analysis of Author Keywords

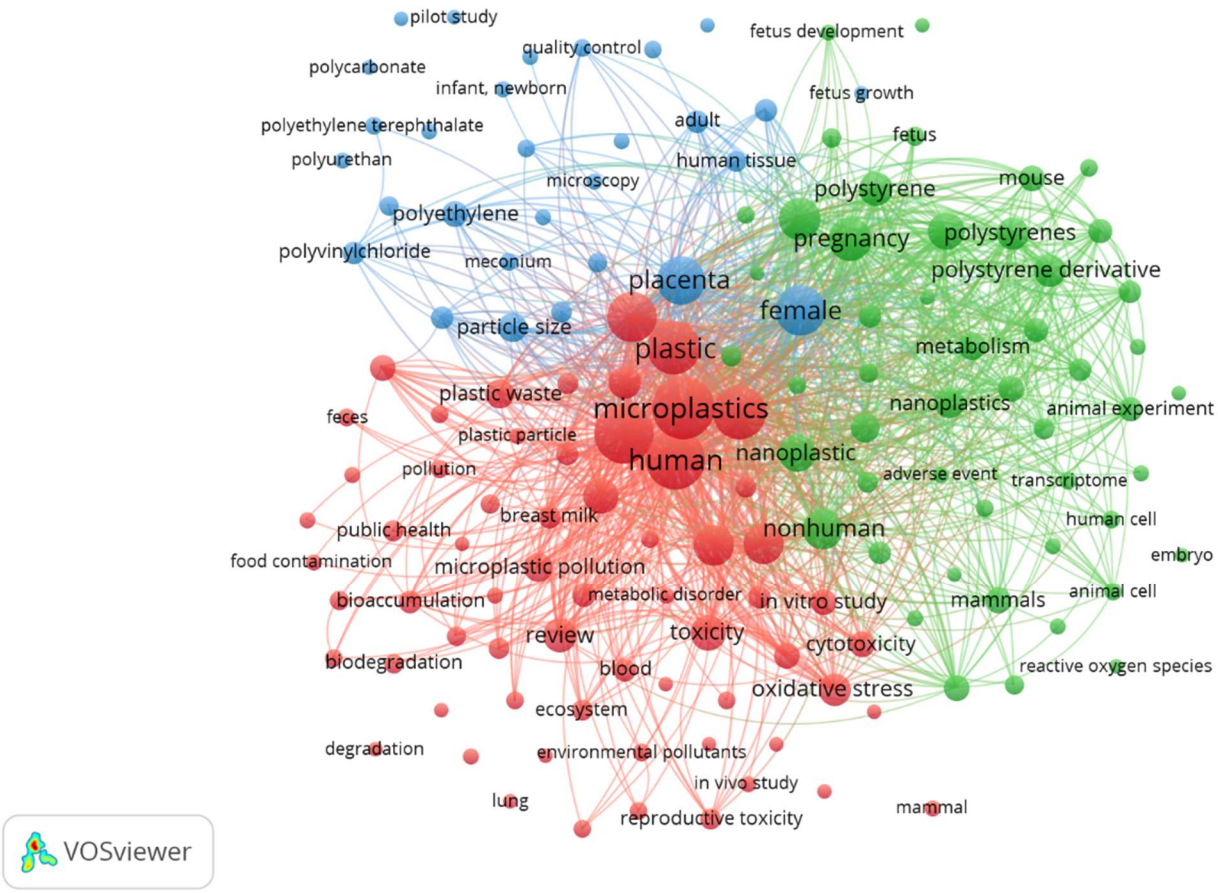

Figure 3 Co-occurrence Network Analysis of Author Keywords

The clusters were divided into 143 items and three clusters, each represented by different colors, as shown in Figure 3. Cluster one (red), cluster two (green), and cluster three (blue) highlight distinct research themes. Based on Figure 3, the most prominent cluster is cluster one (red), which contains 64 items focused on the topic of microplastics in humans. The phrase "microplastics in humans" was linked to several other clusters in the co-occurrence network of author keywords. Among these, cluster two (green) centers on pregnancy and includes 50 items, while cluster three (blue) focuses on the placenta, comprising 29 items. This analysis underscores the interconnected nature of research topics related to microplastics, emphasizing their impact on human health, particularly in relation to pregnancy and placental development.

4. Co-occurrence Network by Author Keywords 2022-2023

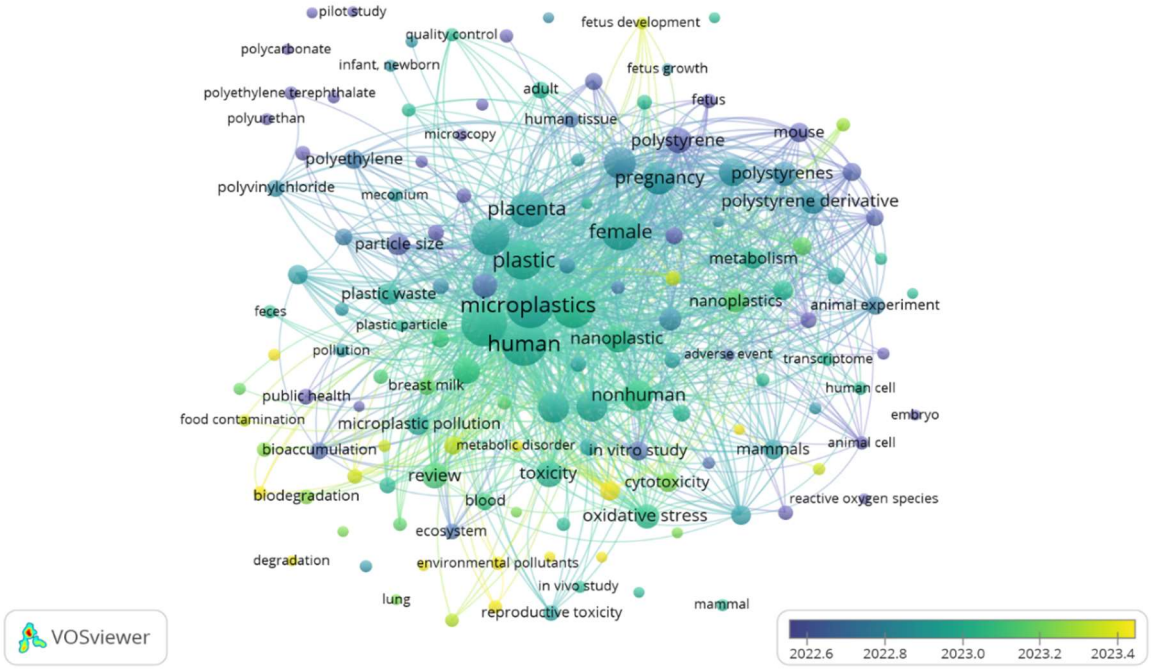

Figure 4. Co-occurrence Network by Author Keywords 2022-2023

Additionally, the bibliometric analysis of microplastics in pregnant women and the placenta suggests potential directions for future research, as indicated by the visualization of keyword occurrences over time. In Figure 4, the keywords highlighted in light blue have been frequently used in previous studies, indicating established research areas. Meanwhile, the keywords shown in yellow represent terms that are currently emerging in research and may lead to breakthroughs when combined with other keywords. This category includes "health risks," "environmental pollutants," "water pollutants," and "biodegradation." The bibliometric results revealed several publications related to the keyword “environmental pollutants” as a novel area, prompting a further literature review. The findings of this review are as follows:

Table 2 Microplastics in Humans Due to Environmental Pollutants

No.	Countries	Population Sample	Method	Measured Variables	Results	Ref
1.	China	Seventeen pregnant women were monitored from dietary intake to environmental exposure.	Experiment	17 placenta	The results showed that microplastics were detected in all samples, with an average abundance of 2.70 particles/g, ranging from 0.28 to 9.55 particles/g. PVC and PP polymers dominated these samples, with	(10)

					maternal exposure likely originating from the consumption of contaminated food in the environment.	
No.	**Countries**	**Population Sample**	**Method**	**Measured Variables**	**Results**	**Ref**
2.	China	Data from 18 pairs of mothers and their newborns were collected to assess microplastic exposure.	Experiment	Maternal feces and placenta.	The results showed that 12 fecal samples contained microplastics with an average abundance of 26.6 particles/g. Microplastics were found in the placenta in all samples, with an average abundance of 18.0 particles/g. Water consumption and the use of facial cleansers or toothpaste may serve as sources of exposure for pregnant women.	(11)
3.	Germany	Three pairs of pregnant women and their babies gave consent to participate in this pilot trial as part of the study.	Experiment	Maternal feces and placenta.	The results showed that all feces and placental samples tested positive for microplastics, with an average abundance of 0.48 particles/g.recorded. In the African water samples, 257-1215 particles/m^3 were found.	(12)

DISCUSSION

This study reveals an increasing trend in the literature on microplastics in humans, particularly focusing on pregnant women. Figure 1 shows that publications on microplastics in pregnant women and the placenta peaked in 2023. This year, there was heightened awareness of how microplastics enter the food chain and human bodily systems, including those of pregnant women. Microplastics, including blood, placenta, and amniotic fluid, have been detected in various parts of the human body. Concerns regarding fetal health impacts have spurred further research in this area.

Figure 2 indicates that articles and reviews are two publication categories that have seen an increase. The growing volume of literature on this issue stems from concerns that microplastics may lead to various health disorders, including inflammation, oxidative stress, and endocrine system dysfunction. In humans, chronic exposure to microplastics is suspected to be associated with diseases such as cancer, hormonal imbalances, and cardiovascular issues. Research findings have identified microplastics in different parts of the human body, including the lungs, blood, intestines, and placenta. These discoveries have strongly motivated scientists to delve deeper into the impact of microplastics. Enhanced detection capabilities have opened the door to more studies and prompted critical questions regarding the effects of everyday microplastic exposure. Research in this field is expected to expand further in the future, particularly with policies focusing on limiting single-use plastics and emphasizing water, air, and food quality, which is likely to encourage more studies on the effectiveness of regulations in reducing human microplastic exposure. Consequently, human microplastics have become an increasingly compelling research area.

Figure 3 shows the contributions from seven countries in publishing studies on microplastics in humans, with 39 publications in China, followed by the United States and India. China has emerged as a global leader in research and publications on microplastics, particularly regarding their impact on humans. In 2021, China contributed over 25% of the global research on microplastics, with approximately 1,489 publications, and continues to lead in this field. Chinese research institutions, such as the Chinese Academy of Sciences, play a pivotal role in these publications, significantly contributing to global research on this topic.

The United States ranks second, with 16 publications. The U.S. has made significant strides in advancing our understanding of how microplastics interact with human biology, including their effects on human-derived cells. While behind China, the United States is still a major contributor to microplastics research, including studies on their impact on human health. The U.S. has published approximately 789 articles on microplastics, accounting for 13.44% of global research on the topic, making it the second-largest contributor after China. These publications focused on the presence of microplastics in various environments and their potential toxicological effects on human health, including ingestion, absorption, and cellular impacts.

India ranked third in publication count, with a total of 12 publications. India has made significant contributions to microplastics research, particularly regarding environmental impacts and their presence in various ecosystems. However, the number of citations specifically addressing microplastics in humans from publications in India is still growing compared to that in leading countries, such as China and the United States. A substantial portion of research has focused on microplastics along India's coastal areas and water bodies, including pioneering studies on their environmental distribution, degradation, and ecological impact. Although environmental microplastics have been extensively researched in India, human-centered studies continue to develop.

Figure 3 highlights international collaboration networks among countries, showing different clusters in microplastics research on pregnant women and the placenta. While China has the highest number of publications, India stands out as the most internationally collaborative country, working closely with scientists from the United States, Japan, Spain, and China. This aligns with findings from (13) this indicates that papers with international co-authors often achieve higher citation averages. Figure 3 further illustrates the countries by publication evolution over time, with China shown in orange as a country with substantial publications in earlier research phases.

Based on the systematic review analysis outlined in Table 1, there is evidence of global development regarding microplastics as a source of human exposure. Marine animal contamination by plastic particles can occur through direct consumption or trophic transfer. For example, when people eat small fish, they consume the entire fish body, including the intestines, where microplastics are often found. This type of contamination through direct consumption, also known as bioaccumulation, should not be overlooked, because these fish generally consume microplastics at high concentrations. (14). The primary route of microplastic (MP) exposure in humans is through food consumption, including seafood contaminated with microplastics (15) commercially processed fish (16) sea salt (17) honey, beer, and food components. Most food products are occasionally contaminated by impurities from processing materials and contaminants present in their packaging (18).

Given its high nutritional value, seafood plays a vital role in human diet. Consequently, the consumption of contaminated seafood increases health risks, especially for small fish that are eaten (19). This aligns with studies highlighting the presence of microplastics in various commercially harvested aquatic species such as shellfish, oysters, crabs, shrimp, and fish (11). These tiny particles enter drinking water, seafood, and various freshwater sources, potentially putting unsuspecting individuals at a risk of ingesting them. Vulnerable groups, including pregnant women and newborns, face particular risks owing to their increased sensitivity to contaminants (19). The presence of microplastics in drinking water sources, including tap and bottled water, has become a growing concern. Pregnant women or newborns who rely on these sources may unknowingly ingest microplastics, potentially exposing themselves to associated contaminants. The potential accumulation of microplastics in the food chain, especially in fish and shellfish, appears to be the primary route of human exposure to microplastics. Food contamination with microplastics could have health impacts, particularly for pregnant women, owing to the higher vulnerability in this group (20).

The second route of exposure involves the inhalation of air and dust containing microplastics [14]. Airborne particulate matter has gained increasing attention in recent years because of its ability to travel long distances and penetrate the human respiratory system, making it difficult to avoid. During critical stages of pregnancy and for vulnerable newborns, common sources of airborne particulates include lifestyle habits and atmospheric pollution (19). The third route of exposure is skin contact. Microplastics are commonly used as exfoliants, thickeners, and binding agents in cosmetics and personal care products. People who use these products may absorb microplastics from their skin. Direct contact with these particles has raised concerns regarding their potential health impacts. This aligns with research by (11) suggesting that the use of cosmetics, facial cleansers, and toothpastes can lead to microplastic exposure through the skin.

However, this study had several limitations. First, it relies on the Scopus search engine, meaning that research published in sources that are not indexed by Scopus is not included. Second, citation counts from Scopus are generally more conservative than those from Google Scholar, which may result in potentially underestimating citation figures. Lastly, the number of papers reported by certain institutions and researchers includes various types of papers, such as original research, reviews, viewpoints, editorials, case reports, and letters to the editor. Therefore, the total number of articles may not reflect the original research conducted by different researchers accurately.

In general, our findings indicate a significant interest among international researchers in the field of microplastics research on humans. However, this interest remains concentrated in a limited number of research centers, highlighting the need for broader participation in human microplastics research. The results of this study underscore the need for enhanced research on the presence of microplastics in the human body. To address this gap, it is crucial to conduct multi-center studies, improve research skills among doctors across various institutions and educational sectors, and design research with greater translational value to improve outcomes in microplastic research on humans and their prevention. Achieving these goals requires substantial funding, and it is essential to raise awareness among funding agencies about this issue. At the policy level, there is a need to formulate research policies specific to each country, focusing on improving of infrastructure and funding to support human microplastic research. Furthermore, these policies should encourage research efforts that offer additional benefits to individuals, encompassing short, medium, and long-term

outcomes.

CONCLUSIONS AND IMPLICATIONS

Bibliometric analysis of research on microplastics in pregnant women and the placenta indicates a rising trend in the number of publications, with China as the primary contributor. The leading authors in this field include Xinyuan Liu, Shaojie Liu, and Xingfen Yang. The most prominent groups in the co-occurrence keyword analysis focused on microplastics, pregnant women, placenta, health risks, and pollutants. The results highlight potential research directions, including health risk interventions and environmental pollutants in the development of microplastics in pregnant women and the placenta. The increasing research on microplastics shows that there is a higher awareness of the impact of microplastics on humans, especially pregnant women. This research can be conducted in various developing countries with different levels of pollutants such as Indonesia, especially in industrial and urban areas to develop waste management technologies that can reduce the risk of microplastic pollution to the environment and humans, especially pregnant women. As well as innovations in environmental health technology to detect the presence of microplastics in pregnant women and their risks in the future. This data will be very useful for future research as well as useful for public health policies and preventive interventions in high-risk countries.

CONFLICT OF INTEREST STATEMENT

The author declares that there is no conflict of interest in the implementation and reporting of this research. This research was conducted independently without any influence or intervention from any party that could affect the objectivity of the research results. Conflict of interest Nothing has been announced. Confession We would like to express our gratitude and appreciation to the Education Fund Management Institution for its support and encouragement to this research effort.

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