Research in Health Science
ISSN 2470-6205 (Print) ISSN 2470-6213 (Online)
Vol. 11, No. 3, 2026
www.scholink.org/ojs/index.php/rhs

Original Paper

The Impact of Microplastics on Metabolic Disorders Worldwide: A Bibliometric Analysis

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Received: August 16, 2026 Accepted: September 3, 2026 Online Published: September 8, 2026

doi:10.22158/rhs.v11n3p94 URL: http://dx.doi.org/10.22158/rhs.v11n3p94

Abstract

Background: *In recent years, the impact of microplastics on metabolic disorders has attracted widespread attention. As the field develops rapidly, analyzing research trends and identifying research hotspots is crucial to guide future directions, and a comprehensive bibliometric analysis can provide valuable insights for this purpose.*

Methods: *This study focused on documents published between 2019 and 2026, and the data came from the Web of Science Core Collection (WoSCC). Use CiteSpace and VOSviewer to conduct visual analysis of authors, institutions, countries, co-cited references and keywords to reveal the knowledge structure and emerging trends in the field.*

Results: *A total of 140 documents from 66 journals, involving 971 researchers, 480 institutions and 41 countries/regions, were included in the analysis. The number of published articles worldwide is on the rise, especially in the past decade. China is the country with the most publications, Capital Medical University is the institution with the most publications, and Jin Yuanxiang is the author with the most publications. Keywords analysis shows that current research hotspots include nanoplastics, inflammation, polystyrene nanoplastics, and glucose metabolism.*

Conclusion: *This study provides a comprehensive overview of the global research landscape, highlights the rapid growth and increasing complexity of this field, identifies key research hotspots and trends, and points to emerging directions that are critical for the further development of this field.*

Keywords

bibliometrics, microplastic, metabolic disorder, research trends, emerging frontiers

1. Introduction

"Microplastics" is used to describe plastic fibers, particles, and films that are less than 5 mm in size[1]. They are found in the air[2], oceans[3], soils[4], sediments, and surface waters[5,6] around the world, and have even been found in the sparsely populated Antarctic[7] and Arctic. Some studies reported that the concentration of microplastics in surface water is between 10^{-5} and 10^{5} sheets/m^3 and up to 67,500 mg/kg in soil[8-12]. Microplastics may also be compounded with persistent organic pollutants (POPs) and antibiotics to form composite pollutants in the ecosystem, thus causing harm to plants, animals, and microorganisms, and migrating into humans through the food chain [13].

Plastics are extensively used nowadays in numerous fields owing to their convenience, higher stability, durability, versatility, and economy[14]. It is estimated that nearly 85% of used plastics are not recycled and thus directly or indirectly enter into the surroundings [15,16]. Once released into the environment, plastics are degraded into small fragments or particles due to weathering, mechanical forces of water, ultraviolet (UV) radiation, and biological metabolism. Generally, it is defined as microplastic (MPs) when the size of plastic debris or particles is less than 5 mm[17]. Such MPs fragmentation will further form of smaller-sized nanoplastics (NPs)[18]. For NPs, there is no uniform definition, but it has been widely accepted that they are particles of similar composition with a size below 100 nm[19,20] or 1000 nm[21,22]. More seriously, the decomposition processes will continue, and more MPs will remain transformed into NPs [23]. Besides, the commercial application is also a signifcant source of NP release in the environment [24]. The size changes of plastic fragments from micrometers to nanometers will lead to modifcations in physicochemical properties. In addition, the environmental behavior of plastic particles (e.g., aggregation and migration), bioaccumulated properties, and toxicity are also highly size-dependent [25]. NPs could be detected in aquatic and terrestrial environments, including lakes, oceans, and soils[26]. NPs have a small volume and large specific surface area, making them easily adsorb and carry other pollutants[24]. Contaminants can be released again into food chains via the NP ingestion by organisms and then enriched in high-trophic organisms[27,28]. Previous toxicity experiments also suggested that NPs potentially harm biological bodies and even human health[29]. Microplastics and nanoplastics were included as they are occasionally used interchangeably in the literature.

The diagnostic criteria for metabolic syndrome (MetS) are that the patient has weight gain and any two of hypertension, abnormal glucose metabolism or abnormal lipid metabolism. Bibliometric analysis is a statistical method for rapid quantitative analysis and visualization of scientific findings, research hotspots and trends using public literature databases. This method is widely used in the medical field and allows for systematic analysis of specific studies to show development trends over the years and identify scientific frontiers in a short period of time. This study aims to fill the shortcomings of traditional reviews. Since previous studies may not have adopted the diagnostic criteria for metabolic syndrome (MetS), this study expanded the concept of metabolic disorders in order to include more relevant literature. Through bibliometric and visual analysis, the research status and development trends of the impact of microplastics on metabolic disorders from 2019 to 2026 will be described in detail.

Bibliometrics is an interdisciplinary discipline that uses mathematical and statistical measurement techniques to conduct quantitative analysis of academic publications. An overall and objective bibliometric evaluation of the literature on a specific topic can help deepen the understanding of the current research landscape and provide a reference for the selection of research directions. To our knowledge, there is currently no bibliometric analysis in this area. This study conducted a bibliometric visual analysis of relevant literature on the impact of microplastics on metabolic disorders, covering dimensions such as authors, institutions, countries/regions, co-cited references, and keywords. It aimed to objectively evaluate the research structure and development trends in the main fields of microplastics and metabolic disorders, and provide new insights and clues for subsequent research in this field.

2. Materials and Methods

2.1 Data Source and Search Strategy

The Web of Science Core Collection (WoSCC) bibliographic database stands as one of the largest and the most comprehensive electronic scientific literature databases globally, widely favored by academic researchers. An extensive search was conducted on the database on 8th August 2026, and relevant literature published was downloaded since 2019 for analysis. The search strategy utilized in this study was set as follows: TS=("microplastic" OR "microplastics" OR "micro-plastic" OR "micro-plastics" OR "micro-sized plastic" OR "micro-sized plastics" OR "micro-nano plastic" OR "micro-nano plastics" OR "nanoplastic" OR "nanoplastics" OR "nano-plastic" OR "nano-plastics" OR "nano-sized plastic" OR "nano-sized plastics") AND TS=("metabolic disorder" OR "metabolic disorders" OR "metabolic disease" OR "metabolic syndrome")

The type of publication was limited to Article or Review, and the language was set to English only. Subsequently, the search results were documented with the content of "Full Record and Cited Reference" in the "Plain Text" format. A total of 140 papers were included in the analysis.

2.2 Data Analysis and Visualization

The downloaded files were imported into CiteSpace (version 7.0.R0), VOSviewer (version 1.6.20), and Pajek 64 (version 6.02) for bibliometric visualization analysis. CiteSpace, developed by Prof. Chao-mei Chen, is a Java application for bibliometric analysis and visualization. In our study, CiteSpace was applied to analyze and visualize national and institutional contributions, authors and co-cited authors, cocited reference clusters and timelines, keywords, and keywords burst. The specific settings of CiteSpace were established as follows: time slicing was from January 2019 to August 2026, with each slice representing 1 year. The term sources and links were set to the default parameters. VOSviewer is another bibliometric analysis software developed by Nees Jan van Eck and Ludo Waltman, which constructs visual network maps based on data. We used VOSviewer software and Pajek software to generate keyword co-occurrence networks. The procedure for data collection and bibliometric analysis are shown in Figure 1.

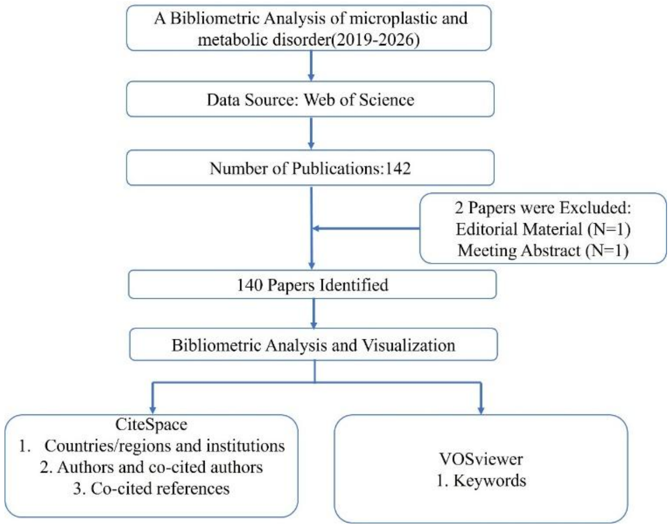


Figure 1. Flowchart for Screening Publications and Conducting Bibliometric Analysis

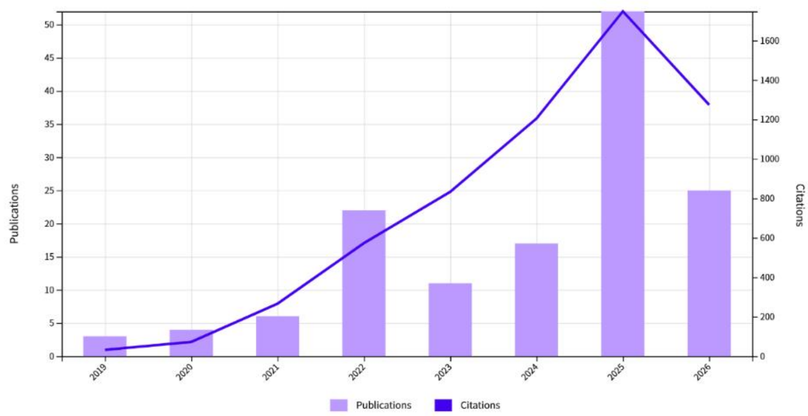


Figure 2. Quantity and Trend in Publication Output for Microplastics and Metabolic Disorders from 2019 to 2026

3. Results

3.1 Quantitative Analysis of Annual Publication Output

According to the search criteria, a total of 142 pieces of literature were identified from the WoSCC database. 2 irrelevant records were screened out based on the exclusion criteria of document type and language, including 1 Editorial Material and 1 Meeting Abstract. Ultimately, 140 studies, comprising 97 articles and 43 reviews, were collected for the final analysis. Figure 2 shows the annual number of papers published related to microplastics and metabolic disorders from 2019 to 2026. The annual academic output remained below 10 in the initial phase lasting from 2019 to 2021. During the subsequent phase, the output of publications overall continuously increased in a fluctuating manner. Strikingly, the number of papers rose rapidly from 2022 to 2026, peaking at 52 scholarly articles published in 2025. Based on these results, we anticipate that the number of annual publications will persistently increase, indicating that studies on microplastics and metabolic disorders are gaining interest.

3.2 Distribution of Countries/Regions and Institutions

A total of 41 countries/regions and 480 institutions have contributed to the field of microplastics and metabolic disorders. The top 10 most productive countries/regions and institutions are summarized in Table 1. The results show that China (2019), the United States (2020) and Italy (2021) started research in this field earlier, establishing a strong foundation for future advancements. China (2019) started early, and its development has been also rapid, contributing the largest volume of publications (98, 70%), significantly higher than other countries/regions, followed by the United States (10, 7.14%), and India (9, 6.43%). The output from other countries/regions in the top 10 list have fewer than 9 publications each. Findings from Figure 3 reveal that China is a leading cooperation center (centrality = 0.42) in this field, with Japan(0.34) , the United States (0.33), and India (0.25) ranking second, third, and fourth respectively. The top 10 most productive institutions are distributed across 2 countries, with 8 located in China and 2 in Spain. The three institutions that publishing the most relevant papers are the Capital Medical University (9, 6.43%), Chinese Academy of Sciences (8, 5.71%), and Zhejiang University of Technology (5, 3.57%). Although the Ocean University of China and University of Chinese Academy of Sciences ranks sixth and eighth (3, 2.14%), they have the highest centrality (0.26), closely followed by the Nanjing University (0.12), indicating that these institutions occupy significant positions in the research of microplastics and metabolic disorders (Figure 4).

Table 1. Publications in the 10 Most Productive Countries/Regions and Institutions

Rank	Country/Regions	Year	Count (%)	Centrality	Institutions	Year	Count (%)	Centrality
1	China	2019	98(70.00)	0.42	Capital Medical University	2022	9(6.43)	0.07
2	the United States	2020	10(7.14)	0.33	Chinese Academy of Sciences	2021	8(5.71)	1
3	India	2023	9(6.43)	0.25	Zhejiang University of Technology	2019	5(3.57)	0.01
4	South Korea	2023	7(5.00)	0.09	Nanjing University	2020	4(2.86)	0.12
5	Italy	2021	7(5.00)	0.02	Shanghai Jiao Tong University	2023	3(2.14)	0.06
6	Japan	2024	4(2.86)	0.34	Ocean University of China	2022	3(2.14)	0.26
7	Australia	2022	4(2.86)	0.11	Yangzhou University	2023	3(2.14)	0.01
8	Iran	2025	4(2.86)	0.08	University of Chinese Academy of Sciences	2021	3(2.14)	0.26
9	Spain	2022	3(2.14)	0	Consejo Superior de Investigaciones Cientificas	2022	3(2.14)	0.02

					(CSIC)			
10	Pakistan	2022	3(2.14)	0.07	CSIC-UAM - Instituto de Investigacion en Ciencias de la Alimentacion (CIAL)	2022	2(1.43)	0

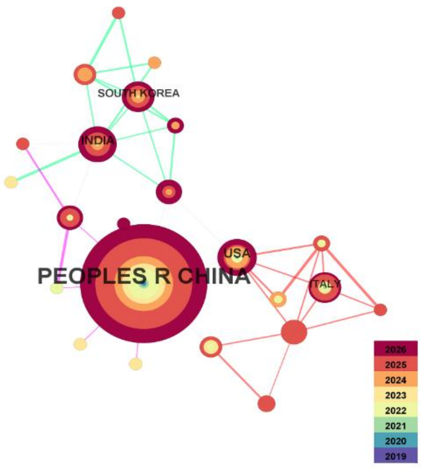


Figure 3. The Visualization Map of Leading Countries/Regions Contributing to Research on Microplastics and Metabolic Disorders

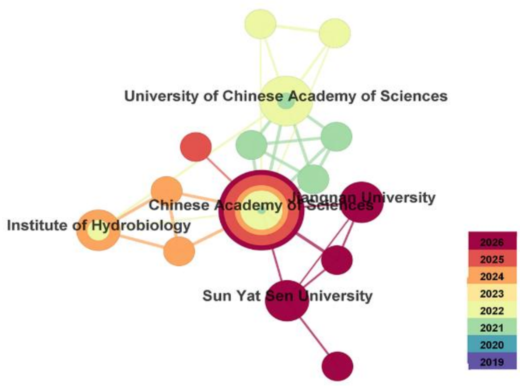


Figure 4. The Visualization Map of Leading Institutions Contributing to Research on Microplastics and Metabolic Disorders

3.3 Analysis of Authors and Co-cited Authors

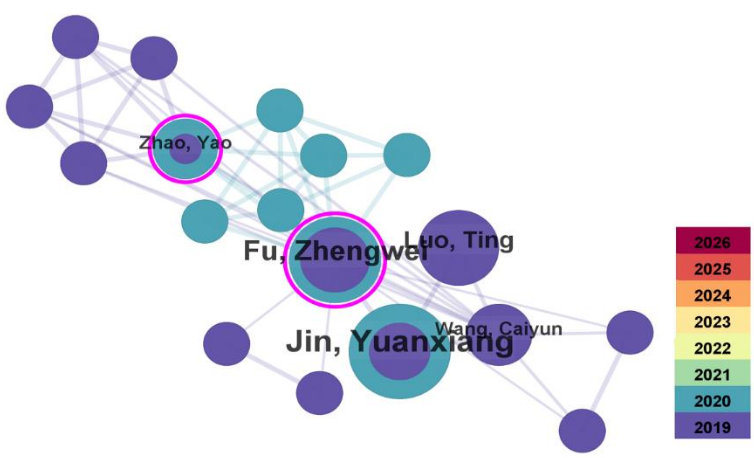
Research on microplastics and metabolic disorders has seen contributions from 971 scholars, and the top 10 productive authors and co-cited authors are list in Table 2. Among these top authors with the most published papers, 9 are from China, one is from Italy. In terms of high productivity, Jin, Yuanxiang (Zhejiang University of Technology, China) leads with 5 literature, right after whom Fu, Zhengwei (Zhejiang University of Technology, China) with 4, Luo, Ting (Zhejiang University of Technology, China) and Cappello, Tiziana (University of Messina, Italy) with 3. The other authors in the top 10 list have fewer than 3 documents each (Figure 5A). Zhao, Yao have the highest centrality

(0.63), closely followed by Wang, Caiyun (0.36), indicating that these authors occupy significant positions in the research of microplastics and metabolic disorders (Figure 5A). Co-cited author analysis examines instances where the works of two authors are simultaneously cited by a third author. A greater number of co-citations suggests that the authors have similar academic interests and that their research is closely aligned. The top 10 co-cited authors were referenced more than 20 times each. The most frequency cocited author is Jin, Yuanxiang (Zhejiang University of Technology, China), with 42 citations, who is also the most productive author (Figure 5B). Following him are Antonio Ragusa (36 citations; Sassuolo Hospital, Italy) and Yongfeng Deng (36 citations; Nanjing University, China). China has not only produced the largest number of publications but also has the most productive and frequently co-cited authors, highlighting its rapid advancement in this research area.

Table 2. Top 10 Authors and Co-cited Authors

Rank	Author	Count	Centrality	Co-cited author	Citations	Centrality
1	Jin, Yuanxiang	5	0	Jin YX	42	0.17
2	Fu, Zhengwei	4	1	Ragusa A	36	0.1
3	Luo, Ting	3	0	Deng YF	36	0.06
4	Cappello, Tiziana	3	0.14	Lu L	35	0.28
5	Zhang, Yan	2	0.17	Leslie Ha	34	0.04
6	Zhao, Yao	2	0.63	Qiao RX	31	0.21
7	Wang, Jun	2	0	Prata JC	31	0.03
8	Cheng, Haodong	2	0.02	Wang J	25	0.08
9	Wang, Qing	2	0	Lu YF	25	0.1
10	Wang, Caiyun	2	0.36	Wright SL	23	0.07

A.



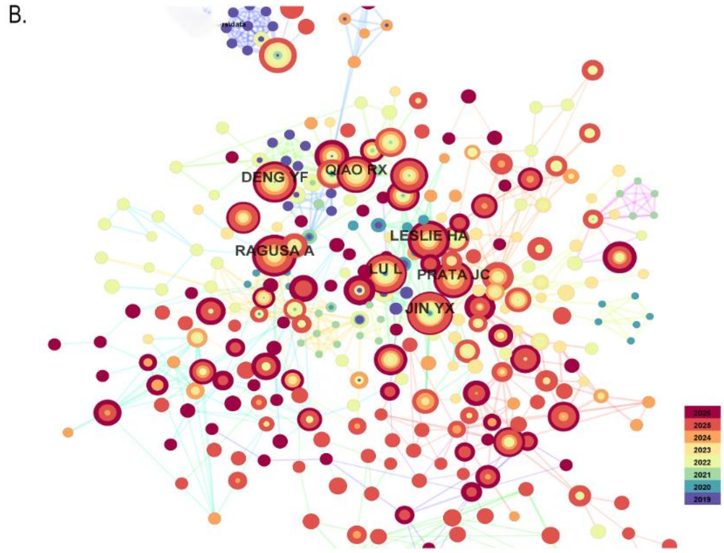


Figure 5 The Visualization Map of Influential Authors (A) and Co-cited Authors (B) in the field of Microplastics and Metabolic Disorders

3.4 Co-cited References Analysis and Clustering Network

Literature co-citation analysis reveals the relationship between documents by examining the frequency at which they are cited. A total of 374 co-cited references in the research of microplastics and metabolic disorders were visualized, and the first authors of the top 10 most co-cited references are depicted in Figure 6A. The size of the circles is proportional to the co-citation frequency, and the redder the color, the more cocitations it has within the time zone. Additionally, a complete list of the top 10 co-cited references is present in Table 4. All references were cocited at least 18 times. The top 3 highly co-cited are as follows: The most co-cited article is ‘Plasticenta: First evidence of microplastics in human placenta’ published in Environment international with 32 citations, authored by (Antonio Ragusa et al., 2021). The second article, published in Environment International by Heather A Leslie et al. (2022), is titled “Discovery and quantification of plastic particle pollution in human blood”. The third co-cited reference is “Polystyrene microplastics induce gut microbiota dysbiosis and hepatic lipid metabolism disorder in mice” published in Science of the Total Environment by (Liang Lu et al., 2018). The results of these studies lay the foundation for further research on microplastics and metabolic disorders.

Cluster analysis of literature co-citation objectively reveals the knowledge structure of the research field. We further generated a visual map of the top 10 clusters based on the cocited references (Figure 6B). Cluster #0, identified as liver damage, was the largest cluster, followed by human health (cluster #1), glucose metabolism (cluster #2), human metabolism (cluster #3), mediterranean mussel mytilus galloprovincialis (cluster #4), polystyrene microplastic exposure (cluster #5), developmental origin (cluster #6), mammalian fertility (cluster #7), critical review (cluster #8), and gut barrier microbiota (cluster #9).

As shown in Figure 7A, we conducted a timeline of co-cited references to visualize the evolution of research trends and hotspots over time. As we have seen, cluster #6 and cluster #9 began study earlier, cluster #0 and #2 has high concentration of nodes with citation bursts in recent years, and cluster #1, #5, and #6 are considered research fronts as they are still ongoing. Figure 7B illustrates the dependency relationships between different research clusters, highlighting the mutual influence and citation relationships among them. Consistent with Figure 7A, cluster #0 and #2 serves as significant reference basis for subsequent research, while cluster, #1, #5 and #6 represent the current frontiers of research. This graph indicates that in the study of liver damage, research on cluster #5 serve as important reference foundation.

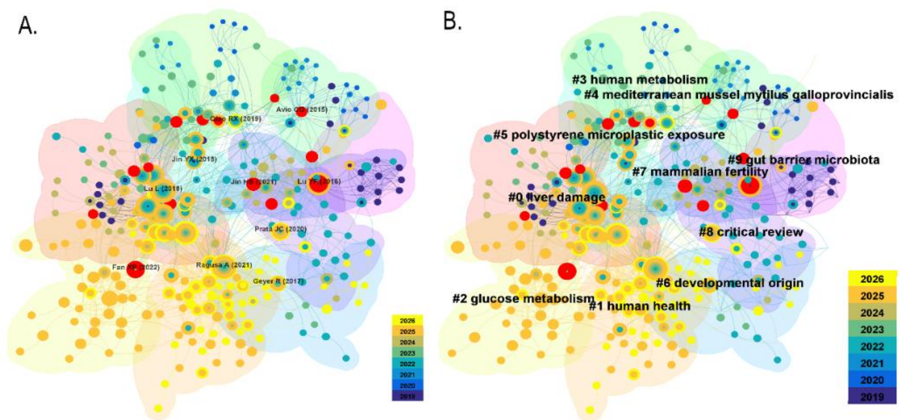


Figure 6. (A) The Visualization Map of Co-cited References on Microplastics and Metabolic Disorders. (B) The Clustering Network Map of Co-cited References

Table 4. Top 10 Co-cited References

Ranks	Title	Journal	Co-citation
1	Plasticenta: First evidence of microplastics in human placenta	Environment international	32
2	Discovery and quantification of plastic particle pollution in human blood	Environment International	31
3	Polystyrene microplastics induce gut microbiota dysbiosis and hepatic lipid metabolism disorder in mice	Science of the Total Environment	31
4	Tissue accumulation of microplastics in mice and biomarker responses suggest widespread health risks of exposure	sciescientific reports	27
5	Impacts of polystyrene microplastic on the gut barrier, microbiota and metabolism of mice	Science of the Total Environment	24
6	Uptake and accumulation of polystyrene microplastics in zebrafish (Danio rerio) and toxic effects in liver	Environmental Science & Technology	24
7	Microplastics induce intestinal inflammation, oxidative stress,	Science of the Total	22

	and disorders of metabolome and microbiome in zebrafish	Environment	
8	Detection of Various Microplastics in Human Stool A Prospective Case Series	Annals of Internal Medicine	20
9	Environmental exposure to microplastics: An overview on possible human health effects	Science of The Total Environment	18
10	Human Consumption of Microplastics	Environmental Science & Technology	18

Figure 7. (A) The Timeline View of Co-citation Clusters. (B) The Dependency Relationships among Different Co-citation Clusters

3.5 Keywords Co-occurrence Analysis of Research Hotspots

Through the co-occurrence analysis of keywords (Figures 8A, B), we can quickly capture the current hotspots and future research directions in this discipline. A total of 453 keywords were extracted from these papers, with 15 keywords appearing more than 5 times. Table 5 presents the top 10 high-frequency keywords in research on microplastics and metabolic disorders. Among these keywords, “microplastics” (n = 50) and “nanoplastics” (n = 28) are the most frequently used terms, followed by “gut microbiota” with 22 occurrences. Additionally, the total link strengths, which refers to the total number of co-occurrences of a keyword with others, for these two keywords exceed 50. We analyzed the top 12 keywords with the strongest citation bursts from 2019 onwards (Table 6). As indicated by the red segments, these keywords experienced a blowout in usage at this period. The keyword “accumulation” has the strongest burst (burst strength 1.74). Furthermore, we also found that “nanoplastics,” “inflammation,” “polystyrene nanoplastics,” and “glucose metabolism” have emerged more recently, revealing that these topics might represent current hotspots in the field of microplastics and metabolic disorders.

3.6 Co-occurrence Network and Thematic Clustering Analysis

A co-occurrence network of high-frequency keywords was constructed to identify major research themes of the impact of microplastics on metabolic disorders. The cluster analysis, based on the association strength and total link strength of each term, delineated 10 distinct thematic clusters (Clusters 1-10, each representing a specific research focus (Figure 8B).

3.6.1 Characterization of Individual Clusters

Cluster 1: Hepatoenteric axis and polystyrene microplastics

This cluster stays centered on the classic gut-liver axis, especially how polystyrene microplastics interfere with it. Terms that appear often, like “gut microbiota,” “metabolomics,” and “joint toxicity,” point to work linking the microbiome to changes in liver metabolism. “Gut barrier” and “liver-brain axis” show up closely with these terms, which puts attention on cross-talk across more than one organ. Most of these studies use mice as the primary model organism.

Cluster 2: Aquatic Toxicity and Lipid Dysregulation

Work done in zebrafish groups polystyrene nanoplastics and triclosan together because both disrupt lipid metabolism and glycolipid metabolism. The repeated use of terms like “accumulation” and “gut health” suggests these substances build up in specific tissues and then affect metabolism in aquatic organisms. It frames the issue in ecotoxicology, linking exposure to metabolic disorder outcomes.

Cluster 3: Host metabolic diseases and inflammatory drivers

This cluster ties microplastic exposure to well-known metabolic syndrome patterns, where “obesity,” “metabolic disease,” and “inflammation” sit at the center. Terms like “exposomes” and “early-onset colorectal cancer” widen the picture. They point to life course environmental exposures and how chronic diseases develop. “Gut microbiome” shows up as a connecting term, linking outside contaminants with host inflammation and metabolic outcomes.

Cluster 4: Maternal and infant exposure and nanoplastics

In this cluster, “nanoplastics” shows up most often, along with “placenta.” The focus stays on developmental toxicity and transgenerational toxicity. Terms like “maternal exposure,” “endocrine disrupting chemicals,” and “neurotoxicity” point to risks during early-life stages. Phthalates come up too, treated as coexisting contaminants.

Cluster 5: Mechanistic Toxicology and Oxidative Stress

This cluster treats “oxidative stress” as the main pathway, with an occurrence frequency of 14. Work grouped here uses “molecular docking” along with “machine learning” as paired computational tools to predict toxicological interactions. “NMR-based metabolomics” comes up alongside “pollution,” which ties these mechanism-focused studies to the messier conditions found in real environmental settings.

Cluster 6: Human health and bioaccumulation

This cluster links environmental monitoring to real clinical concerns. The main terms here are “human health” and “bioaccumulation.” The key pathological endpoints are “metabolic disorders” and “inflammatory response.” And “ocean pollution” keeps the topic grounded in the wider ecological context.

Cluster 7: Microplastics and intestinal barrier dysfunction

This cluster stands out because it has the highest total link strength at 108, and “Microplastics” sits at the center of it. The links around “colonic dysbiosis” and “intestinal permeability” point to a clear mechanism: damage to the intestinal barrier is tied to metabolic disorders. This same idea shows up again in several other clusters.

Cluster 8: Environmental pollutants and glucose homeostasis

The cluster links “environmental pollution” and “air pollution” with “glucose metabolism” and “insulin resistance”. “Pesticides” show up alongside these topics as a major coexisting pollutant. Overall, it points to microplastics affecting pancreatic function and broader glycemic regulation, especially in the context of mixed environmental stressors.

Cluster 9: Dysbiosis and digestive system pathology

Focusing on “dysbiosis” and “digestive system,” this cluster highlights microbial community changes as major mediators of health risks. It can be considered a functional extension of cluster 7, but focuses more on pathological endpoints rather than mechanistic permeability.

Cluster 10: Hepatotoxicity and metabolic disorders in terrestrial models

This smaller cluster uses “liver” and “chicken” as target organs and model organisms respectively, focusing on metabolic disorders in avian species, suggesting a translational perspective from aquatic to terrestrial food chain toxicology.

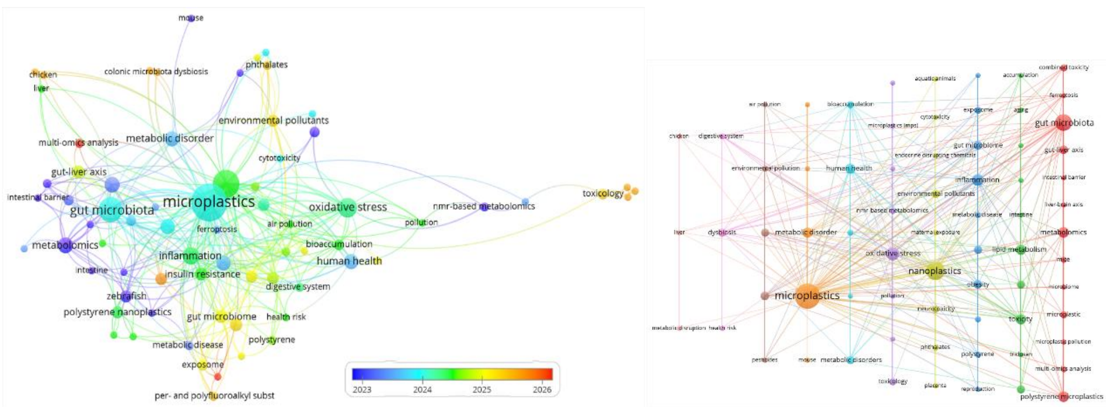


Figure 8. (A) The Visualization Map of Keywords Co-occurrence Network on Microplastics and Metabolic Disorders. (B) Cluster of Keywords Co-occurrence Network by Pajek.

Table 5. The Top 10 Keywords

	Keyword	**Occurrences**	**Total link strength**
1	microplastics	50	108
2	nanoplastics	28	73
3	gut microbiota	22	44
4	oxidative stress	14	38
5	inflammation	11	32
6	metabolomics	9	21
7	polystyrene microplastics	9	18
8	human health	8	21
9	lipid metabolism	8	17
10	metabolic disorder	8	14

Table 6. Top 12 Keywords with the Strongest Citation Bursts

Keyword	Strength	Begin	End	2019-2026
accumulation	1.74	**2019**	2021	
fresh water	1.46	**2019**	2022	
toxicity	1.91	**2022**	2023	
metabolism	1.68	**2022**	2022	
microbiota	1.65	**2022**	2023	
particles	1.62	**2022**	2024	
daphnia magna	1.55	**2022**	2022	
nanoplastics	3.19	**2023**	2023	
inflammation	1.46	**2023**	2023	
polystyrene nanoplastics	1.43	**2024**	2026	
expression	1.72	**2025**	2026	
glucose metabolism	1.72	**2025**	2026	

4. Discussion

It is necessary to conduct scientometric analysis of microplastics and metabolic disorders research from the global perspective, which can provide helpful information to encourage further research, despite the increasing number of publications in this field. The scientometric analysis refers to a powerful approach that uses literature indicators to qualitatively and quantitatively evaluate the complex knowledge structure and explore development trends. Furthermore, it can objectively illustrate the research hotspots and frontiers in the research field through visual symbols and graphics. Through bibliometric analysis, main research fields, and new research directions can be timely and comprehensively achieved by researchers. Compared with bibliographic reviews that summarize the research progress and propose future research priorities on a particular topic in the field, bibliometric-based analyses can provide a more comprehensive perspective and visual analysis results on the research trends in the field, and the data is more objective. Data-based review, similar to meta-analysis, is a class of important and valuable tools to summarize data from many studies and perform statistical analysis. With the aim of assessment of the effect sizes across different studies and the analysis of the variability between studies, new hypotheses and experimental designs can be generated. In conclusion, bibliometric analysis can provide a more comprehensive and objective visual result compared with bibliographic and data-based review, when analyzing a specifc research field. Therefore, a scientometric analysis was conducted and aim to systematically evaluate and quantify the progress of the impact of microplastics on metabolic disorders (from 2019 to 2026), in order to provide a more comprehensive view of microplastics and metabolic disorders research trends.

4.1 General Information

As of 8th August 2026, a total of 140 publications are included, with contributions from 971 authors across 66 journals, 480 institutions and 41 countries/regions.

The results show that China (2019), the United States (2020) and Italy (2021) started research in this field earlier, establishing a strong foundation for future advancements. China (2019) started early, and its development has been also rapid, contributing the largest volume of publications (98, 70%), significantly higher than other countries/regions, followed by the United States (10, 7.14%), and India (9, 6.43%). China is a leading cooperation center (centrality = 0.42) in this field, with Japan(0.34) , the United States (0.33), and India (0.25) ranking second, third, and fourth respectively. The Capital Medical University (9, 6.43%) of China published the most relevant papers. Additionally, the distribution of institutions and collaboration network explain why China and the United States involved in the most papers in this field. Their strong academic infrastructures, substantial government funding, and international collaborations contributed to the growth of microplastics and metabolic disorders research and implies that establishing premier research institutions is crucial for elevating the prominence of the academic community.

In terms of high productivity authors, Jin, Yuanxiang (Zhejiang University of Technology, China) leads with 5 literature, published the most relevant papers. Cappello, Tiziana (University of Messina, Italy) published 3 literature, ranked third along with other authors. Zhao, Yao have the highest centrality (0.63), closely followed by Wang, Caiyun (0.36), indicating that these authors occupy significant positions in the research of the impact of microplastics on metabolic disorders. The most frequency cocited author is Jin, Yuanxiang (Zhejiang University of Technology, China), with 42 citations, who is also the most productive author. China has not only produced the largest number of publications but also has the most productive and frequently co-cited authors, highlighting its rapid advancement in this research area.

4.2 Hotspots and Emerging Frontiers

4.2.1 Co-cited References

Co-cited references are regarded as the foundational research within a particular field. A total of 374 co-cited references in the research of microplastics and metabolic disorders were visualized. The most co-cited article is ‘Plasticenta: First evidence of microplastics in human placenta’. The results of these studies lay the foundation for further research on the impact of microplastics on metabolic disorders.

The cluster analysis of literature co-citation provides an insightful perspective on the evolving knowledge structure in the field of the impact of microplastics on metabolic disorders. The top 10 clusters based on the cocited references were Cluster #0, identified as liver damage, was the largest cluster, followed by human health (cluster #1), glucose metabolism (cluster #2), human metabolism (cluster #3), mediterranean mussel mytilus galloprovincialis (cluster #4), polystyrene microplastic exposure (cluster #5), developmental origin (cluster #6), mammalian fertility (cluster #7), critical review (cluster #8), and gut barrier microbiota (cluster #9). Cluster #6 and cluster #9 began study earlier, cluster #0 and #2 has high concentration of nodes with citation bursts in recent years, and cluster #1, #5, and #6 are considered research fronts as they are still ongoing. Cluster #0 and #2 serves as significant reference basis for subsequent research, while cluster, #1, #5 and #6 represent the current frontiers of research.

4.2.2 Burst of Keywords

Keyword patterns in bibliometrics can hint at what topics are heating up in a field. Tracking how often certain keywords appear, and when they start showing up, gives a useful picture of how the area is changing over time. In this study, 453 keywords were pulled from the papers. Out of those, 15 showed up more than 5 times. The most frequent terms were “microplastics” (microplastics, appearing 50 times) and “nanoplastics” (nanoplastics, appearing 28 times). “Gut microbiota” (intestinal flora) came next, appearing 22 times. Both keywords have a total link strength above 50. In the timeline view, “nanoplastics”, “inflammation”, “polystyrene nanoplastics” and “glucose metabolism” showed up later than the others. This timing suggests these topics are likely current research hotspots in studies on microplastics and metabolic disorders.

4.2.3 Inter-Cluster Relationships and Thematic Integration

A total of 71 high-frequency keywords were extracted and subjected to co-occurrence analysis, resulting in the identification of 10 distinct clusters. The network structure reveals a clear, multi-layered framework linking external microplastics exposure to metabolic disorders.

Core-Pathway Axis (Clusters 5, 7, and 9): The main biological thread runs through oxidative stress (Cluster 5), intestinal permeability and colonic dysbiosis (Cluster 7), and generalized dysbiosis (Cluster 9). Put together, these three clusters make the mechanism feel realistic. Oxidative injury can kick off local inflammation. The inflamed gut barrier becomes more permeable, so microbial products can pass into circulation and set off metabolic disturbances, which lines up with microplastics-driven metabolic impairment.

The Model-Organism Continuum spans Clusters 1, 2, 4, and 10, and it mostly reflects the experimental systems used in this area. Cluster 2 relies on zebrafish, while Cluster 10 uses chicken. Together they cover aquatic and land-based non-mammalian models. Cluster 1 focuses on mice, which are treated as the standard mammalian model. Cluster 4 shifts attention to the maternal-fetal axis. That adds a developmental angle and shows that results from these animal studies are being applied to sensitive windows of human exposure.

Translational Bridge to Human Disease (Clusters 3, 6, and 8): These three clusters are where the mechanistic and model-based results start to line up with what is seen in human disease. Cluster 6 (human health, bioaccumulation) and Cluster 8 (insulin resistance, glucose metabolism) connect toxicological findings to endpoints that matter clinically. Cluster 3 (obesity, inflammation, ex-PFAS) brings in the exposome concept. It treats microplastics as part of a wider mix of environmental chemicals that act together and shape complex metabolic syndromes.

Metabolomics shows up across the review, especially in Cluster 1. In Cluster 5, the work shifts toward NMR-based metabolomics, along with machine learning and molecular docking. Together, these methods point to a move away from mainly descriptive toxicology and toward more predictive work that brings multi-omics together. Researchers are using them more often to connect environmental monitoring in Clusters 2 and 8 with clinical phenotyping in Clusters 3 and 6.

Taken together, the co-occurrence network tells a fairly clear story. It starts with environmental microplastics and nanoplastics (Clusters 2, 4, 7). From there, the focus shifts to oxidative stress and barrier disruption (Clusters 5, 7, 9). The next step is gut-liver and gut-brain crosstalk (Cluster 1). The chain ends with systemic metabolic disorders, including obesity and insulin resistance (Clusters 3, 6, 8). These links show up across multiple model systems and life stages, which gives the overall pattern added support.

4.3 Strengths and Limitations

This study is the first to map out the past two decades of research on how microplastics relate to metabolic disorders using bibliometric analysis. It looks at publication trends and cross-country collaborations. It tracks research hotspots too. Together, these results give researchers a new and more objective view of how the main topics have shifted, and which areas are likely to shape what comes next in this field. For this research, we used several bibliometric tools at the same time to look at the data from different angles. The main ones were VOSviewer and CiteSpace, which are both well-known in bibliometrics. Using these tools helped us spot hot topics and newer research frontiers more clearly. It gives a wider view than a standard literature review. This study still has limitations. This analysis relies only on the Web of Science Core Collection (WoSCC). Because of that, studies indexed in other databases, like PubMed or Scopus, may not be captured, and some relevant papers could be missed. Still, WoSCC includes the largest volume of academic publications, which helps keep the source data complete. The screening step was limited to English-language publications as well. That choice may mean strong studies published in other languages were left out. Some strong, newly published papers might not show up in this bibliometric analysis. The literature quality evaluation system has method limits, and newer work can score low on citation frequency and centrality even if it is high quality.

5. Conclusion

This bibliometric analysis looks at how research on microplastics and metabolic disorders has changed over the past two decades. It tracks how the topic has grown, where the main research directions are, and which newer areas are starting to draw attention. Overall, the field has expanded quickly and the work has become more complex over time. The results point to major input from top institutions and researchers worldwide, with China and the United States standing out for both research output and influence. Still, the analysis shows that authors need to work together more. Terms like "Nanoplastics", "inflammation", "polystyrene nanoplastics" and "glucose metabolism" keep coming up, and they now look like the main hot spots guiding where the field is heading. Molecular docking and machine learning are being used more often. These tools point to computational methods becoming part of how researchers predict toxicological interactions. More advanced approaches, like nuclear magnetic resonance metabolomics, are expected to support work in this area. take a closer look at the different ways microplastics can cause metabolic disorders. It pulls together what researchers know so far about microplastics and metabolic disorders. The research area is still moving fast, and it is likely to keep expanding.

Fund project

This article is supported by the project: Teaching Reform Project of Shanxi Province Universities: "Case Study and Practice of 'Environmental Hygiene' Based on Visual Teaching, J20230505".

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