



## Unveiling the hidden world of gut health: Exploring cutting-edge research through visualizing randomized controlled trials on the gut microbiota

Sa'ed H Zyoud, Muna Shakhshir, Amani S Abushanab, Amer Koni, Moyad Shahwan, Ammar Abdulrahman Jairoun, Adham Abu Taha, Samah W Al-Jabi

**Specialty type:** Medicine, research and experimental

**Provenance and peer review:** Invited article; Externally peer reviewed.

**Peer-review model:** Single blind

**Peer-review report's scientific quality classification**

Grade A (Excellent): 0  
Grade B (Very good): B  
Grade C (Good): C  
Grade D (Fair): 0  
Grade E (Poor): 0

**P-Reviewer:** Gupta L, Indonesia; Papazafiropoulou A, Greece

**Received:** June 3, 2023

**Peer-review started:** June 3, 2023

**First decision:** August 5, 2023

**Revised:** August 12, 2023

**Accepted:** August 18, 2023

**Article in press:** August 18, 2023

**Published online:** September 16, 2023



**Sa'ed H Zyoud, Amani S Abushanab, Amer Koni, Samah W Al-Jabi,** Department of Clinical and Community Pharmacy, College of Medicine and Health Sciences, An-Najah National University, Nablus 44839, Palestine

**Sa'ed H Zyoud,** Clinical Research Centre, An-Najah National University Hospital, Nablus 44839, Palestine

**Muna Shakhshir,** Department of Nutrition, An-Najah National University Hospital, Nablus 44839, Palestine

**Amer Koni,** Division of Clinical Pharmacy, Hematology and Oncology Pharmacy Department, An-Najah National University Hospital, Nablus 44839, Palestine

**Moyad Shahwan,** College of Pharmacy and Health Sciences, Ajman University, Ajman 346, United Arab Emirates

**Ammar Abdulrahman Jairoun,** Department of Health and Safety, Dubai Municipality, Dubai 67, United Arab Emirates

**Ammar Abdulrahman Jairoun,** Discipline of Clinical Pharmacy, School of Pharmaceutical Sciences, Universiti Sains Malaysia (USM), Pulau Pinang 11500, Malaysia

**Adham Abu Taha,** Department of Pathology, An-Najah National University Hospital, Nablus 44839, Palestine

**Adham Abu Taha,** Department of Biomedical Sciences, College of Medicine and Health Sciences, An-Najah National University, Nablus 44839, Palestine

**Corresponding author:** Sa'ed H Zyoud, PhD, Director, Full Professor, Department of Clinical and Community Pharmacy, College of Medicine and Health Sciences, An-Najah National University, Academic Street, Nablus 44839, Palestine. [saedzyoud@yahoo.com](mailto:saedzyoud@yahoo.com)

### Abstract

#### BACKGROUND

The gut microbiota plays a crucial role in gastrointestinal and overall health. Randomized clinical trials (RCTs) play a crucial role in advancing our knowledge

and evaluating the efficacy of therapeutic interventions targeting the gut microbiota.

## AIM

To conduct a comprehensive bibliometric analysis of the literature on RCTs involving the gut microbiota.

## METHODS

Using bibliometric tools, a descriptive cross-sectional investigation was conducted on scholarly publications concentrated on RCTs related to gut microbiota, spanning the years 2003 to 2022. The study used VOSviewer version 1.6.9 to examine collaboration networks between different countries and evaluate the frequently employed terms in the titles and abstracts of the retrieved publications. The primary objective of this analysis was to identify key research areas and focal points associated with RCTs involving the gut microbiota.

## RESULTS

A total of 1061 relevant articles were identified from the 24758 research articles published between 2003 and 2022. The number of publications showed a notable increase over time, with a positive correlation ( $R^2 = 0.978$ ,  $P < 0.001$ ). China ( $n = 276$ , 26.01%), the United States ( $n = 254$ , 23.94%), and the United Kingdom ( $n = 97$ , 9.14%) were the leading contributing countries. *Københavns Universitet* ( $n = 38$ , 3.58%) and *Dankook University* ( $n = 35$ , 3.30%) were the top active institutions. The co-occurrence analysis shows current gut microbiota research trends and important topics, such as obesity interventions targeting the gut microbiota, the efficacy and safety of fecal microbiota transplantation, and the effects of dietary interventions on humans.

## CONCLUSION

The study highlights the rapid growth and importance of research on RCTs that involve the gut microbiota. This study provides valuable insight into research trends, identifies key players, and outlines potential future directions in this field. Additionally, the co-occurrence analysis identified important topics that play a critical role in the advancement of science and provided insights into future research directions in this field.

**Key Words:** Gut microbiota; Microbiome; Randomized clinical trials; Bibliometric analysis

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**Core Tip:** This bibliometric analysis provides valuable insights into the growing research on randomized clinical trials (RCTs) involving the gut microbiota. The study identifies key research areas, prominent contributors, and collaboration networks. The analysis reveals that interventions targeting the gut microbiota for managing obesity, fecal microbiota transplantation, and the impact of diet interventions on the gut microbiota are important focal points. The study underscores the significance of RCTs in understanding the gut microbiota and offers directions for future research in this field.

**Citation:** Zyoud SH, Shakhshir M, Abushanab AS, Koni A, Shahwan M, Jairoun AA, Abu Taha A, Al-Jabi SW. Unveiling the hidden world of gut health: Exploring cutting-edge research through visualizing randomized controlled trials on the gut microbiota. *World J Clin Cases* 2023; 11(26): 6132-6146

**URL:** <https://www.wjgnet.com/2307-8960/full/v11/i26/6132.htm>

**DOI:** <https://dx.doi.org/10.12998/wjcc.v11.i26.6132>

## INTRODUCTION

The gastrointestinal microbiota is a crucial organ contributing significantly to gastrointestinal and general health. Over the past few decades, understanding of this organ has improved substantially thanks to abundant influential research on the gastrointestinal microbiome[1-4].

“Microbiome” is the genetic material of microorganisms in a given environment. “Intestinal microbiome” refers to the various bacteria present in the human digestive system[5,6], where the host-microorganisms interact with each other. Bacteria dominate these microbial communities, especially in the intestines[7], interact with the host, and are considered a vital regulator of digestion in the gastrointestinal tract. Many genes in microorganisms create metabolites that affect host cell function and physiology[8,9]. Many studies demonstrate that gut microbial makeup and function can affect human health and disease. This affects metabolism, immunity, and neurobehavior. Numerous scholarly sources stress how crucial it is to understand the role of the microbiome in human health[10-12].

Clinical trials are the most reliable way to evaluate medicines’ safety and efficacy[13-15], minimize biases, and influence medical practice more than other study designs; as a result, they continue to be valued and applied by medical research more than other study designs[16]. Randomized clinical trials (RCTs) are an experimental approach and essential for assessing the impact of treatment interventions on the gut microbiota[17]. This unique investigation of RCTs on the gut microbiota is growing as evidence-based medicine evolves and is needed to understand and assess intestinal

tract microbial therapies and is needed to understand and assess intestinal tract microbial therapies[18,19]. RCTs can evaluate intestinal microbiota composition, function and demonstrate responses after probiotic supplementations, food modifications, or alternative therapy. The interpretation of research and scientific discoveries related to RCTs involving gut microbiota is not fully studied. However, ongoing research in this area will probably persist, as suggested by studies that are akin to those centered on microbiota[20-22], including investigations into the role of the gut microbiota in schizophrenia[23], nutrition[24], bone metabolism[25], cardiovascular diseases[26-28], atherosclerosis[29], diabetes (both type 1 and type 2)[30,31], irritable bowel syndrome[32,33], depression[34], autoimmune diseases[35], rheumatoid arthritis[36], attention deficit and hyperactivity disorder[37], cancer[38-42], the microbiome-gut-brain axis[38-42], and fecal microbiota transplantation[43-47].

These findings show that RCTs on the intestinal microbiota may be comparable. Thus, this study's major goal is a comprehensive bibliometric analysis of RCTs on intestinal microbiota. This analysis identifies focus areas that can influence future research to understand this specialty's evolution better. This study could become a crucial academic reference for scholars studying current trends and relevant subjects in this field by rigorously evaluating data and identifying research needs. It also helps multidisciplinary scholars comprehend sector professionals' recent assessments.

## MATERIALS AND METHODS

### Study design

A descriptive cross-sectional study was performed in publications that used bibliometric tools to focus on RCTs involving the gut microbiota between 2003 and 2022.

### Data source

The researchers accessed specialized scientific documents through SciVerse Scopus. Scopus is Elsevier's premier abstract and citation database. It allows users to search for academic articles, books, conference papers, and patents that have been published. Scopus is distinguished from other databases such as Web of Science, PubMed, and Google Scholar by its superior quality and breadth of coverage[48,49]. Using the SciVerse Scopus database, the researchers conducted a bibliometric study. Bibliometric studies analyze patterns of scientific publication and citation using quantitative methods. Unlike systematic and scoping reviews, bibliometric studies do not require researchers to peruse and evaluate individual articles[50-53]. Instead, bibliometric studies can be utilized to identify trends in research output, patterns of collaboration, and citation rates.

### Search strategy

To find RCTs that were relevant to the topic of gut microbiota, we did a thorough search of the Scopus database from January 1, 2003 to December 31, 2022. We collected all of the necessary articles on the same day, May 5, 2023, to eliminate the possibility of biases produced by database upgrades and revisions. Our search method was precise and extensive, utilizing complicated search engines and combining various terms and phrases related to RCTs and gut microbiota. The following steps were followed to retrieve the data for this study.

**Step 1:** We entered the terminology associated with the gut microbiota, derived from various sources, including PubMed Medical Subject Headings (MeSH), previous systematic and meta-analyses of the gut microbiota[54-59], and bibliometric studies[24,31,42,60,61], into the Scopus research engine. All selected terms were placed in the "Article Title" section.

**Step 2:** We narrowed down the search results from step 1 to include only documents with the phrase "randomized controlled trials" and related terms in their titles or abstracts. Relevant MeSH terms for RCTs were obtained from MeSH and previous systematic reviews and meta-analyses[62-67].

**Step 3:** The search was limited to primary research articles, excluding other forms of publications such as errata, editorials, letters, and proceedings.

### Validation of the search strategy

It is well known that no search query is 100% perfect, and false positive and negative results are always possible. Instead of conducting a simultaneous search in the title, abstract, and keywords, a deliberate search approach was implemented, focusing solely on the chosen terms within the title. This specific search strategy was adopted to ensure reliability. Using this method, the likelihood of retrieving a negligible number of documents with inaccurate positive results is minimized, thus improving the trustworthiness of the findings[68-72]. In contrast, conducting a search of titles, abstracts, and keywords is likely to generate a significant number of false positives. This is because the main focus of these studies is not directly related to RCTs that specifically focus on gut microbiota but rather on various other topics.

The study used a research strategy that was validated to ensure reliable and precise results. To avoid false positive outcomes, documents with even numbers (10, 20, 30, 40, *etc.*) up to the end of the retrieved document list were scrutinized by evaluating their titles and abstracts. The research strategy was continuously refined until a completely accurate set of randomly selected outcomes was achieved.

To ensure the absence of false negative results, we validated our research strategy by examining the research productivity of 20 active authors in the field. We manually reviewed their publications to identify relevant RCTs on the gut microbiota. We then compared the number of publications identified with those obtained through our research

strategy using the Spearman correlation test[73]. The study found a robust and statistically significant correlation ( $P < 0.001$ ;  $r = 0.963$ ) between the two sets of findings, highlighting the high level of validity. Notably, Sweileh *et al*[74,75] previously used this validation method.

### **Bibliometric analysis**

Bibliometric indicators were collected using an Excel spreadsheet. Key bibliometric indicators that were analyzed include the following: publication trends, citation patterns, h-index and the top 10 countries, journals, institutions, funding agencies, and cited publications. The displayed *Impact Index Per Article* indicates the ten most frequently referenced papers, sourced from the *Reference Citation Analysis* (RCA) database available at <https://www.referencecitationanalysis.com/>. RCA is an openly accessible citation analysis repository spanning diverse academic domains, and it is under the ownership of Baishideng Publishing Group Inc. The organization is headquartered in Pleasanton, CA 94566, United States[76-78].

### **Visualization analysis**

The network maps in this study were generated using version 1.6.9 of the VOSviewer software developed by Leiden University in the Netherlands. These maps visually represent the interconnection of terms extracted from article titles or abstracts of articles, highlighting the collaborative relationships between different countries. By utilizing VOSviewer, a tool for creating knowledge networks based on scientific research, we can observe the advancements made in various research fields and potentially predict future research trends. VOSviewer employs co-occurrence analysis, grouping terms into clusters with different colors. Consequently, analyzing clusters within the co-occurrence network of terms found in titles and abstracts enhances the effectiveness of identifying research hotspots. This approach enables the illustration and identification of developing trends[79,80].

## **RESULTS**

### **Volume of publications**

Between 2003 and 2022, a total of 24758 research articles were published on the topic of gut microbiota. However, when the search was limited to articles specifically related to RCTs involving the gut microbiota, Scopus identified 1061 relevant articles.

### **Growth and productivity trends**

Figure 1 presents the growth and productivity trends in research related to RCTs involving the gut microbiota over the past two decades. The graph illustrates an upward trend in the number of publications, with a remarkable increase from 1 in 2003 to 249 in 2022. The growth occurred in two phases: The first was a period of relatively slow publication from 2003 to 2017, followed by a rapid increase from 2018 to 2022. A linear regression analysis conducted in this study shows a strong positive correlation ( $R^2 = 0.978$ ,  $P < 0.001$ ) between the annual publication count and the respective year of publication.

### **Performance of countries/regions**

In the field of study, Table 1 provides a ranking of the top ten countries based on their research activity. Our analysis revealed that among a total of 1061 publications released in 77 countries, the ten countries with the highest research activity contributed 830 publications. These top 10 countries collectively represent 78.23% of the total publications. In particular, China holds the highest position with 276 publications, accounting for 26.01% of the total. Following closely, the United States secures the second spot with 254 publications (23.94%), followed by the United Kingdom with 97 publications (9.14%) and the Netherlands with 76 publications (7.16%). Figure 2 illustrates the international research collaboration between countries, showing a minimum contribution of 10 articles to the study field. The map encompasses 28 countries, and those positioned centrally, such as the United States, the United Kingdom, and China, possess larger node sizes, signifying a greater number of documents with international collaboration.

### **Active institutions/organizations**

Table 2 presents the top ten institutions among 4793 that have actively participated in the production of research publications related to RCTs and gut microbiota. The findings suggest that these institutions have collectively contributed to 22.43% of the total documents published in this field. Københavns University has secured the top spot by producing 38 documents, accounting for 3.58% of the total publications. Dankook University follows closely behind with 35 publications (3.30%), and the Ministry of Education China and Wageningen University & Research have produced 30 publications (2.83%) and 28 publications (2.64%), respectively. The majority of active institutions were based in the United States, with three institutions represented. China had two institutions, while Denmark, South Korea, Canada, France, Finland, and Spain each had one institution represented.

### **Top funding agencies**

Table 3 presents the top 10 funding agencies that have contributed significantly to this field. The findings suggest that these institutions have collectively contributed to 23.84% of the total documents published in this field. In particular, the National Natural Science Foundation of China ( $n = 91$ ; 8.58%), the National Institutes of Health ( $n = 67$ ; 6.31%), the

**Table 1 The ten most active countries from 2003 to 2022 in research related to randomized controlled trials involving gut microbiota**

| Ranking          | Country        | No. of documents | %     |
|------------------|----------------|------------------|-------|
| 1 <sup>st</sup>  | China          | 276              | 26.01 |
| 2 <sup>nd</sup>  | United States  | 254              | 23.94 |
| 3 <sup>rd</sup>  | United Kingdom | 97               | 9.14  |
| 4 <sup>th</sup>  | Netherlands    | 76               | 7.16  |
| 5 <sup>th</sup>  | Italy          | 61               | 5.75  |
| 5 <sup>th</sup>  | South Korea    | 61               | 5.75  |
| 7 <sup>h</sup>   | Canada         | 60               | 5.66  |
| 8 <sup>th</sup>  | Spain          | 54               | 5.09  |
| 9 <sup>th</sup>  | Australia      | 53               | 5.00  |
| 10 <sup>th</sup> | Denmark        | 52               | 4.90  |

**Table 2 The top ten active institutions in research related to randomized controlled trials involving gut microbiota from 2003 to 2022**

| Ranking          | Institute                        | Country       | No. of documents | %    |
|------------------|----------------------------------|---------------|------------------|------|
| 1 <sup>st</sup>  | Københavns Universitet           | Denmark       | 38               | 3.58 |
| 2 <sup>nd</sup>  | Dankook University               | South Korea   | 35               | 3.30 |
| 3 <sup>rd</sup>  | Ministry of Education China      | China         | 30               | 2.83 |
| 4 <sup>th</sup>  | Wageningen University & Research | United States | 28               | 2.64 |
| 5 <sup>th</sup>  | Harvard Medical School           | United States | 21               | 1.98 |
| 6 <sup>th</sup>  | University of Calgary            | Canada        | 20               | 1.89 |
| 7 <sup>th</sup>  | Helsingin Yliopisto              | Finland       | 19               | 1.79 |
| 7 <sup>th</sup>  | Chinese Academy of Sciences      | China         | 19               | 1.79 |
| 9 <sup>th</sup>  | University of California, Davis  | United States | 18               | 1.70 |
| 10 <sup>th</sup> | INSEM                            | France        | 17               | 1.60 |
| 10 <sup>th</sup> | Instituto de Salud Carlos III    | Spain         | 17               | 1.60 |

**Table 3 The top ten funding agencies that have published the most research on randomized controlled trials involving gut microbiota between 2003 and 2022**

| Ranking          | Funding agencies   | Country        | No. of documents | %    |
|------------------|--|----------------|------------------|------|
| 1 <sup>st</sup>  | National Natural Science Foundation of China                     | China          | 91               | 8.58 |
| 2 <sup>nd</sup>  | National Institutes of Health                                    | United States  | 67               | 6.31 |
| 3 <sup>rd</sup>  | National Institute of Diabetes and Digestive and Kidney Diseases | United States  | 32               | 3.02 |
| 3 <sup>rd</sup>  | National Key Research and Development Program of China           | China          | 32               | 3.02 |
| 5 <sup>th</sup>  | European Regional Development Fund                               | European Union | 20               | 1.89 |
| 6 <sup>th</sup>  | Instituto de Salud Carlos III                                    | Spain          | 18               | 1.70 |
| 6 <sup>th</sup>  | National Center for Advancing Translational Sciences             | United States  | 18               | 1.70 |
| 8 <sup>h</sup>   | National Health and Medical Research Council                     | Australia      | 14               | 1.32 |
| 8 <sup>th</sup>  | National Research Foundation of Korea                            | South Korea    | 14               | 1.32 |
| 10 <sup>th</sup> | National Cancer Institute  | United States  | 13               | 1.23 |



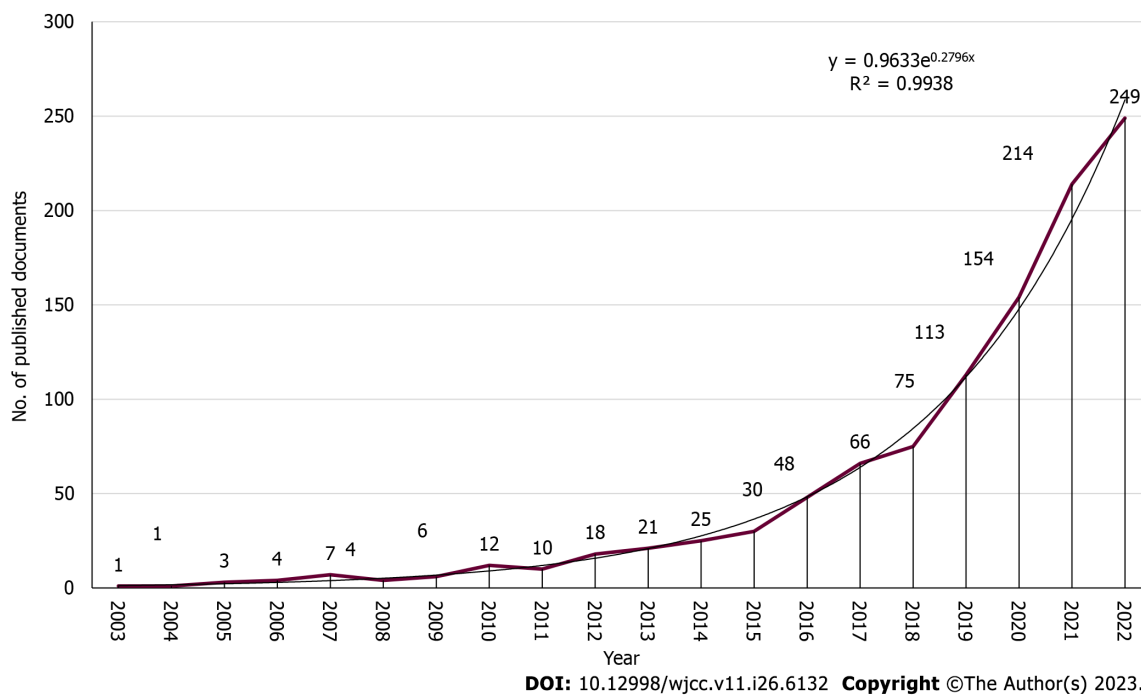


Figure 1 Trends in publications for research related to randomized controlled trials involving gut microbiota from 2003 to 2022.

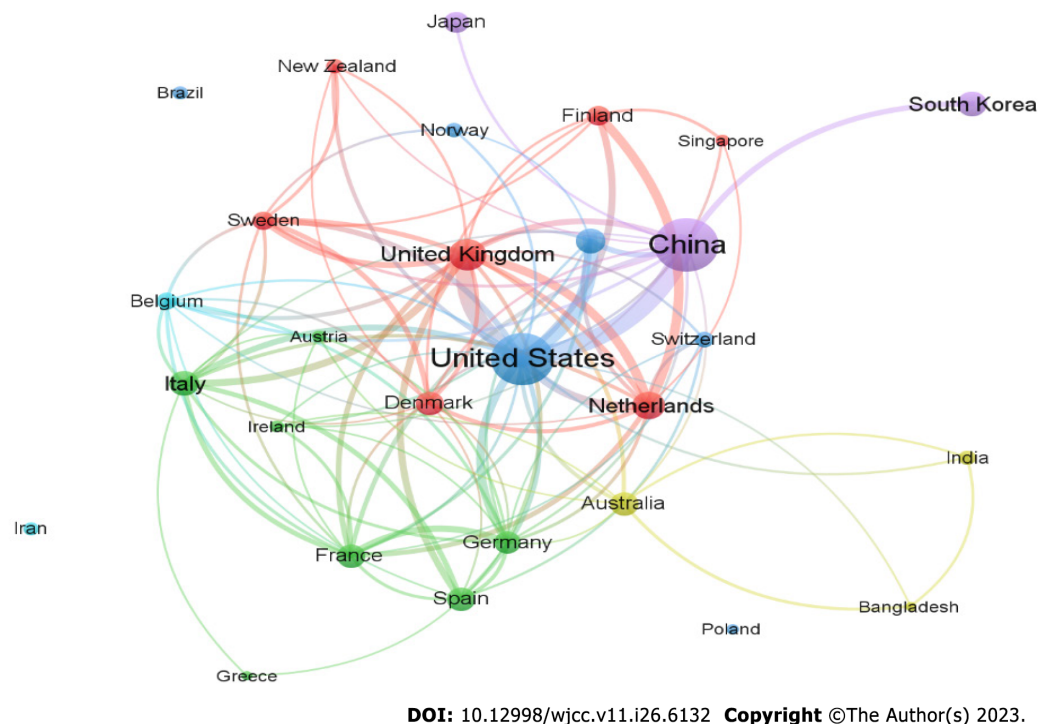


Figure 2 International (cross-country) research collaboration between countries with a minimum contribution of 10 articles. There were 28 countries on the map. VOSviewer software version 1.6.19 was used to create the map.

National Institute of Diabetes and Digestive and Kidney Diseases ( $n = 32$ ; 3.02%), and the National Key Research and Development Program of China ( $n = 32$ ; 3.02%) emerged as key players in funding. It is worth mentioning that the United States has made the largest contribution to this field, with the majority of active funding agencies being based in the country. In fact, four of the represented funding agencies are from the United States.

### Top active journals

Table 4 presents the top 10 journals ranked by number of publications. In total, these journals have published 228 articles, representing approximately 21.49% of all publications. The journal with the highest number of articles is *Nutrients*, which

**Table 4** The leading journals with the most publications in research on randomized controlled trials involving gut microbiota from 2003 to 2022

| Ranking         | Journal/source title                          | No. of documents | %    | IF <sup>1</sup> |
|-----------------|---|------------------|------|-----------------|
| 1 <sup>st</sup> | <i>Nutrients</i>                              | 50               | 4.71 | 6.706           |
| 2 <sup>nd</sup> | <i>Plos one</i>                               | 26               | 2.45 | 3.752           |
| 3 <sup>rd</sup> | <i>Scientific Reports</i>                     | 24               | 2.26 | 4.996           |
| 4 <sup>th</sup> | <i>European Journal of Nutrition</i>          | 20               | 1.89 | 4.865           |
| 5 <sup>th</sup> | <i>American Journal of Clinical Nutrition</i> | 19               | 1.79 | 8.472           |
| 5 <sup>th</sup> | <i>Clinical Nutrition</i>                     | 19               | 1.79 | 7.643           |
| 7 <sup>th</sup> | <i>BMJ Open</i>                               | 18               | 1.70 | 3.006           |
| 7 <sup>h</sup>  | <i>Journal of Nutrition</i>                   | 18               | 1.70 | 4.687           |
| 9 <sup>th</sup> | <i>Frontiers in Nutrition</i>                 | 17               | 1.60 | 6.59            |
| 9 <sup>th</sup> | <i>Gut</i>                                    | 17               | 1.60 | 31.793          |

<sup>1</sup>2021 Journal Citation Reports™ (Clarivate, 2022).

IF: Impact factor.

has published 50 articles. *Plos One* follows with 26 articles, *Scientific Reports* with 24 articles, and *European Journal of Nutrition Clinical Nutrition* with 20 articles.

### Analysis of citations

Based on citation analysis, it was found that the retrieved articles had received an average of 40.9 citations, resulting in an h-index of 96 and a total of 43393 citations. Among these articles, 102 did not receive any citations, while 92 received more than 100 citations. The number of citations for these articles ranged from 0 to 1977. **Table 5** presents the top ten publications[81-90] related to RCTs and the gut microbiota, which collectively received 7894 citations with a citation range of 414 to 1977.

### Co-occurrence analysis

By examining the frequency of terms in article titles and abstracts, a co-occurrence network was generated with the aim of identifying current research trends and important topics that play a critical role in the advancement of science. **Figure 3** illustrates the network that comprises 222 terms that were selected from a pool of 24653 terms based on a minimum frequency of 30 occurrences. These terms were further classified into three distinct clusters, with the most frequent terms assigned to specific categories, namely: (1) Interventions targeting the gut microbiota to manage obesity (red cluster); (2) the efficacy and safety of fecal microbiota transplantation (green cluster); and (3) the impact of dietary interventions on the gut microbiota in humans (blue cluster).

### Future research direction analysis

**Figure 4** of VOSviewer employs a color-coded system to represent each term uniquely based on its average frequency in all retrieved publications. The color spectrum varies from yellow for the latest terms to blue for the older ones. Previous studies in this field focused mainly on exploring the effects of dietary interventions on the human gut microbiota before 2019. However, in recent years, new avenues of study have surfaced, including “managing obesity by targeting the gut microbiota” and “assessing the safety and efficacy of fecal microbiota transplantation”.

## DISCUSSION

In this investigation, we used information visualization techniques to analyze primary research articles that examined RCTs and gut microbiota published between 2003 and 2022. Based on the trends we observed, which demonstrated a steady increase in scientific publications over the two-decade period, we have concluded that the gut microbiota has emerged as a rapidly growing and increasingly important area of research. The surge of research activity that followed 2017 can be attributed to seminal publications that have significantly contributed to our understanding of intestinal microbiota diversity, enterotype, sequencing data analysis, and their associations with digestive disorders, particularly inflammatory bowel disease (IBD) and obesity. These publications, which were published between 2009 and 2017[81-90], attracted considerable attention from researchers in this field, leading to an exponential increase in the number of publications.

**Table 5** The ten most-cited articles that cited research involving randomized controlled trials on gut microbiota between 2003 and 2022

| Ref.                                  | Title  | Year | Source title  | Cited by | Impact index per article <sup>1</sup> |
|---------------------------------------|--|------|---|----------|---------------------------------------|
| Vrieze <i>et al</i> [89], 2012        | "Transfer of intestinal microbiota from lean donors increases insulin sensitivity in individuals with metabolic syndrome"  | 2012 | <i>Gastroenterology</i>                                 | 1977     | 171.0                                 |
| Moayyedi <i>et al</i> [85], 2015      | "Fecal Microbiota Transplantation Induces Remission in Patients With Active Ulcerative Colitis in a Randomized Controlled Trial"   | 2015 | <i>Gastroenterology</i>                                 | 1012     | 116.3                                 |
| Wu <i>et al</i> [90], 2017            | "Metformin alters the gut microbiome of individuals with treatment-naïve type 2 diabetes, contributing to the therapeutic effects of the drug"                                       | 2017 | <i>Nature Medicine</i>                                  | 892      | 137.3                                 |
| Subramanian <i>et al</i> [88], 2014   | "Persistent gut microbiota immaturity in malnourished Bangladeshi children"  | 2014 | <i>Nature</i>   | 773      | 89.7                                  |
| Paramsothy <i>et al</i> [86], 2017    | "Multidonor intensive fecal microbiota transplantation for active ulcerative colitis: A randomised placebo-controlled trial"   | 2017 | <i>The Lancet</i>                                       | 754      | 118.3                                 |
| Gareau <i>et al</i> [82], 2010        | "Probiotics and the gut microbiota in intestinal health and disease"   | 2010 | <i>Nature Reviews Gastroenterology and Hepatology</i>   | 596      | 43.5                                  |
| Cani <i>et al</i> [81], 2009          | "Gut microbiota fermentation of prebiotics increases satietogenic and incretin gut peptide production with consequences for appetite sensation and glucose response after a meal"    | 2009 | <i>American Journal of Clinical Nutrition</i>           | 534      | 36.6                                  |
| Queipo-Ortuño <i>et al</i> [87], 2012 | "Influence of red wine polyphenols and ethanol on the gut microbiota ecology and biochemical biomarkers"   | 2012 | <i>American Journal of Clinical Nutrition</i>           | 481      | 41.7                                  |
| Lee <i>et al</i> [84], 2016           | "Frozen vs fresh fecal microbiota transplantation and clinical resolution of diarrhea in patients with recurrent <i>Clostridium difficile</i> infection a randomized clinical trial" | 2016 | <i>JAMA-Journal of the American Medical Association</i> | 461      | 62.3                                  |
| Ianiro <i>et al</i> [83], 2018        | "Randomised clinical trial: Faecal microbiota transplantation by colonoscopy vs. vancomycin for the treatment of recurrent <i>Clostridium difficile</i> infection"                   | 2015 | <i>Alimentary Pharmacology and Therapeutics</i>         | 414      | 47.8                                  |

<sup>1</sup>The impact index per article is presented based on *Reference Citation Analysis* (Source: Baishideng Publishing Group Inc. Pleasanton, CA 94566, United States).

The annual number of publications on the gut microbiota exhibits exponential growth (Figure 1), indicating that this research area is a vibrant and continuously expanding research field. This observation is consistent with previous studies [20-22,91]. Researchers should keep a constant focus on the trends in this field to reveal additional connections between humans and the gastrointestinal microbiome. China is the leading contributor to publications, which may be attributable to the emphasis placed on studying the human microbiome highlighted by the National Natural Science Foundation of China, the 14<sup>th</sup> Five-Year National Key Research and Development Plan, and the Outline of the 2035 Vision Goals[21]. The United States is the second most productive country in terms of publication output, which may be related to the Human Microbiome Project (HMP) programme launched by the National Institutes of Health in 2007 and the Gut Microbiota Brain AXIS programme initiated in 2013[92,93].

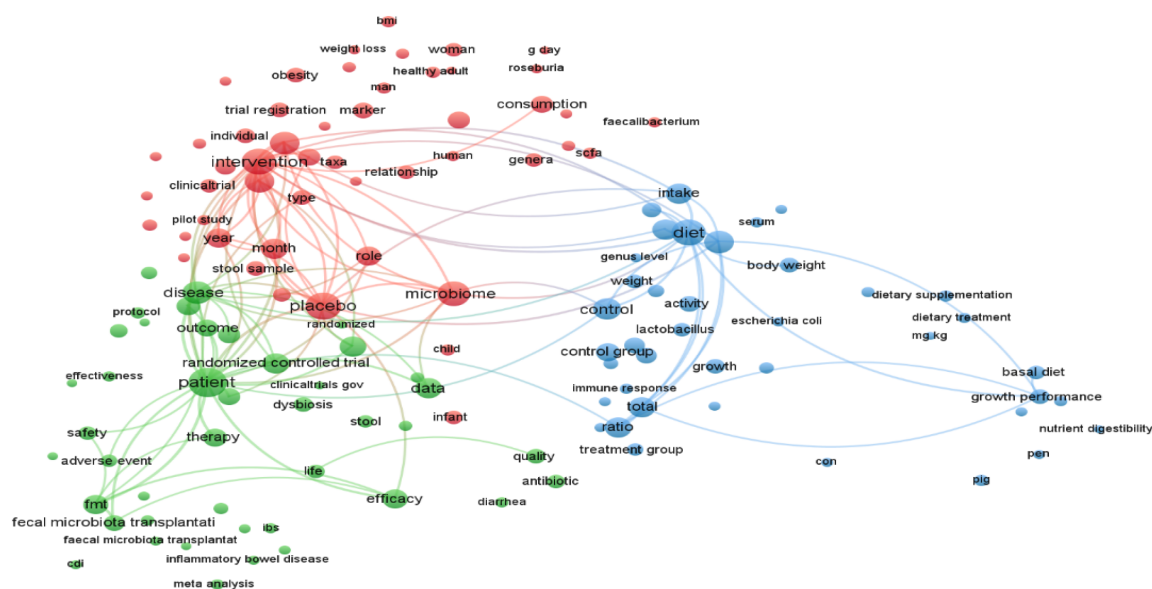
The current study reveals that researchers have paid great attention to publications related to RCTs involving the gut microbiota, especially in recent years. They have published several outstanding articles in leading journals in the medical field, including *Gastroenterology*[85,89], *Nature Medicine*[90], *Nature*[88], *Lancet*[86], *Nature Reviews Gastroenterology and Hepatology*[82], and *JAMA-Journal of the American Medical Association*[84].

The article by Vrieze *et al*[89] published in *Gastroenterology* is the most cited, where the authors suggest a connection between alterations in the intestinal microbiota, insulin resistance, and obesity. In this study, researchers looked at what would happen if they gave men with metabolic syndrome the gut microbiota of lean donors. The goal was to see how the microbiota and receivers' glucose usage changed. The people who took part were given either allogeneic or autologous microbiota infusions in their small intestines. Six weeks after getting a microbiota infusion from lean donors, the insulin sensitivity of the people who got the infusion improved (the median rate of glucose leaving the body went from 26.2 mol/kg/min to 45.3 mol/kg/min;  $P < 0.05$ )[89]. Furthermore, the levels of the intestinal microbiota that produce butyrate also showed an increase. These findings suggest that the intestinal microbiota may be developed as a therapeutic agent to improve human insulin sensitivity.

Moayyedi *et al*[85] published the second most cited article in *Gastroenterology* in 2015. In their study, the authors proposed that fecal microbiota transplantation induces remission in a considerably higher proportion of patients with active ulcerative colitis compared to placebo, with no notable variation in adverse effects. The outcomes are affected by the fecal donor and the duration of ulcerative colitis.

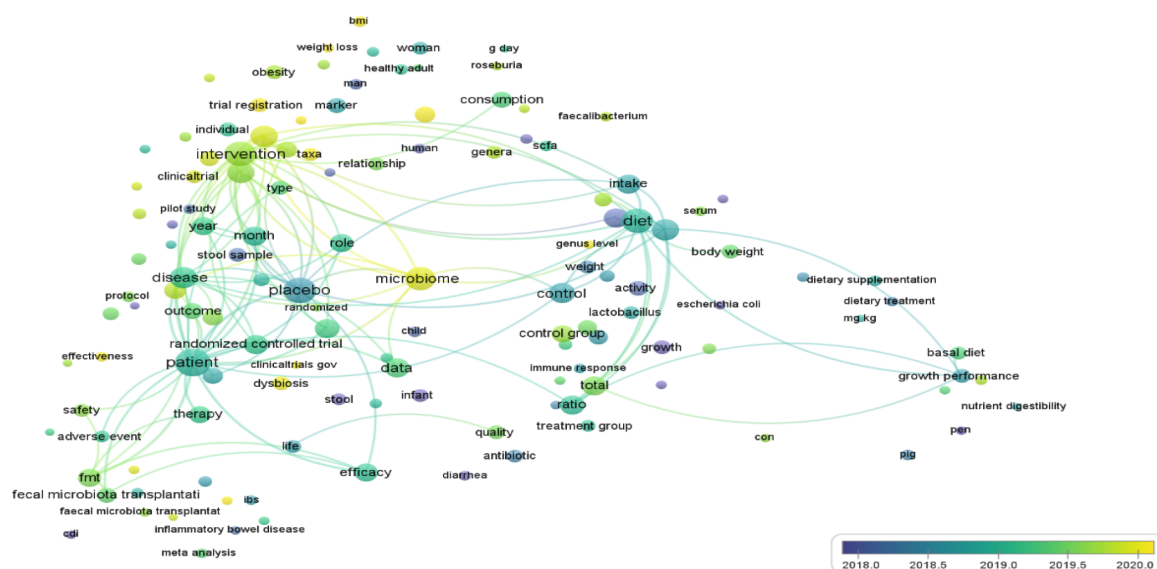
In 2017, Wu *et al*[90] published an article in *Nature Medicine*, which is the third most cited article. The authors discovered that their findings offer evidence to support the idea that the modified gut microbiota mediates certain antidiabetic effects of metformin.





DOI: 10.12998/wjcc.v11.i26.6132 Copyright ©The Author(s) 2023.

**Figure 3** Map generated by VOSviewer 1.6.19 depicting clusters derived from title and abstract term analysis. Cluster variety is indicated by different colors, while term occurrence frequency is represented by circle size. VOSviewer software version 1.6.19 was used to create the map.



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**Figure 4** Visualization of term co-occurrence as an overlay. This map depicts how frequently specific terms have appeared in titles and abstracts over time, with blue nodes representing earlier occurrences and yellow nodes representing later occurrences. VOSviewer software version 1.6.19 was used to create the map.

The current study identified, visualized, and described three research hotspots in publications related to RCTs involving the gut microbiota. Among these, evaluating the safety and efficacy of fecal microbiota transplantation (FMT) was the main topic and received greater attention. FMT is a new therapy[46,94] being tested for autoimmune diseases [95], IBD[96,97], liver encephalopathy[98], and neurological disorders[99]. It has been extensively examined for recurrent *Clostridium difficile* infections[100-104]. FMT may assist patients with metabolic syndrome[105,106] and insulin resistance [107], especially when employing lean donors. This therapy increased gut microbiota diversity and insulin sensitivity.

The gut microbiome has been targeted to manage obesity in recent years. Weight gain and related comorbidities can be prevented or treated by manipulating gut flora[108]. Prebiotics, probiotics, synbiotics, FMT, and other therapies can be used[17]. These therapies depend on the structure and composition of the resident microbiota and a thorough understanding of the dynamic changes that occur over time[109,110]. Through intensive research, some processes of the gut microbiota have been better studied in relation to their association with obesogenic mechanisms. For example, one such process involves the participation of the gut microbiota in bile acid metabolism, which ultimately contributes in different ways to increased glucagon-like peptide 1 production. These effects result in improved glucose homeostasis,

decreased fat absorption, reduced insulin resistance, and a decreased likelihood of weight gain[111]. The gut microbiota's impact on immune function modifications may also influence body weight control[112,113]. Numerous studies have also explored the impact of physical activity on the gut microbiota with the aim of improving body weight management[114, 115].

### Strengths and limitations

This study represents the first bibliometric analysis to evaluate the performance of scientific publications focused on RCTs involving the gut microbiota. Our findings provide valuable information for researchers seeking to identify research subjects, research hotspots, and development trends related to RCTs and the gut microbiota. However, it is important to acknowledge certain limitations. First, the study was conducted exclusively on publications in the Scopus database. Although Scopus is widely recognized as the most commonly used and trusted[116-120], a small number of outlier publications from alternative sources such as PubMed and Web of Science may have been omitted. However, this bibliometric study presents the initial comprehensive analysis of global publications on RCTs and gut microbiota using Scopus and VOSviewer. It showcases the advantages of bibliometric analysis in evaluating research productivity in this field in a standardized way. Second, although we used a comprehensive list of keywords based on previous systematic reviews and meta-analyses[54-59] and bibliometric studies[24,31,42,60,61], it is possible that certain pertinent keywords could be overlooked, which could result in false negative results. Third, our selection of the ten most highly cited papers may have been influenced by the time-dependent nature of citation searches, which tend to favor older publications. Fourth, our analysis was limited to searching for titles and specific search phrases related to RCTs and gut microbiota, potentially missing relevant articles that used these terms as keywords or included them in the text. Finally, it is important to acknowledge that the results generated by Scopus reflect the nature and scope of the data it encompasses, which may lead to the scattering of research output from active institutions and the underrepresentation of certain funding agencies. To ensure the accuracy and impartiality of our results, we followed a specified methodology and avoided any manipulations or merging of the Scopus output.

## CONCLUSION

Based on the results presented, the study of publications related to RCTs involving the gut microbiota has experienced a significant increase in research activity in the past two decades. A robust positive correlation is observed between the annual count of publications and the respective year of publication. International research collaboration has been depicted on a map with the United States, the United Kingdom, and China as the countries with the largest node sizes, indicating greater collaboration. China leads research, followed by the United States and United Kingdom. The co-occurrence analysis shows current gut microbiota research trends and important topics, such as obesity interventions targeting the gut microbiota, the efficacy and safety of fecal microbiota transplantation, and the effects of dietary interventions on humans. The findings imply that future research could focus on generating new therapies, researching the possibilities of fecal microbiota transplantation to treat various diseases, and studying the effects of dietary interventions on gut microbiota and human health.

## ARTICLE HIGHLIGHTS

### Research background

The gut microbiome contains bacteria, fungi, and viruses. Recent research reveals that the gut microbiota, the microbial community in the gastrointestinal tract, affects immune system function and host inflammation.

### Research motivation

Clinical investigations have provided evidence of connections between the human microbiome and various diseases. However, fundamental inquiries still need to be addressed regarding the generalizability of this knowledge.

### Research objectives

To identify and assess the current state and trends in global research output on randomized clinical trials (RCTs) centered on gut microbiota. Additionally, this study aimed to analyze the key areas of research visually focused within this particular sector.

### Research methods

The body of literature on RCTs centered on the gut microbiota was compiled using the Scopus database and *Reference Citation Analysis* (RCA). In addition, VOSviewer software was utilized to assess the collected data from relevant scholarly articles visually.

### Research results

This study is the first bibliometric analysis of worldwide research patterns on RCTs centered on gut microbiota. There has been a notable increase in scholarly works focusing on RCTs and gut microbiota in recent years. The results of our study

indicate that future research will focus on interventions targeting obesity by manipulating the gut microbiota, evaluating the efficacy and safety of fecal microbiota transplantation, and exploring the impact of dietary interventions on the human gut microbiota.

### Research conclusions

The report shows the tremendous expansion and importance of gut microbiota RCTs. Identifies major actors, research trends, and future prospects in this subject. The co-occurrence analysis also revealed key themes that promote science and suggested future study options.

### Research perspectives

Over the past decades, a series of investigations have yielded compelling findings regarding the considerable significance of the gut microbiota in human health and its correlation with various diseases. The intricate and interconnected dynamics of gut fungi, bacteria, and the host's immune system play a crucial role in preserving the equilibrium of the host's physiological processes while also exerting an impact on the progression, advancement, and potential therapeutic outcomes of diseases.

## FOOTNOTES

**Author contributions:** Zyoud SH developed the concept for the manuscript, reviewed the literature, designed the study, collected the data, analyzed the data, made significant contributions to the existing literature search and interpretation of the manuscript, and wrote the manuscript; Shakhshir M contributed to the conceptualization and methodology of the study, involved in the interpretation of the data, contributed to the manuscript writing, and made revisions to the initial draft; Koni A, Abushanab AS, Jairoun AA, Shahwan WM, Abu Taha A, and Al-Jabi SW participated in the interpretation of the data, and made revisions to the initial draft; all authors provided a critical review and approved the final manuscript before submission.

**Conflict-of-interest statement:** The authors have no financial disclosures or conflicts of interest to declare.

**PRISMA 2009 Checklist statement:** The authors have read the PRISMA 2009 Checklist, and the manuscript was prepared and revised according to the PRISMA 2009 Checklist.

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**Country/Territory of origin:** Palestine

**ORCID number:** Sa'ed H Zyoud 0000-0002-7369-2058; Muna Shakhshir 0000-0002-6213-8457; Amani S Abushanab 0000-0001-6290-787X; Amer Koni 0000-0002-0514-9352; Moyad Shahwan 0000-0001-8367-4841; Ammar Abdulrahman Jairoun 0000-0002-4471-0878; Adham Abu Taha 0000-0002-2889-1138; Samah W Al-Jabi 0000-0002-4414-9427.

**S-Editor:** Chen YL

**L-Editor:** A

**P-Editor:** Zhao S

## REFERENCES

- 1 Guinane CM, Cotter PD. Role of the gut microbiota in health and chronic gastrointestinal disease: understanding a hidden metabolic organ. *Therap Adv Gastroenterol* 2013; **6**: 295-308 [PMID: 23814609 DOI: 10.1177/1756283X13482996]
- 2 Bull MJ, Plummer NT. Part I: The Human Gut Microbiome in Health and Disease. *Integr Med (Encinitas)* 2014; **13**: 17-22 [PMID: 26770121]
- 3 Thursby E, Juge N. Introduction to the human gut microbiota. *Biochem J* 2017; **474**: 1823-1836 [PMID: 28512250 DOI: 10.1042/BCJ20160510]
- 4 Hou K, Wu ZX, Chen XY, Wang JQ, Zhang D, Xiao C, Zhu D, Koya JB, Wei L, Li J, Chen ZS. Microbiota in health and diseases. *Signal Transduct Target Ther* 2022; **7**: 135 [PMID: 35461318 DOI: 10.1038/s41392-022-00974-4]
- 5 Berg G, Rybakova D, Fischer D, Cernava T, Vergès MC, Charles T, Chen X, Coccolin L, Eversole K, Corral GH, Kazou M, Kinkel L, Lange L, Lima N, Loy A, Macklin JA, Maguin E, Mauchline T, McClure R, Mitter B, Ryan M, Sarand I, Smidt H, Schelkle B, Roume H, Kiran GS, Selvin J, Souza RSC, van Overbeek L, Singh BK, Wagner M, Walsh A, Sessitsch A, Schlöter M. Microbiome definition re-visited: old concepts and new challenges. *Microbiome* 2020; **8**: 103 [PMID: 32605663 DOI: 10.1186/s40168-020-00875-0]
- 6 Ursell LK, Metcalf JL, Parfrey LW, Knight R. Defining the human microbiome. *Nutr Rev* 2012; **70** Suppl 1: S38-S44 [PMID: 22861806 DOI: 10.1111/j.1753-4887.2012.00493.x]
- 7 Parker A, Lawson MAE, Vaux L, Pin C. Host-microbe interaction in the gastrointestinal tract. *Environ Microbiol* 2018; **20**: 2337-2353 [PMID: 28892253 DOI: 10.1111/1462-2920.13926]
- 8 Liu J, Tan Y, Cheng H, Zhang D, Feng W, Peng C. Functions of Gut Microbiota Metabolites, Current Status and Future Perspectives. *Aging Dis* 2022; **13**: 1106-1126 [PMID: 35855347 DOI: 10.14336/AD.2022.0104]

- 9 **Gilbert JA**, Blaser MJ, Caporaso JG, Jansson JK, Lynch SV, Knight R. Current understanding of the human microbiome. *Nat Med* 2018; **24**: 392-400 [PMID: 29634682 DOI: 10.1038/nm.4517]
- 10 **Afzaal M**, Saeed F, Shah YA, Hussain M, Rabail R, Socol CT, Hassoun A, Pateiro M, Lorenzo JM, Rusu AV, Aadil RM. Human gut microbiota in health and disease: Unveiling the relationship. *Front Microbiol* 2022; **13**: 999001 [PMID: 36225386 DOI: 10.3389/fmicb.2022.999001]
- 11 **Durack J**, Lynch SV. The gut microbiome: Relationships with disease and opportunities for therapy. *J Exp Med* 2019; **216**: 20-40 [PMID: 30322864 DOI: 10.1084/jem.20180448]
- 12 **Valdes AM**, Walter J, Segal E, Spector TD. Role of the gut microbiota in nutrition and health. *BMJ* 2018; **361**: k2179 [PMID: 29899036 DOI: 10.1136/bmj.k2179]
- 13 **Gagliardi A**, Totino V, Cacciotti F, Iebba V, Neroni B, Bonfiglio G, Trancassini M, Passariello C, Pantanella F, Schippa S. Rebuilding the Gut Microbiota Ecosystem. *Int J Environ Res Public Health* 2018; **15** [PMID: 30087270 DOI: 10.3390/ijerph15081679]
- 14 **Fong W**, Li Q, Yu J. Gut microbiota modulation: a novel strategy for prevention and treatment of colorectal cancer. *Oncogene* 2020; **39**: 4925-4943 [PMID: 32514151 DOI: 10.1038/s41388-020-1341-1]
- 15 **Gebrayel P**, Nicco C, Al Khodor S, Bilinski J, Caselli E, Comelli EM, Egert M, Giaroni C, Karpinski TM, Loniewski I, Mulak A, Reygnier J, Samczuk P, Serino M, Sikora M, Terranegra A, Ufnal M, Villegier R, Pichon C, Konturek P, Edeas M. Microbiota medicine: towards clinical revolution. *J Transl Med* 2022; **20**: 111 [PMID: 35255932 DOI: 10.1186/s12967-022-03296-9]
- 16 **Hariton E**, Locascio JJ. Randomised controlled trials - the gold standard for effectiveness research: Study design: randomised controlled trials. *BJOG* 2018; **125**: 1716 [PMID: 29916205 DOI: 10.1111/1471-0528.15199]
- 17 **Jüni P**, Altman DG, Egger M. Systematic reviews in health care: Assessing the quality of controlled clinical trials. *BMJ* 2001; **323**: 42-46 [PMID: 11440947 DOI: 10.1136/bmj.323.7303.42]
- 18 **Sibbald B**, Roland M. Understanding controlled trials. Why are randomised controlled trials important? *BMJ* 1998; **316**: 201 [PMID: 9468688 DOI: 10.1136/bmj.316.7126.201]
- 19 **Wood L**, Egger M, Gluud LL, Schulz KF, Jüni P, Altman DG, Gluud C, Martin RM, Wood AJ, Sterne JA. Empirical evidence of bias in treatment effect estimates in controlled trials with different interventions and outcomes: meta-epidemiological study. *BMJ* 2008; **336**: 601-605 [PMID: 18316340 DOI: 10.1136/bmj.39465.451748.AD]
- 20 **Huang X**, Fan X, Ying J, Chen S. Emerging trends and research foci in gastrointestinal microbiome. *J Transl Med* 2019; **17**: 67 [PMID: 30819194 DOI: 10.1186/s12967-019-1810-x]
- 21 **Yuan X**, Chang C, Chen X, Li K. Emerging trends and focus of human gastrointestinal microbiome research from 2010-2021: a visualized study. *J Transl Med* 2021; **19**: 327 [PMID: 34332587 DOI: 10.1186/s12967-021-03009-8]
- 22 **Yue YY**, Fan XY, Zhang Q, Lu YP, Wu S, Wang S, Yu M, Cui CW, Sun ZR. Bibliometric analysis of subject trends and knowledge structures of gut microbiota. *World J Clin Cases* 2020; **8**: 2817-2832 [PMID: 32742991 DOI: 10.12998/wjcc.v8.i13.2817]
- 23 **Yang C**, Lin X, Wang X, Liu H, Huang J, Wang S. The schizophrenia and gut microbiota: A bibliometric and visual analysis. *Front Psychiatry* 2022; **13**: 1022472 [PMID: 36458121 DOI: 10.3389/fpsy.2022.1022472]
- 24 **Zyoud SH**, Shakhshir M, Abushanab AS, Al-Jabi SW, Koni A, Shahwan M, Jairoun AA, Abu Taha A. Mapping the global research landscape on nutrition and the gut microbiota: Visualization and bibliometric analysis. *World J Gastroenterol* 2022; **28**: 2981-2993 [PMID: 35978868 DOI: 10.3748/wjg.v28.i25.2981]
- 25 **Zhang Z**, Zhang Z, Shu H, Meng Y, Lin T, Ma J, Zhao J, Zhou X. Association between gut microbiota and bone metabolism: Insights from bibliometric analysis. *Front Physiol* 2023; **14**: 1156279 [PMID: 37153210 DOI: 10.3389/fphys.2023.1156279]
- 26 **Mu F**, Tang M, Guan Y, Lin R, Zhao M, Zhao J, Huang S, Zhang H, Wang J, Tang H. Knowledge Mapping of the Links Between the Gut Microbiota and Heart Failure: A Scientometric Investigation (2006-2021). *Front Cardiovasc Med* 2022; **9**: 882660 [PMID: 35571213 DOI: 10.3389/fcvm.2022.882660]
- 27 **Sheng M**, Xu S, Chen WW, Li FQ, Zhong YM, Ouyang YX, Liao YL, Lai P. A bibliometric analysis of studies on the gut microbiota in cardiovascular disease from 2004 to 2022. *Front Cell Infect Microbiol* 2022; **12**: 1083995 [PMID: 36683688 DOI: 10.3389/fcimb.2022.1083995]
- 28 **Long D**, Mao C, Zhang X, Liu Y, Shanguan X, Zou M, Zhu Y, Wang X. Coronary heart disease and gut microbiota: A bibliometric and visual analysis from 2002 to 2022. *Front Cardiovasc Med* 2022; **9**: 949859 [PMID: 36158832 DOI: 10.3389/fcvm.2022.949859]
- 29 **Wang Y**, Li D, Jia Z, Hui J, Xin Q, Zhou Q, Cong W, Xu F. A Bibliometric Analysis of Research on the Links Between Gut Microbiota and Atherosclerosis. *Front Cardiovasc Med* 2022; **9**: 941607 [PMID: 35903667 DOI: 10.3389/fcvm.2022.941607]
- 30 **Dehghanbanadaki H**, Aazami H, Ejtahed HS, Sohrabi A, Raftar SKA, Tarashi S, Tabatabaei-Malazy O, Bahramali G, Siadat SD, Esfahani EN, Razi F. The global scientific publications on gut microbiota in type 2 diabetes: a bibliometric, Scientometric, and descriptive analysis. *J Diabetes Metab Disord* 2022; **21**: 13-32 [PMID: 35673416 DOI: 10.1007/s40200-021-00920-1]
- 31 **Guo K**, Li J, Li X, Huang J, Zhou Z. Emerging trends and focus on the link between gut microbiota and type 1 diabetes: A bibliometric and visualization analysis. *Front Microbiol* 2023; **14**: 1137595 [PMID: 36970681 DOI: 10.3389/fmicb.2023.1137595]
- 32 **Wan C**, Kong X, Liao Y, Chen Q, Chen M, Ding Q, Liu X, Zhong W, Xu C, Liu W, Wang B. Bibliometric analysis of the 100 most-cited papers about the role of gut microbiota in irritable bowel syndrome from 2000 to 2021. *Clin Exp Med* 2022 [PMID: 36522553 DOI: 10.1007/s10238-022-00971-5]
- 33 **Zyoud SH**, Smale S, Waring WS, Sweileh W, Al-Jabi SW. Global research trends in the microbiome related to irritable bowel syndrome: A bibliometric and visualized study. *World J Gastroenterol* 2021; **27**: 1341-1353 [PMID: 33833487 DOI: 10.3748/wjg.v27.i13.1341]
- 34 **Zhu X**, Hu J, Deng S, Tan Y, Qiu C, Zhang M, Ni X, Lu H, Wang Z, Li L, Chen H, Huang S, Xiao T, Shang D, Wen Y. Bibliometric and Visual Analysis of Research on the Links Between the Gut Microbiota and Depression From 1999 to 2019. *Front Psychiatry* 2020; **11**: 587670 [PMID: 33488420 DOI: 10.3389/fpsy.2020.587670]
- 35 **Zhang Y**, Peng Y, Xia X. Autoimmune diseases and gut microbiota: a bibliometric and visual analysis from 2004 to 2022. *Clin Exp Med* 2023 [PMID: 36859447 DOI: 10.1007/s10238-023-01028-x]
- 36 **Dong Y**, Yao J, Deng Q, Li X, He Y, Ren X, Zheng Y, Song R, Zhong X, Ma J, Shan D, Lv F, Wang X, Yuan R, She G. Relationship between gut microbiota and rheumatoid arthritis: A bibliometric analysis. *Front Immunol* 2023; **14**: 1131933 [PMID: 36936921 DOI: 10.3389/fimmu.2023.1131933]
- 37 **Zhao M**, Meng Y, Cao B, Tong J, Liu X, Yan H, Yang H, Han H, Liang X, Chen H. A bibliometric analysis of studies on gut microbiota in attention-deficit and hyperactivity disorder from 2012 to 2021. *Front Microbiol* 2023; **14**: 1055804 [PMID: 37007507 DOI: 10.3389/fmicb.2023.1055804]



- 38 **Chen H**, Lai Y, Ye C, Wu C, Zhang J, Zhang Z, Yao Q. Global research trends between gut microbiota and lung cancer from 2011 to 2022: A bibliometric and visualization analysis. *Front Oncol* 2023; **13**: 1137576 [PMID: 36910658 DOI: 10.3389/fonc.2023.1137576]
- 39 **Chen Z**, Ding C, Gu Y, He Y, Chen B, Zheng S, Li Q. Association between gut microbiota and hepatocellular carcinoma from 2011 to 2022: Bibliometric analysis and global trends. *Front Oncol* 2023; **13**: 1120515 [PMID: 37064156 DOI: 10.3389/fonc.2023.1120515]
- 40 **Wu W**, Ouyang Y, Zheng P, Xu X, He C, Xie C, Hong J, Lu N, Zhu Y, Li N. Research trends on the relationship between gut microbiota and colorectal cancer: A bibliometric analysis. *Front Cell Infect Microbiol* 2022; **12**: 1027448 [PMID: 36699721 DOI: 10.3389/fcimb.2022.1027448]
- 41 **Yang S**, Zhao S, Ye Y, Jia L, Lou Y. Global research trends on the links between gut microbiota and cancer immunotherapy: A bibliometric analysis (2012-2021). *Front Immunol* 2022; **13**: 952546 [PMID: 36090978 DOI: 10.3389/fimmu.2022.952546]
- 42 **Zyoud SH**, Al-Jabi SW, Amer R, Shakhshir M, Shahwan M, Jairoun AA, Akkawi M, Abu Taha A. Global research trends on the links between the gut microbiome and cancer: a visualization analysis. *J Transl Med* 2022; **20**: 83 [PMID: 35148757 DOI: 10.1186/s12967-022-03293-y]
- 43 **Hao S**, Yang S, Zhang N, Cheng H. Fecal Microbiota Transplantation Research over the Past Decade: Current Status and Trends. *Can J Infect Dis Med Microbiol* 2023; **2023**: 6981721 [PMID: 36654766 DOI: 10.1155/2023/6981721]
- 44 **Liew JY**, Vanoh D. Predictors Affecting Diabetes Related Distress among Diabetes Patients. *Malays J Med Sci* 2022; **29**: 94-101 [PMID: 35528811 DOI: 10.21315/mjms2022.29.2.9]
- 45 **Li Y**, Zou Z, Bian X, Huang Y, Wang Y, Yang C, Zhao J, Xie L. Fecal microbiota transplantation research output from 2004 to 2017: a bibliometric analysis. *PeerJ* 2019; **7**: e6411 [PMID: 30809438 DOI: 10.7717/peerj.6411]
- 46 **Wang M**, Xie X, Zhao S, Han W, Zhang Y. Global research trends and hotspots of fecal microbiota transplantation: A bibliometric and visualization study. *Front Microbiol* 2022; **13**: 990800 [PMID: 36060783 DOI: 10.3389/fmicb.2022.990800]
- 47 **Zhang F**, Yang P, Chen Y, Wang R, Liu B, Wang J, Yuan M, Zhang L. Bibliometric and visual analysis of fecal microbiota transplantation research from 2012 to 2021. *Front Cell Infect Microbiol* 2022; **12**: 1057492 [PMID: 36439220 DOI: 10.3389/fcimb.2022.1057492]
- 48 **Falagas ME**, Pitsouni EI, Malietzis GA, Pappas G. Comparison of PubMed, Scopus, Web of Science, and Google Scholar: strengths and weaknesses. *FASEB J* 2008; **22**: 338-342 [PMID: 17884971 DOI: 10.1096/fj.07-9492LSF]
- 49 **Kulkarni AV**, Aziz B, Shams I, Busse JW. Comparisons of citations in Web of Science, Scopus, and Google Scholar for articles published in general medical journals. *JAMA* 2009; **302**: 1092-1096 [PMID: 19738094 DOI: 10.1001/jama.2009.1307]
- 50 **Grant MJ**, Booth A. A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Info Libr J* 2009; **26**: 91-108 [PMID: 19490148 DOI: 10.1111/j.1471-1842.2009.00848.x]
- 51 **Levac D**, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. *Implement Sci* 2010; **5**: 69 [PMID: 20854677 DOI: 10.1186/1748-5908-5-69]
- 52 **Møller AM**, Myles PS. What makes a good systematic review and meta-analysis? *Br J Anaesth* 2016; **117**: 428-430 [PMID: 28077528 DOI: 10.1093/bja/aew264]
- 53 **Sweileh WM**. A bibliometric analysis of health-related literature on natural disasters from 1900 to 2017. *Health Res Policy Syst* 2019; **17**: 18 [PMID: 30744641 DOI: 10.1186/s12961-019-0418-1]
- 54 **Gong B**, Wang C, Meng F, Wang H, Song B, Yang Y, Shan Z. Association Between Gut Microbiota and Autoimmune Thyroid Disease: A Systematic Review and Meta-Analysis. *Front Endocrinol (Lausanne)* 2021; **12**: 774362 [PMID: 34867823 DOI: 10.3389/fendo.2021.774362]
- 55 **Hung CC**, Chang CC, Huang CW, Nouchi R, Cheng CH. Gut microbiota in patients with Alzheimer's disease spectrum: a systematic review and meta-analysis. *Aging (Albany NY)* 2022; **14**: 477-496 [PMID: 35027502 DOI: 10.18632/aging.203826]
- 56 **Iglesias-Vázquez L**, Van Ginkel Riba G, Arijia V, Canals J. Composition of Gut Microbiota in Children with Autism Spectrum Disorder: A Systematic Review and Meta-Analysis. *Nutrients* 2020; **12** [PMID: 32192218 DOI: 10.3390/nu12030792]
- 57 **Nikolova VL**, Smith MRB, Hall LJ, Cleare AJ, Stone JM, Young AH. Perturbations in Gut Microbiota Composition in Psychiatric Disorders: A Review and Meta-analysis. *JAMA Psychiatry* 2021; **78**: 1343-1354 [PMID: 34524405 DOI: 10.1001/jamapsychiatry.2021.2573]
- 58 **Sanada K**, Nakajima S, Kurokawa S, Barceló-Soler A, Ikuse D, Hirata A, Yoshizawa A, Tomizawa Y, Salas-Valero M, Noda Y, Mimura M, Iwanami A, Kishimoto T. Gut microbiota and major depressive disorder: A systematic review and meta-analysis. *J Affect Disord* 2020; **266**: 1-13 [PMID: 32056863 DOI: 10.1016/j.jad.2020.01.102]
- 59 **So D**, Whelan K, Rossi M, Morrison M, Holtmann G, Kelly JT, Shanahan ER, Staudacher HM, Campbell KL. Dietary fiber intervention on gut microbiota composition in healthy adults: a systematic review and meta-analysis. *Am J Clin Nutr* 2018; **107**: 965-983 [PMID: 29757343 DOI: 10.1093/ajcn/nqy041]
- 60 **Zyoud SH**, Shakhshir M, Abushanab AS, Koni A, Shahwan M, Jairoun AA, Al-Jabi SW. Mapping the output of the global literature on the links between gut microbiota and COVID-19. *J Health Popul Nutr* 2023; **42**: 3 [PMID: 36653831 DOI: 10.1186/s41043-023-00346-w]
- 61 **Deng R**, Wang M, Song Y, Shi Y. A Bibliometric Analysis on the Research Trend of Exercise and the Gut Microbiome. *Microorganisms* 2023; **11** [PMID: 37110325 DOI: 10.3390/microorganisms11040903]
- 62 **Aiolfi A**, Cavalli M, Ferraro SD, Manfredini L, Bonitta G, Bruni PG, Bona D, Campanelli G. Treatment of Inguinal Hernia: Systematic Review and Updated Network Meta-analysis of Randomized Controlled Trials. *Ann Surg* 2021; **274**: 954-961 [PMID: 33427757 DOI: 10.1097/SLA.0000000000004735]
- 63 **Chua ME**, Kim JK, Ming JM, De Cotiis KN, Yang SS, Rickard M, Lorenzo AJ, Dos Santos J. Scoping review of recent evidence on the management of pediatric urolithiasis: summary of meta-analyses, systematic reviews and relevant randomized controlled trials. *Pediatr Surg Int* 2022; **38**: 1349-1361 [PMID: 35939126 DOI: 10.1007/s00383-022-05190-3]
- 64 **Dinu M**, Pagliai G, Angelino D, Rosi A, Dall'Asta M, Bresciani L, Ferraris C, Guglielmetti M, Godos J, Del Bo' C, Nucci D, Meroni E, Landini L, Martini D, Sofi F. Effects of Popular Diets on Anthropometric and Cardiometabolic Parameters: An Umbrella Review of Meta-Analyses of Randomized Controlled Trials. *Adv Nutr* 2020; **11**: 815-833 [PMID: 32059053 DOI: 10.1093/advances/nmaa006]
- 65 **Gavelin HM**, Dong C, Minkov R, Bahar-Fuchs A, Ellis KA, Lautenschlager NT, Mellow ML, Wade AT, Smith AE, Finke C, Krohn S, Lampit A. Combined physical and cognitive training for older adults with and without cognitive impairment: A systematic review and network meta-analysis of randomized controlled trials. *Ageing Res Rev* 2021; **66**: 101232 [PMID: 33249177 DOI: 10.1016/j.arr.2020.101232]
- 66 **Krüger JF**, Hillesheim E, Pereira ACSN, Camargo CQ, Rabito EI. Probiotics for dementia: a systematic review and meta-analysis of randomized controlled trials. *Nutr Rev* 2021; **79**: 160-170 [PMID: 32556236 DOI: 10.1093/nutrit/nuaa037]
- 67 **Morgan RL**, Preidis GA, Kashyap PC, Weizman AV, Sadeghirad B; McMaster Probiotic, Prebiotic, and Synbiotic Work Group. Probiotics Reduce Mortality and Morbidity in Preterm, Low-Birth-Weight Infants: A Systematic Review and Network Meta-analysis of Randomized Trials. *Gastroenterology* 2020; **159**: 467-480 [PMID: 32592699 DOI: 10.1053/j.gastro.2020.05.096]



- 68 **Sweileh WM.** Global research activity on antimicrobial resistance in food-producing animals. *Arch Public Health* 2021; **79**: 49 [PMID: 33849636 DOI: 10.1186/s13690-021-00572-w]
- 69 **Sweileh WM.** Bibliometric analysis of peer-reviewed literature on antimicrobial stewardship from 1990 to 2019. *Global Health* 2021; **17**: 1 [PMID: 33397377 DOI: 10.1186/s12992-020-00651-7]
- 70 **Sweileh WM.** Health-related publications on people living in fragile states in the alert zone: a bibliometric analysis. *Int J Ment Health Syst* 2020; **14**: 70 [PMID: 32868982 DOI: 10.1186/s13033-020-00402-6]
- 71 **Sweileh WM.** Global research publications on systemic use of off-label and unlicensed drugs: A bibliometric analysis (1990-2020). *Int J Risk Saf Med* 2022; **33**: 77-89 [PMID: 34275912 DOI: 10.3233/JRS-210012]
- 72 **Sweileh WM.** Global Research Activity on Elder Abuse: A Bibliometric Analysis (1950-2017). *J Immigr Minor Health* 2021; **23**: 79-87 [PMID: 32488667 DOI: 10.1007/s10903-020-01034-1]
- 73 **Karasneh RA, Al-Azzam SI, Alzoubi KH, Hawamdeh SS, Sweileh WM.** Global Research Trends of Health-Related Publications on Ramadan Fasting from 1999 to 2021: A Bibliometric Analysis. *J Relig Health* 2022; **61**: 3777-3794 [PMID: 35524937 DOI: 10.1007/s10943-022-01573-x]
- 74 **Sweileh WM.** Substandard and falsified medical products: bibliometric analysis and mapping of scientific research. *Global Health* 2021; **17**: 114 [PMID: 34556126 DOI: 10.1186/s12992-021-00766-5]
- 75 **Sweileh WM.** Global research activity on mathematical modeling of transmission and control of 23 selected infectious disease outbreak. *Global Health* 2022; **18**: 4 [PMID: 35062966 DOI: 10.1186/s12992-022-00803-x]
- 76 **Wang JL, Ma YJ, Ma L, Ma N, Guo DM, Ma LS.** Baishideng's Reference Citation Analysis database announces the first Article Influence Index of multidisciplinary scholars. *World J Clin Cases* 2022; **10**: 10391-10398 [PMID: 36312463 DOI: 10.12998/wjcc.v10.i29.10391]
- 77 **Wang JL, Ma YJ, Ma L, Ma N, Guo DM, Ma LS.** Baishideng's Reference Citation Analysis database announces the first Journal Article Influence Index of 101 core journals and a list of high-quality academic journals in gastroenterology and hepatology. *World J Gastroenterol* 2022; **28**: 5383-5394 [PMID: 36312837 DOI: 10.3748/wjg.v28.i37.5383]
- 78 **Wang JL, Ma YJ, Ma L, Ma N, Guo DM, Ma LS.** Baishideng's Reference Citation Analysis database announces the first Journal Article Influence Index of 104 core journals and a list of high-quality academic journals in orthopedics. *World J Orthop* 2022; **13**: 891-902 [PMID: 36312521 DOI: 10.5312/wjo.v13.i10.891]
- 79 **van Eck NJ, Waltman L.** Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics* 2010; **84**: 523-538 [PMID: 20585380 DOI: 10.1007/s11192-009-0146-3]
- 80 **van Eck NJ, Waltman L.** Citation-based clustering of publications using CitNetExplorer and VOSviewer. *Scientometrics* 2017; **111**: 1053-1070 [PMID: 28490825 DOI: 10.1007/s11192-017-2300-7]
- 81 **Cani PD, Lecourt E, Dewulf EM, Sohet FM, Pachikian BD, Naslain D, De Backer F, Neyrinck AM, Delzenne NM.** Gut microbiota fermentation of prebiotics increases satietogenic and incretin gut peptide production with consequences for appetite sensation and glucose response after a meal. *Am J Clin Nutr* 2009; **90**: 1236-1243 [PMID: 19776140 DOI: 10.3945/ajcn.2009.28095]
- 82 **Gareau MG, Sherman PM, Walker WA.** Probiotics and the gut microbiota in intestinal health and disease. *Nat Rev Gastroenterol Hepatol* 2010; **7**: 503-514 [PMID: 20664519 DOI: 10.1038/nrgastro.2010.117]
- 83 **Ianiro G, Masucci L, Quaranta G, Simonelli C, Lopetuso LR, Sanguinetti M, Gasbarrini A, Cammarota G.** Randomised clinical trial: faecal microbiota transplantation by colonoscopy plus vancomycin for the treatment of severe refractory *Clostridium difficile* infection-single versus multiple infusions. *Aliment Pharmacol Ther* 2018; **48**: 152-159 [PMID: 29851107 DOI: 10.1111/apt.14816]
- 84 **Lee CH, Steiner T, Petrof EO, Smieja M, Roscoe D, Nematallah A, Weese JS, Collins S, Moayyedi P, Crowther M, Ropeleski MJ, Jayaratne P, Higgins D, Li Y, Rau NV, Kim PT.** Frozen vs Fresh Fecal Microbiota Transplantation and Clinical Resolution of Diarrhea in Patients With Recurrent *Clostridium difficile* Infection: A Randomized Clinical Trial. *JAMA* 2016; **315**: 142-149 [PMID: 26757463 DOI: 10.1001/jama.2015.18098]
- 85 **Moayyedi P, Surette MG, Kim PT, Libertucci J, Wolfe M, Onischi C, Armstrong D, Marshall JK, Kassam Z, Reinisch W, Lee CH.** Fecal Microbiota Transplantation Induces Remission in Patients With Active Ulcerative Colitis in a Randomized Controlled Trial. *Gastroenterology* 2015; **149**: 102-109.e6 [PMID: 25857665 DOI: 10.1053/j.gastro.2015.04.001]
- 86 **Paramsothy S, Kamm MA, Kaakoush NO, Walsh AJ, van den Bogaerde J, Samuel D, Leong RWL, Connor S, Ng W, Paramsothy R, Xuan W, Lin E, Mitchell HM, Borody TJ.** Multidonor intensive faecal microbiota transplantation for active ulcerative colitis: a randomised placebo-controlled trial. *Lancet* 2017; **389**: 1218-1228 [PMID: 28214091 DOI: 10.1016/S0140-6736(17)30182-4]
- 87 **Queipo-Ortuño MI, Boto-Ordóñez M, Murri M, Gomez-Zumaquero JM, Clemente-Postigo M, Estruch R, Cardona Diaz F, Andrés-Lacueva C, Tinahones FJ.** Influence of red wine polyphenols and ethanol on the gut microbiota ecology and biochemical biomarkers. *Am J Clin Nutr* 2012; **95**: 1323-1334 [PMID: 22552027 DOI: 10.3945/ajcn.111.027847]
- 88 **Subramanian S, Huq S, Yatsunenko T, Haque R, Mahfuz M, Alam MA, Benezra A, DeStefano J, Meier MF, Muegge BD, Barratt MJ, VanArendonk LG, Zhang Q, Province MA, Petri WA Jr, Ahmed T, Gordon JI.** Persistent gut microbiota immaturity in malnourished Bangladeshi children. *Nature* 2014; **510**: 417-421 [PMID: 24896187 DOI: 10.1038/nature13421]
- 89 **Vrieze A, Van Nood E, Holleman F, Salojärvi J, Kootte RS, Bartelsman JF, Dallinga-Thie GM, Ackermans MT, Serlie MJ, Oozeer R, Derrien M, Druesne A, Van Hylckama Vlieg JE, Bloks VW, Groen AK, Heilig HG, Zoetendal EG, Stroe ES, de Vos WM, Hoekstra JB, Nieuwdorp M.** Transfer of intestinal microbiota from lean donors increases insulin sensitivity in individuals with metabolic syndrome. *Gastroenterology* 2012; **143**: 913-6.e7 [PMID: 22728514 DOI: 10.1053/j.gastro.2012.06.031]
- 90 **Wu H, Esteve E, Tremaroli V, Khan MT, Caesar R, Mannerås-Holm L, Ståhlman M, Olsson LM, Serino M, Planas-Fèlix M, Xifra G, Mercader JM, Torrents D, Burcelin R, Ricart W, Perkins R, Fernández-Real JM, Bäckhed F.** Metformin alters the gut microbiome of individuals with treatment-naïve type 2 diabetes, contributing to the therapeutic effects of the drug. *Nat Med* 2017; **23**: 850-858 [PMID: 28530702 DOI: 10.1038/nm.4345]
- 91 **Zyoud SH, Smale S, Waring WS, Sweileh WM, Al-Jabi SW.** Global research trends in microbiome-gut-brain axis during 2009-2018: a bibliometric and visualized study. *BMC Gastroenterol* 2019; **19**: 158 [PMID: 31470803 DOI: 10.1186/s12876-019-1076-z]
- 92 **Integrative HMP (iHMP) Research Network Consortium.** The Integrative Human Microbiome Project: dynamic analysis of microbiome-host omics profiles during periods of human health and disease. *Cell Host Microbe* 2014; **16**: 276-289 [PMID: 25211071 DOI: 10.1016/j.chom.2014.08.014]
- 93 **Wang HX, Wang YP.** Gut Microbiota-brain Axis. *Chin Med J (Engl)* 2016; **129**: 2373-2380 [PMID: 27647198 DOI: 10.4103/0366-6999.190667]
- 94 **Silk DB, Davis A, Vulevic J, Tzortzis G, Gibson GR.** Clinical trial: the effects of a trans-galactooligosaccharide prebiotic on faecal microbiota

- and symptoms in irritable bowel syndrome. *Aliment Pharmacol Ther* 2009; **29**: 508-518 [PMID: [19053980](#) DOI: [10.1111/j.1365-2036.2008.03911.x](#)]
- 95 **Zeng L**, Deng Y, Yang K, Chen J, He Q, Chen H. Safety and efficacy of fecal microbiota transplantation for autoimmune diseases and autoinflammatory diseases: A systematic review and meta-analysis. *Front Immunol* 2022; **13**: 944387 [PMID: [36248877](#) DOI: [10.3389/fimmu.2022.944387](#)]
- 96 **Dang X**, Xu M, Liu D, Zhou D, Yang W. Assessing the efficacy and safety of fecal microbiota transplantation and probiotic VSL#3 for active ulcerative colitis: A systematic review and meta-analysis. *PLoS One* 2020; **15**: e0228846 [PMID: [32182248](#) DOI: [10.1371/journal.pone.0228846](#)]
- 97 **Hsu M**, Tun KM, Batra K, Haque L, Vongsavath T, Hong AS. Safety and Efficacy of Fecal Microbiota Transplantation in Treatment of Inflammatory Bowel Disease in the Pediatric Population: A Systematic Review and Meta-Analysis. *Microorganisms* 2023; **11** [PMID: [37317246](#) DOI: [10.3390/microorganisms11051272](#)]
- 98 **Bajaj JS**, Kassam Z, Fagan A, Gavis EA, Liu E, Cox JJ, Kheradman R, Heuman D, Wang J, Gurry T, Williams R, Sikaroodi M, Fuchs M, Alm E, John B, Thacker LR, Riva A, Smith M, Taylor-Robinson SD, Gillevet PM. Fecal microbiota transplant from a rational stool donor improves hepatic encephalopathy: A randomized clinical trial. *Hepatology* 2017; **66**: 1727-1738 [PMID: [28586116](#) DOI: [10.1002/hep.29306](#)]
- 99 **Tian H**, Wang J, Feng R, Zhang R, Liu H, Qin C, Meng L, Chen Y, Fu Y, Liang D, Yuan X, Zhai Y, Zhu Q, Jin L, Teng J, Ding X, Wang X. Efficacy of faecal microbiota transplantation in patients with progressive supranuclear palsy-Richardson's syndrome: a phase 2, single centre, randomised clinical trial. *EClinicalMedicine* 2023; **58**: 101888 [PMID: [36969340](#) DOI: [10.1016/j.eclinm.2023.101888](#)]
- 100 **Shogbesan O**, Poudel DR, Victor S, Jehangir A, Fadahunsi O, Shogbesan G, Donato A. A Systematic Review of the Efficacy and Safety of Fecal Microbiota Transplant for Clostridium difficile Infection in Immunocompromised Patients. *Can J Gastroenterol Hepatol* 2018; **2018**: 1394379 [PMID: [30246002](#) DOI: [10.1155/2018/1394379](#)]
- 101 **Wilcox MH**, McGovern BH, Hecht GA. The Efficacy and Safety of Fecal Microbiota Transplant for Recurrent Clostridium difficile Infection: Current Understanding and Gap Analysis. *Open Forum Infect Dis* 2020; **7**: ofaa114 [PMID: [32405509](#) DOI: [10.1093/ofid/ofaa114](#)]
- 102 **Kelly CR**, Khoruts A, Staley C, Sadowsky MJ, Abd M, Alani M, Bakow B, Curran P, McKenney J, Tisch A, Reinert SE, Machan JT, Brandt LJ. Effect of Fecal Microbiota Transplantation on Recurrence in Multiply Recurrent Clostridium difficile Infection: A Randomized Trial. *Ann Intern Med* 2016; **165**: 609-616 [PMID: [27547925](#) DOI: [10.7326/M16-0271](#)]
- 103 **Youngster I**, Sauk J, Pindar C, Wilson RG, Kaplan JL, Smith MB, Alm EJ, Gevers D, Russell GH, Hohmann EL. Fecal microbiota transplant for relapsing Clostridium difficile infection using a frozen inoculum from unrelated donors: a randomized, open-label, controlled pilot study. *Clin Infect Dis* 2014; **58**: 1515-1522 [PMID: [24762631](#) DOI: [10.1093/cid/ciu135](#)]
- 104 **Kao D**, Roach B, Silva M, Beck P, Rioux K, Kaplan GG, Chang HJ, Coward S, Goodman KJ, Xu H, Madsen K, Mason A, Wong GK, Jovel J, Patterson J, Louie T. Effect of Oral Capsule- vs Colonoscopy-Delivered Fecal Microbiota Transplantation on Recurrent Clostridium difficile Infection: A Randomized Clinical Trial. *JAMA* 2017; **318**: 1985-1993 [PMID: [29183074](#) DOI: [10.1001/jama.2017.17077](#)]
- 105 **Li Y**, Zhang T, Sun J, Liu N. Fecal Microbiota Transplantation and Health Outcomes: An Umbrella Review of Meta-Analyses of Randomized Controlled Trials. *Front Cell Infect Microbiol* 2022; **12**: 899845 [PMID: [35832379](#) DOI: [10.3389/fcimb.2022.899845](#)]
- 106 **Proença IM**, Allegratti JR, Bernardo WM, de Moura DTH, Ponte Neto AM, Matsubayashi CO, Flor MM, Kotinda APST, de Moura EGH. Fecal microbiota transplantation improves metabolic syndrome parameters: systematic review with meta-analysis based on randomized clinical trials. *Nutr Res* 2020; **83**: 1-14 [PMID: [32987284](#) DOI: [10.1016/j.nutres.2020.06.018](#)]
- 107 **Wu Z**, Zhang B, Chen F, Xia R, Zhu D, Chen B, Lin A, Zheng C, Hou D, Li X, Zhang S, Chen Y, Hou K. Fecal microbiota transplantation reverses insulin resistance in type 2 diabetes: A randomized, controlled, prospective study. *Front Cell Infect Microbiol* 2022; **12**: 1089991 [PMID: [36704100](#) DOI: [10.3389/fcimb.2022.1089991](#)]
- 108 **Davis CD**. The Gut Microbiome and Its Role in Obesity. *Nutr Today* 2016; **51**: 167-174 [PMID: [27795585](#) DOI: [10.1097/NT.000000000000167](#)]
- 109 **Gill VJS**, Soni S, Shringarpure M, Anusheel, Bhardwaj S, Yadav NK, Patel A. Gut Microbiota Interventions for the Management of Obesity: A Literature Review. *Cureus* 2022; **14**: e29317 [PMID: [36161997](#) DOI: [10.7759/cureus.29317](#)]
- 110 **Lee P**, Yacyshyn BR, Yacyshyn MB. Gut microbiota and obesity: An opportunity to alter obesity through faecal microbiota transplant (FMT). *Diabetes Obes Metab* 2019; **21**: 479-490 [PMID: [30328245](#) DOI: [10.1111/dom.13561](#)]
- 111 **Sarmiento-Andrade Y**, Suárez R, Quintero B, Garrochamba K, Chapela SP. Gut microbiota and obesity: New insights. *Front Nutr* 2022; **9**: 1018212 [PMID: [36313072](#) DOI: [10.3389/fnut.2022.1018212](#)]
- 112 **Khan S**, Luck H, Winer S, Winer DA. Emerging concepts in intestinal immune control of obesity-related metabolic disease. *Nat Commun* 2021; **12**: 2598 [PMID: [33972511](#) DOI: [10.1038/s41467-021-22727-7](#)]
- 113 **Stephens RW**, Arhire L, Covasa M. Gut Microbiota: From Microorganisms to Metabolic Organ Influencing Obesity. *Obesity (Silver Spring)* 2018; **26**: 801-809 [PMID: [29687647](#) DOI: [10.1002/oby.22179](#)]
- 114 **Zhang L**, Liu Y, Wang X, Zhang X. Physical Exercise and Diet: Regulation of Gut Microbiota to Prevent and Treat Metabolic Disorders to Maintain Health. *Nutrients* 2023; **15** [PMID: [36986268](#) DOI: [10.3390/nu15061539](#)]
- 115 **Aragón-Vela J**, Solis-Urra P, Ruiz-Ojeda FJ, Álvarez-Mercado AI, Olivares-Arancibia J, Plaza-Díaz J. Impact of Exercise on Gut Microbiota in Obesity. *Nutrients* 2021; **13** [PMID: [34836254](#) DOI: [10.3390/nu13113999](#)]
- 116 **Ogunsakin RE**, Ebenezer O, Jordaan MA, Shapi M, Ginindza TG. Mapping Scientific Productivity Trends and Hotspots in Remdesivir Research Publications: A Bibliometric Study from 2016 to 2021. *Int J Environ Res Public Health* 2022; **19** [PMID: [35886696](#) DOI: [10.3390/ijerph19148845](#)]
- 117 **Rojas-Montesino E**, Méndez D, Espinosa-Parrilla Y, Fuentes E, Palomo I. Analysis of Scientometric Indicators in Publications Associated with Healthy Aging in the World, Period 2011-2020. *Int J Environ Res Public Health* 2022; **19** [PMID: [35897359](#) DOI: [10.3390/ijerph19158988](#)]
- 118 **Obaideen K**, Abu Shihab KH, Madkour MI, Faris ME. Seven decades of Ramadan intermittent fasting research: Bibliometrics analysis, global trends, and future directions. *Diabetes Metab Syndr* 2022; **16**: 102566 [PMID: [35872466](#) DOI: [10.1016/j.dsx.2022.102566](#)]
- 119 **Trejo-Castro AI**, Carrion-Alvarez D, Martinez-Torteya A, Rangel-Escareño C. A Bibliometric Review on Gut Microbiome and Alzheimer's Disease Between 2012 and 2021. *Front Aging Neurosci* 2022; **14**: 804177 [PMID: [35898324](#) DOI: [10.3389/fnagi.2022.804177](#)]
- 120 **Sweileh WM**. Patient satisfaction with nursing care: A bibliometric and visualization analysis (1950-2021). *Int J Nurs Pract* 2022; **28**: e13076 [PMID: [35822232](#) DOI: [10.1111/ijn.13076](#)]



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