

Nutrition as a Foundation for Human Capital Bibliometric Evidence and its Impact on Child Health and Development

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Abstract. Introduction. Child nutrition is crucial in developing human capital, affecting physical growth, cognitive development, and long-term health consequences. This study aims to analyze worldwide research trends in child nutrition from 2016 to 2025, emphasizing principal contributors, topic goals, and research deficiencies.

Methods. A bibliometric study was performed using the Scopus database, extracting 276 articles and reviews in English published in the domains of medicine and health. Data were examined using VOS viewer (version 1.1.20) to illustrate publishing patterns, prominent nations, institutions, authors, journals, highly cited works, and networks of keyword co-occurrence.

Results and Discussion. Research production consistently rose from 2016, reaching a zenith of 223 articles in 2022, followed by a significant decline in 2024–2025. The United States dominated publishing volume, followed by the United Kingdom, Canada, and India, with little contribution from emerging nations. Prominent institutions include the Johns Hopkins Bloomberg School of Public Health, Harvard T.H. Chan School of Public Health, and UNICEF. G. Kac was the most prolific author, while the *American Journal of Clinical Nutrition* had the most significant citation impact. Prominently referenced papers focused on clinical nutrition protocols, pediatric health, and public health strategies. Keyword mapping identified significant themes such as exclusive breastfeeding, micronutrient supplementation, childhood obesity prevention, maternal-child health, and public health education.

Conclusion. Global research on child nutrition has expanded in size and breadth, including clinical, public health, and behavioral aspects. Nonetheless, enduring gaps between wealthy and developing nations underscore the need for more equitable research contributions. These results provide a basis for targeted measures to improve child nutrition, mitigate malnutrition, and promote health equity globally.

1. Introduction

Nutrition in children relates to consuming vital nutrients necessary for physical growth, cognitive advancement, and general well-being [1]. Good nutrition in children is essential for establishing a foundation for lifetime health, including avoiding malnutrition, long-term diseases, and delays in growth [2]. The crucial phase of childhood, from birth to adolescence, is marked by fast growth and development, making balanced and age-appropriate nutrition an essential component of child health programs [1]. Malnutrition, including undernutrition and overnutrition, presents considerable global issues for children [3]. Undernutrition may result in slowed growth, weakened immune systems, and diminished cognitive functions. At the same time, overnutrition is linked to the rising prevalence of childhood obesity and related health issues, including diabetes and heart disease [4]. Resolving these difficulties requires a comprehensive strategy incorporating food security, education, healthcare, and

sustainable development strategies [5]. A study by [6] shows that nutrition in children is crucial for their growth and development. Interventions like Ready-to-use therapeutic foods (RUTF), nutrition education, and micronutrient supplementation are essential to prevent and treat undernutrition, particularly in vulnerable populations like preschool children in Nigeria. According to [7], nutrition during early childhood significantly influences health and development, shaping food preferences and preventing nutritional deficiencies. Adequate and balanced nutrition in this critical period can reduce the risk of chronic inflammatory diseases in adulthood, promoting long-term health and well-being. Another study by [8] found that nutrition in children is crucial for growth and development. Key interventions include promoting exclusive breastfeeding for the first six months, proper feeding practices, and educating caregivers about nutrition, while addressing underlying issues such as poverty, access to healthcare, and sanitation. The study by [9] utilized bibliometric analysis as a statistical tool to evaluate the literature on nutrition,

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focusing on researcher output and its impact. Data for the analysis was retrieved from the Web of Science. The bibliometric analysis revealed a total of 3,686 articles published in India from 2010 to 2019. The Journal of Food Science and Technology was identified as the leading Journal, with 114 publications and 3,355 citations. The result also underscores the significance of nutrition research in India and the contribution of various authors and journals to the field. In another study by [10], the bibliometric analysis of child nutrition identified 1,398 highly cited papers from 2009 to 2019, highlighting research hotspots like food allergies and obesity, with significant contributions from the USA, UK, and Canada, while developing countries lagged. [11], Mapping the Scientific Research on Nutrition and Mental Health: A Bibliometric Analysis. The study aims to explore the growing interest in the connection between nutrition and mental health. This area has led to the emergence of nutritional psychiatry research, which focuses on understanding these interactions. The methodology involved a systematic search of a significant academic database, followed by extensive bibliometric analysis and visualization to map the landscape of research in nutritional psychiatry, focusing on growth, key contributors, and thematic trends. These studies utilized the Web of Science and Google Scholar as their primary sources to address this gap. This study used the Scopus database. This study investigates the following questions.

Q1- What are the publication trends in the nutrition of children?

Q2- Who are the top contributing authors, institutions, and countries to the nutrition of children?

Q3- Which are the top-cited articles in the nutrition of children?

Q4- What are the major themes and topics in children's intellectual structure of nutrition?

Bibliometric methodologies aim to recognize significant authors, institutions, and countries contributing to the domain of child nutrition. The study analyzes the most frequently referenced publications and their thematic emphasis while investigating the conceptual framework and principal issues in child nutrition research, including treatments and research gaps. This study contributes a thorough bibliometric analysis of child nutrition research from 2016 to 2025. It provides significant insights into international research trends, emphasizing important contributors, impactful publications, and developing issues within the field. This study contributes a thorough bibliometric analysis of child nutrition research from 2016 to 2025. It provides significant insights into international research trends, emphasizing important contributors, impactful publications, and developing issues within the field. The study highlights research gaps and inequities in contributions between developed and developing nations, highlighting areas that require further attention, especially in underrepresented regions. This study enhances understanding of child nutrition interventions and effectiveness, assisting policymakers and professionals in formulating specific strategies for combating malnutrition. Furthermore, using the Scopus database improves the reliability and breadth of bibliometric research in contrast

to prior studies dependent on restricted sources. The results provide a benchmark for future study and enhance worldwide initiatives aimed at improving child nutrition and well-being. This study aims to analyze worldwide research trends in child nutrition from 2016 to 2025, emphasizing principal contributors, topic goals, and research deficiencies.

2. Methodology

The literature review is a popular approach used to transform literature content into objective and systematic formats to identify, specify, map, and evaluate the material; yet, it has not succeeded in defining the relevant intellectual domain [12]. The bibliometric study addresses this problem by statistically assessing the existing literature. Moreover, the bibliometric analysis might identify research gaps and provide direction for future studies on the growing subject [13]. Furthermore, the bibliometric methodology can manage extensive volumes of papers to construct a scientific framework of study subjects, in contrast to the conventional organized method [14]. The bibliometric analysis used bibliographic data to explain the internal links within the literature, examine citation and co-citation indicators, and algorithmically discover clusters. There are two primary categories of bibliometric procedures: evaluative and relational techniques [15]. The evaluative technique utilizes productivity metrics, including publication counts, impact indicators, and various descriptive data types to assess intellectual advancement [16]. In contrast, the relational technique systematically analyzes knowledge structures through co-authorship, co-word, co-citation, and bibliographic coupling analyses [17]. This study used a bibliometric methodology, an analytical framework grounded on bibliographical data, to examine the advancement of nutrition in children's research, the relationships among research themes, and the features that have been extensively explored. The first stage in bibliometric research is to find databases that facilitate learning [10]. This research obtained the data analyzed from the Scopus database in January 2025. Scopus, established in 2004 by Elsevier, is an interdisciplinary reporting platform that boasts the largest global database of abstracts and citations, covering over 87 million documents from more than 7,000 publishers across countries, along with 17 million author profiles [18]. Data was gathered by searching using the words "Nutrition" and "Children" under the areas of article title, abstract, and keywords. The data search time is restricted to 2016–2025, yielding 276 documents. As shown in Figure 1, the bibliometric workflow provides a structured approach to analyzing and visualizing research trends. To analyze and visualize the data, the VOS viewer software application is used. VOS viewer is a powerful visualization program that uses a distance-based mapping approach to visualize things [19]. The VOS viewer program presents data as networks and clusters, differentiated by color according to link, link strength, and overall link strength across articles [20].

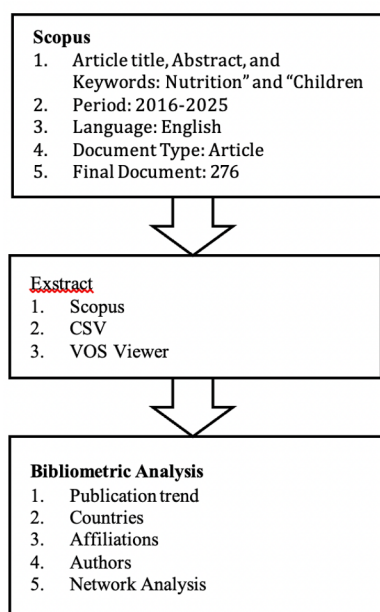


Figure 1: Present data screening and analysis procedure.

3. Result and discussion

Figure 2 illustrates a consistent rise in research production on child nutrition from 2016 to 2022. In 2016, there were 143 publications, which declined to 137 in 2017 but exhibited a steady rise Following, culminating in a high of 223 publications in 2022. This expansion indicates a rising worldwide interest in tackling child nutrition challenges, propelled by increased knowledge of its essential role in mitigating malnutrition, enhancing health outcomes, and fostering sustainable development [21]. The steady increase in publications, especially from 2018 to 2022, corresponds with international initiatives to achieve the goals of sustainable development (SDGs), such as reducing hunger and promoting children's health (UNICEF, 2022). Nevertheless, a large decrease is seen in 2024, With just 178 publications, followed by an additional decrease to 7 publications in 2025. This decrease may indicate reporting delays, shifts in funding priorities, or interruptions resulting from global events like the COVID-19 pandemic. The study indicates an increasing volume of research focused on both undernutrition and Overnutrition, highlighting the significance of treatments such as exclusive breastfeeding, vitamin supplementation, and food security initiatives [22]. Despite these endeavors, gaps in research from developing countries endure, underscoring the need for further input from areas most impacted by child malnutrition. This trend highlights the need for ongoing research initiatives to tackle emerging difficulties in child nutrition and guarantee equal advancement worldwide.

As shown in Figure 3, the allocation of publications about child nutrition across different countries indicates that the United States has a significant dominance, significantly exceeding all other countries with 684 articles. This significant advantage may indicate the strong scientific infrastructure and financial support allocated to public health and nutrition in the U.S. [23].

Next to the United States, the United Kingdom ranks second, but with a somewhat reduced Total of publications (180). This finding indicates a significant, if limited, emphasis on child nutrition research relative to the U.S., such as Canada (132 articles) and India (119 publications) exhibit a reasonable degree of research productivity in this area. India's presence It is essential due to its vast population and the considerable issues it encounters with child malnutrition [24]. China, despite its significant population, has a somewhat lower volume of publications (91) than other countries with the same economic and demographic characteristics. It may signify a prospective domain for advancement in child nutrition research in China. Australia ranks second with 81 articles, indicating a steady contribution to the subject. The other countries, such as the Netherlands (66), France (61), Brazil (59), and Italy (59), have comparable publication output, suggesting a less intensive research emphasis on child nutrition relative to the top countries.

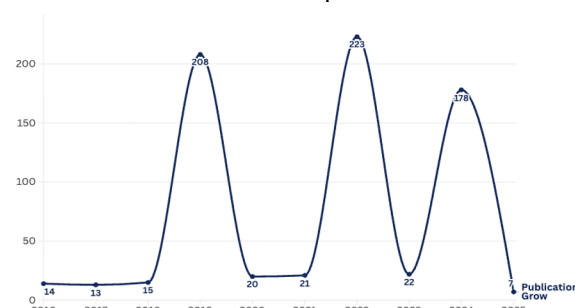


Figure 2. Publication growth. Source: Scopus Database

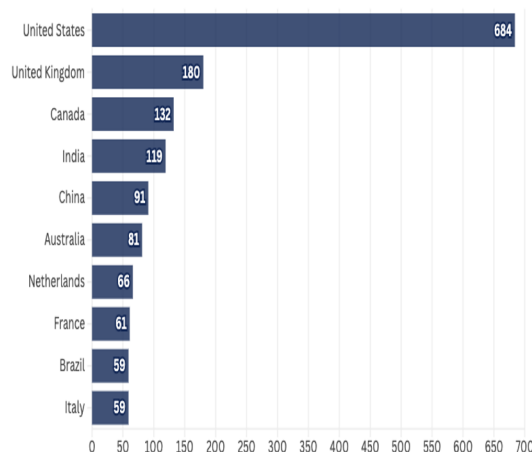


Figure 3. Top contributing Countries. Source: Scopus Database

Figure 4 illustrates the leading affiliations in child nutrition research, emphasizing the institutions with the highest publication output in this domain. The Johns Hopkins Bloomberg School of Public Health stands out as the foremost institution with 45 publications, reflecting its significant dedication to enhancing knowledge and practice in child nutrition. This notable ranking probably indicates the institution's focus on public health research and its commitment to tackling significant health issues affecting global populations [25]. Harvard T.H. Chan School of Public Health, with 37 publications, highlighting its significant impact on public health

discourse and research. The institution's emphasis on broad collaboration as well as dedication to cultivating future leaders in public health significantly enhances its output in child nutrition research [26]. The Hospital for Sick Children in Toronto and the International Food Policy Research Institute exhibit significant contributions with 36 and 35 articles, respectively. These institutes are essential in converting research into clinical applications and policy suggestions, guaranteeing that scientific discoveries significantly influence children's health. UNICEF's inclusion on the list with 34 publications underscores the organization's international influence and dedication to promoting children's rights, particularly the right to sufficient nourishment. The University of North Carolina at Chapel Hill, Great Ormond Street Hospital for Children NHS, Emory University, Erasmus MC Sophia Children's Hospital, and the Chinese Center for Disease Control and Prevention exhibit significant contributions to the subject. Their research endeavors jointly enhance our comprehension of child nutrition and facilitate the formulation of evidence-based strategies to improve children's health outcomes.

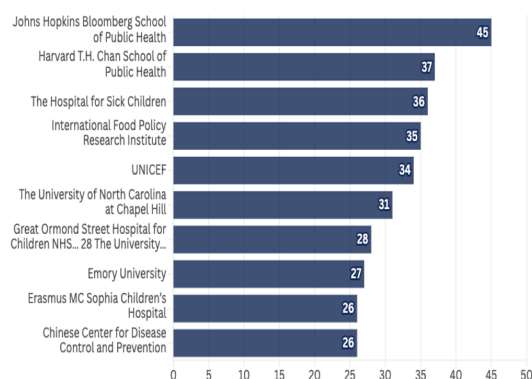


Figure 4. Top contributing Countries. Source: Scopus Database

Contributing Authors

Figure 5 illustrates the contributions of different authors to child nutrition research, quantified by the number of publications. G. Kac is distinguished as the most prolific author, having produced 15 articles, which signifies a significant and ongoing contribution to the area. Kac's study has significantly influenced the comprehension and implementation of child feeding. Next to Kac, S.E. Whaley has produced 14 articles, indicating a significant dedication to this field of study. P. Menon's work is significant, including 13 papers. The extensive works of these authors probably cover several issues in child nutrition, enhancing the overall comprehension of the discipline. D.R. Farias and O. Goulet have each authored 11 papers, demonstrating an ongoing interest in child nutrition research. A group of authors, including J. Bronsky, I. Hojsak, T.A. Lakka, P. Normando, and M.T. Ruel has produced 10 articles. Although their contributions are somewhat inferior to those of the primary authors, their combined efforts constitute a significant portion of the study domain in child nutrition. This figure represents the volume of publications and does not inherently signify the quality or the effect of the study. Nonetheless, it offers a significant

summary of the principal figures who have committed their efforts to the advancement of understanding in the nutrition of children. Contributing Journal

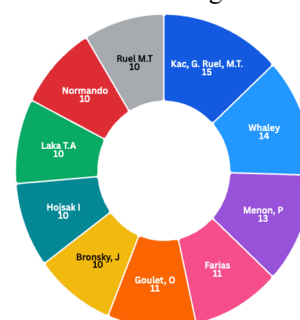


Figure 5. Top Contribution Authors. Source: Scopus Database

In Table 1, the analysis of source documents and citation data reveals valuable insights into the academic landscape of child nutrition research. Among the listed journals, the American Journal of Clinical nutrition stands out as the most influential, with 102 citations, indicating its central role in disseminating high-impact clinical and scientific findings in nutrition. This Journal serves as a key reference for researchers, clinicians, and policy makers involved in child nutrition and related health outcomes [27]. Following this, Clinical Nutrition and the Journal of Pediatric Gastroenterology and Nutrition holds 69 and 50 citations, respectively, underscoring the importance of clinical and gastrointestinal research in understanding pediatric nutritional needs (Binsar et al., 2024; Rosen et al., 2018). These journals often publish studies focused on nutritional therapies, metabolic disorders, and gastrointestinal conditions in children, making them crucial in medical and hospital-based Nutrition research, such as Public Health Nutrition (46 citations), Journal of Nutrition (43 citations), and Journal of Nutrition Education and Behavior (38 citations) reflects the significant role of public health strategies, dietary behaviors, and educational interventions in promoting child nutrition [28]. These journals often explore preventive measures, policy development, and nutrition education programs targeted at both caregivers and children, demonstrating that effective nutrition strategies extend beyond clinical settings. The Maternal and Child Nutrition journal, with 31 citations, highlights the growing attention to Maternal and early childhood nutrition is a critical period that significantly influences long-term health outcomes. Meanwhile, the Journal of the Academy of Nutrition and Dietetics (29 citations) represents the contribution of dietetics professionals and clinical dietitians to evidence-based practices in child nutrition. BMC Public Health, although having a lower citation count (18), contributes to broader discussions on population-level health and nutrition trends, often through open-access and interdisciplinary research. Lastly, the entry "Highest Cited Articles" with 25 citations likely refers to individual landmark studies within the dataset, emphasizing their exceptional influence on the field [29]. Overall, this distribution of citation counts across journals demonstrates the multidisciplinary nature of child nutrition research, integrating clinical sciences, public

health, education, and policy. The high citation rates in clinical and public health journals indicate that both medical treatment and preventive measures are. Strategies are equally prioritized in academic discourse. This analysis also highlights key publication venues for researchers seeking to engage with the most impactful and widely read sources in the field [30].

Table 1. Top contributing journals

No	Journal Name	Total Citations
1	American Journal of Clinical Nutrition	102
2	Clinical Nutrition	69
3	Journal of Pediatric Gastroenterology and Nutrition	50
4	Public Health Nutrition	46
5	Journal of Nutrition	43
6	Journal of Nutrition Education and Behavior	38
7	Maternal and Child Nutrition	31
8	Maternal and Child Nutrition	29
9	BMC Public Health	18
10	Highest Cited Articles	25

4. Highest cited articles

Table 2 presents the ten most cited articles in the field of child nutrition, showcasing studies that have had significant academic influence in recent years. Leading the list is the paper by Vos MB (2017) in the Journal of Pediatric Gastroenterology and Nutrition, Vos et al. (2017) with 727 citations, underscoring its substantial impact on pediatric nutrition research. This Journal appears multiple times

In the ranking, including works by Romano C (2017), with 264 citations, and Romano et al. (2017), Fidler Mis et al. al. (2017) Fidler MIS N (2017, 247 citations, reflecting the Journal's strong role in publishing high-quality and widely referenced research. Other influential works include Fizez T (2016) in the New England Journal of Medicine (414 citations, 25) and Turck D (2016) in Clinical Nutrition 399, Eulmesekian (2016) shows that impactful research is also published in top-tier general and clinical journals. The table also highlights the presence of articles from journals beyond pediatric specialties, such as Circulation (Lloyd-Jones DM, 2022, p. 230) citations,(27) Obesity Reviews (Corvalán C, 2017, 171 citations, Lloyd-Jones et al. (2022) and the American Journal of Clinical Nutrition, Akseer N (2020), 221 citations, Akseer et al.(2020), which reflect the interdisciplinary nature of nutrition research, linking clinical care, public health, and policy. The Journal of the Academy of Nutrition and Dietetics is also represented by Banfield EC (2016) with 255 citations (30). Notably, recent works such as Lloyd-Jones DM (2022) has rapidly accumulated high citation counts, demonstrating that timely and relevant Research can quickly shape the field. Overall, the table illustrates that these ten articles form a core body of literature guiding evidence-based strategies to improve child nutrition globally.

Table 2. Top Highest Article. Source: Scopus database

NO	PAPER	DOI	TOTAL CITATION
1	VOS MB, 2017, J Pediatr Gastroenterol Nutr	10.1097/MPG.00000000000001482	727
2	FIVEZ T, 2016, New Engl J Med	10.1056/NEJMOA1514762	414
3	TURCK D, 2016, Clin Nutr	10.1016/J.CLNU.2016.03.004	399
4	ROMANO C, 2017, J Pediatr Gastroenterol Nutr	10.1097/MPG.00000000000001646	264
5	BANFIELD EC, 2016, J Acad Nutri Diet	10.1016/J.JAND.2015.08.010	255
6	FIDLER MIS N, 2017, J Pediatr Gastroenterol Nutr	10.1097/MPG.00000000000001733	247
7	LLOYD-JONES DM,2022, CIRCULATION	10.1161/CIRCULATIONA HA.122.060911	230
8	AKSEER N, 2020, AM J Clin Nutr	10.1093/AJCN/NQAA171	221
9	SOCHA P 2018, PediatrGastroenterol Nutr	10.1097/MPG.00000000000001787	193
10	CORVALÁN C, 2017, Obes Rev	10.1111/OBR.12571	171

Not just the current nutritional needs of children, but also their growth and development within a broader social and biological framework. This interconnection underscores the need for a comprehensive approach to child nutrition research, taking into account several aspects that may affect a child's nutritional health.

Table 3. Key Words Co-Occurrence.

NO	Keyword	Co-occurrence	Total link Strength
1	Human	1482	34308
2	Child	1316	30709
3	Female	1201	29724
4	Humans	1215	29378
5	Male	1000	25518
6	Preschool Child	650	16862
7	Infant	612	15524
8	Nutritional Status	573	14129
9	Nutrition	571	13656
10	Child Nutrition	489	11500

Source: Scopus database

As presented in Table 3, the most frequent keywords and their total link strengths highlight the dominant themes in child nutrition research. The figure 6 presented is a keyword co-occurrence map generated using VOS viewer, a tool widely used for bibliometric analysis. This visualization illustrates the relationships and clustering of frequently co-occurring keywords in a dataset likely from a collection of academic articles related to human health, nutrition, and child development. Each colored cluster represents a thematic group of keywords that often appear together in publications, and the size of the circles (nodes) reflects the frequency of occurrence of each keyword. The lines (edges) indicate the strength of co-occurrence between terms. At the center of the map, the keyword “human” appears as the largest and most dominant node, indicating it is the most frequently occurring term in the dataset. It is connected to almost all other nodes, showing that Studies involving humans are the central theme. This

term also acts as a bridge across multiple thematic areas, which are expected in the literature related to human health and nutrition. The visualization is divided into several clusters, each representing a specific research focus.

Red Cluster

The Red Cluster indeed centers on maternal and child health, with high-frequency terms such as “infant,” “newborn,” “preschool child,” “maternal health,” and “stunting.” The geographic references, including “India” and “Ethiopia,” indicates that much of the research in this cluster is concentrated in developing countries. It supports the interpretation that the cluster reflects global health concerns, particularly in low-resource settings, where issues such as nutritional deficiencies, limited access to Prenatal and child healthcare, as well as early childhood development challenges, are prevalent. We have revised the text to reflect this insight more clearly and aligned it with the literature on health disparities in these regions.

Green Cluster

This group centers around clinical nutrition and medical research, with terms such as cohort analysis, parenteral nutrition, enteric feeding, clinical trial, and complication, indicating a clinical or hospital. The focus is on nutrition interventions, especially for critically ill patients or individuals with specific medical conditions. The co-occurrence of risk factors and adverse events further supports the idea that. This cluster represents studies analyzing the clinical outcomes of nutritional strategies in vulnerable populations.

Blue Cluster

This cluster is concerned with behavioral and educational aspects of nutrition, involving terms like education, psychology, food preference, fruit, vegetable, exercise, and fast food. It reflects studies exploring how knowledge, attitudes, and behaviors influence dietary choices, particularly in school or community settings. This situation is consistent with growing literature linking nutrition education to behavioral change and public health promotion.

Yellow Cluster

The yellow nodes revolve around nutritional assessments and adolescent health, with key terms such as nutrition surveys, obesity, caloric intake, waist circumference, and fat intake. This cluster likely includes research focused on epidemiological data collection and public health surveillance. The presence of adolescent and cross-sectional studies suggests a focus on youth health patterns and obesity trends, often found in national health monitoring projects. There are also peripheral keywords that, while less frequently used, show connections across clusters such as diarrhea, anemia, vitamin, and mortality, indicating more specific subtopics or secondary outcomes within broader research domains. The proximity of clusters and the density of connecting lines demonstrate interdisciplinary linkages, showing how research in maternal and child health overlaps with clinical nutrition, educational interventions, and public health monitoring. For example, studies in the red cluster (maternal-child health) often intersect with those in the green cluster (Clinical Nutrition), particularly in research addressing

stunting, pregnancy outcomes, and infant feeding practices.

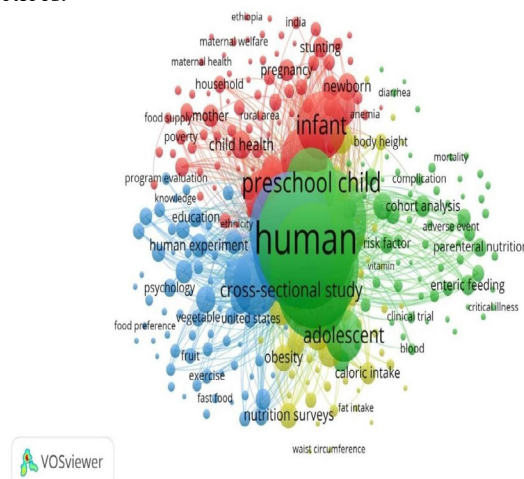


Figure 6. Network Visualization of Keywords

5. Conclusion

This bibliometric study provides a comprehensive overview of global research trends in child nutrition from 2016 to 2025, aiming to map the field's intellectual structure and identify leading contributors, thematic priorities, and existing gaps. Using data from the Scopus database and visualization through VOSviewer software, the analysis of 276 publications revealed a steady increase in output, peaking at 223 articles in 2022, followed by a sharp decline in 2024 and 2025. The United States dominated in publication volume with 684 articles, followed by the United Kingdom, Canada, and India, while developing regions showed limited representation. Leading institutions included the Johns Hopkins Bloomberg School of Public Health, Harvard T.H. Chan School of Public Health, and UNICEF and G. Kac emerged as the most prolific authors. The American Journal of Clinical Nutrition ranked as the most influential Journal, alongside other key outlets such as the Journal of Pediatric Gastroenterology and Nutrition, Clinical Nutrition, and Public Health Nutrition. Highly cited works included Vos MB (2017), Fives T (2016), and Turck D (2016), which shaped critical advancements in clinical nutrition, pediatric health, and public health strategies. Core research themes centered on exclusive breastfeeding, micronutrient supplementation, childhood obesity prevention, and maternal-child health, and public health interventions. Keyword co-occurrence analysis demonstrated strong interdisciplinary linkages across clinical, behavioral, and epidemiological domains, with emphasis on human populations, maternal health, and dietary behaviors. Despite notable progress, significant disparities persist between developed and developing countries, highlighting the urgent need for equitable global research contributions. By providing a detailed mapping of publication trends, key authors, institutions, journals, and landmark studies, this research offers a valuable foundation for policymakers, healthcare professionals, and scholars to design targeted, evidence-

based strategies that advance child nutrition, reduce malnutrition, and promote global health equity.

Author Contribution

Fariba Delju, Mahendro Prasetyo Kusum: conceptualization. Fariba Delju, Mahendro Prasetyo Kusum: Methodology. Fariba Delju software. Mahendro Prasetyo Kusum: Writing original draft preparation. All authors have read and agreed to the published version of the manuscript.

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflict of interest

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