



Mapping the Evolution of Nutrition Education: A Scientometric Review from 1970 to 2023, Unveiling Insights Over Half a Century

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Abstract

This scientometric review aims to systematically analyse and document the development and transformation of nutrition education research over more than fifty years. The study seeks to identify key themes, trends, and shifts in the field, offering a comprehensive overview of its historical trajectory and current state. A thorough visual analysis of the Web of Science Core Collection literature, including publication, institution, country/region, author, journal, keywords, and reference in nutrition education from 1970 to 2023, was carried out using Citespace 5.8.R1 (64-bit). The study employs advanced data mining techniques and network analysis to identify citation bursts, major research themes, and influential works in the field. The analysis reveals several significant trends and shifts in nutrition education research. Key themes such as obesity, nutrition literacy, evidence-based strategies, and localised interventions emerged as focal points of academic discourse. The



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study noted increasing citation bursts related to these themes, indicating a field responsive to emerging health challenges and societal needs. The research landscape evolved from foundational principles in the early years to an era of interdisciplinary approaches and the integration of advanced technologies. The review concludes that nutrition education research has undergone substantial growth and transformation over the past fifty years. It has evolved to address complex nutritional challenges through informed, evidence-based strategies, reflecting its adaptability and responsiveness to changing public health concerns and scientific evidence. This scientometric review maps the field's historical development. It serves as a guidepost for future research directions, underscoring the ongoing importance of nutrition education in enhancing global health and well-being.

Introduction

As a discipline, nutrition education has undergone a profound transformation over the last five decades, closely mirroring the evolution of societal values, technological innovation, and global health perspectives. From its nascent stages in the 1970s, where the focus was squarely on basic dietary knowledge to combat prevalent health issues, to the current era's emphasis on personalised nutrition and sustainability, this field has not just expanded in scope. Still, it has fundamentally shifted in its approach and methodologies.

Beginning in the 1970s, an era that set the foundational stones with a primary focus on basic nutritional knowledge aimed at enhancing public health, this review meticulously traces the evolution of nutrition education against the backdrop of shifting societal perspectives on health, wellness, and dietary habits.

As we traverse through the decades, the review illuminates the field's progression from simple dietary fundamentals to the intricate interplay of micronutrients, balanced diets, and their preventive roles against chronic diseases recognised in the 1980s. The 1990s further unravelled the psychological underpinnings of dietary choices, marking a deeper comprehension of human behaviour's impact on nutrition and initiating dialogues around food security for marginalised communities. The onset of the 21st century heralded a new era, with technology's integration into nutrition education through digital platforms and tools reflecting the digital revolution's influence.

Historical Context and Evolution (1970-2023)

The period from 1970 to 2023 marks a significant era in nutrition education, mirroring broader societal shifts in attitudes toward health, wellness, and dietary habits. In the 1970s, the focus was on imparting basic nutritional knowledge to improve public health outcomes.¹ This era was characterised by an emphasis on diet fundamentals and its impact on health, reflecting the limited understanding and resources available. As we progressed into the 1980s, there was a gradual shift towards more nuanced aspects of nutrition, including the role of micronutrients and the importance of balanced diets in preventing chronic diseases.

By the 1990s, the field had evolved to explore the psychological dimensions of dietary choices, indicating a deeper understanding of the complexities of human behaviour and its influence on nutrition.² This period also began discussions around food security and its impact on nutritional status, especially in underprivileged communities. The early 21st century was marked by a significant turning point, with a surge in studies examining the integration of technology in nutrition education. This period, influenced by the digital revolution, saw the emergence of online platforms and digital tools as mediums for disseminating nutritional knowledge.³ The most recent developments, particularly in the past decade, have been characterised by a growing emphasis on personalised nutrition and sustainable dietary practices. This shift reflects a more holistic approach, considering individual genetic profiles, environmental sustainability, and the long-term

impact of dietary choices on both health and the planet.⁴

Methodological Shifts and Technological Advancements

This review traces the evolution of research methodologies in nutrition education. Initially, studies predominantly employed observational and survey-based methods, providing foundational insights into dietary behaviours and nutritional knowledge.⁵ More exacting and sophisticated study designs, such as randomised controlled trials, longitudinal investigations, and intricate statistical modelling, gradually became more prevalent as the field developed. A more accurate and sophisticated understanding of the results of nutrition education initiatives was made possible by these methodological developments.⁶

The advent and subsequent proliferation of digital technology have revolutionised nutrition education research and practice. Integrating the internet, mobile applications, and later, machine learning and big data analytics have opened new avenues for delivering personalised nutrition education and conducting large-scale, real-time data analysis.⁷ These technological advancements have enhanced the reach and efficacy of nutrition education programs and enabled researchers to explore novel aspects of dietary behaviours and preferences.

Interdisciplinary Integration and Global Perspectives
Nutrition education has evolved from a specialised field to one that intersects with various disciplines, including psychology, technology, environmental studies, and political science.⁸ This interdisciplinary approach has enriched the field, offering comprehensive insights and solutions to complex nutritional challenges. Moreover, the field has increasingly adopted a global perspective, moving beyond a Western-centric view. This shift has led to a recognition and appreciation of diverse dietary patterns, cultural influences, and nutritional challenges faced by different populations across the globe. Such a global approach has been instrumental in developing more inclusive and culturally sensitive nutrition education strategies.⁹

Future Directions and Emerging Themes

As we look towards the future, several emerging trends and themes are shaping the trajectory of

nutrition education research. One of the most critical areas is the exploration of the implications of climate change on global food systems. This includes understanding how shifting weather patterns and environmental degradation impact food production, availability, and nutritional quality.¹⁰ The use of machine learning and artificial intelligence in creating customised nutrition plans is another emerging field. These technologies could completely transform how dietary advice is customised to meet each individual's needs, interests, and health objectives. Additionally, there is an increasing recognition of the need for more inclusive and equitable nutrition education practices. This includes addressing disparities in access to nutritional resources, confronting systemic biases in nutritional guidelines, and ensuring that nutrition education is relevant and accessible to diverse populations. Such efforts are crucial in making nutrition education a tool for promoting individual health, social equity, and justice. In summary, this scientometric review chronicles the historical development of nutrition education and highlights its evolving, multifaceted nature. It underscores the need for ongoing adaptation to societal changes, technological advancements, and emerging global challenges, ensuring that nutrition education is vital in promoting health and well-being in an ever-changing world.

Materials and Methods

Survey Methodology

Identification of Search Terms

The process began with identifying search terms, focusing on "nutrition education" as the primary term. This choice reflects the study's aim to explore the broad and multifaceted educational approach encompassing basic nutrition, food systems, and the relationship between diet, health, and disease prevention. Nutrition education is understood as a process that disseminates knowledge and motivates individuals to adopt healthier eating behaviours and food choices.

Sources of Data, Search For Articles, and Qualifying Requirement

For data sourcing and the search for relevant articles, the Web of Science Core Collection (WOSCC) by Thomson Reuters was selected as the primary database. The WOSCC is renowned for its comprehensive coverage of various sectors, making it an ideal choice for accessing a wide range

of peer-reviewed, high-quality academic research articles. This decision underscores the importance of utilising reputable sources that can provide reliable and authoritative information on the evolution of nutrition education.

The search strategy involved a systematic screening of records from the inception of the WOSCC database in 1970 through to the end of 2023, allowing for an extensive review of the literature over this period. The inclusion criteria were strictly limited to academic research articles, ensuring the focus remained on original research contributions to the field. This approach was taken to guarantee the scientific rigour and relevance of the selected studies. Consequently, non-article sources such as conference papers, book chapters, review articles, abstracts, letters, data papers, and correction papers were excluded from the review. This exclusion criterion was applied to maintain a clear focus on empirical research findings and theoretical contributions that could provide insights into the evolution and impact of nutrition education.

Additionally, the review was confined to publications in English, a decision driven by the study's scope, timeline, and funding constraints. This language limitation was deemed necessary to manage the feasibility of conducting the review within the available resources, despite its potential to exclude relevant studies published in other languages.

The literature search and selection process for this scientometric review was thus characterised by a targeted approach to identifying relevant search terms, a commitment to sourcing high-quality data from a reputable database, and a clear inclusion and exclusion criteria. These methodological choices reflect the study's aim to systematically map the development of nutrition education as a scientific field, providing a thorough and nuanced understanding of its historical context, methodological shifts, technological advancements, interdisciplinary integration, global perspectives, and future directions.

Statistical Examination and Interpretation of Data

A detailed bibliometric methodology leveraging the capabilities of CiteSpace software (version 6.1.R2) to conduct a comprehensive scientometric analysis

of the scientific publication network within the field of nutrition education. This approach is instrumental in uncovering trends, patterns, and the most influential works and authors in the domain, offering a panoramic view of the field's evolution over more than five decades.

CiteSpace Software Application

CiteSpace is a powerful tool for visualizing and analyzing trends and patterns in scientific literature. It facilitates the examination of the development of research fields, the identification of key nodes and clusters within scientific networks, and the understanding of the dynamics of scholarly communications. For this study, CiteSpace was utilized to conduct a scientometric analysis, focusing on identifying significant trends and shifts within the realm of nutrition education research.

Data Source and Input

The Web of Science Core Collection (WOSCC) served as the primary data source for this analysis. The WOSCC is recognised for its comprehensive, multidisciplinary coverage of high-quality, peer-reviewed publications. The search strategy was tailored to extract articles from 1970 to the end of 2023, using "nutrition education" as the principal search term. This wide temporal range was chosen to capture the field's evolution from its early stages to its current state.

Analysis Features in CiteSpace

The analysis conducted with CiteSpace focused on several key bibliometric indicators:

Sigma Measures

Sigma measures combine centrality and burstiness scores to highlight the influence of a particular article within the network and the sudden spikes in its citation over time. This metric is crucial for identifying groundbreaking works that have rapidly gained attention within the scientific community.

Degree Centrality

This metric quantifies the total number of citations linking one article to another within the network, providing insights into the most referenced and influential articles in nutrition education. A high degree of centrality indicates a pivotal work that has significantly impacted the domain.

Centrality

Centrality measures an article's importance in the context of the entire citation network. Articles with high centrality scores are considered key nodes that contribute to developing and disseminating knowledge within the field. They often represent seminal works or pivotal research findings.

titles, abstracts, author keywords, and Keywords Plus. This broad spectrum of term sources ensured a thorough semantic analysis, capturing the full breadth of topics, concepts, and thematic areas covered in nutrition education literature. By examining these diverse term sources, the analysis identified the core themes, emerging topics, and shifts in research focus over time.

Term Sources and Text Processing

CiteSpace analysed a comprehensive set of term sources in processing the literature data, including

Figure 1 displays the research framework that was employed for this investigation.

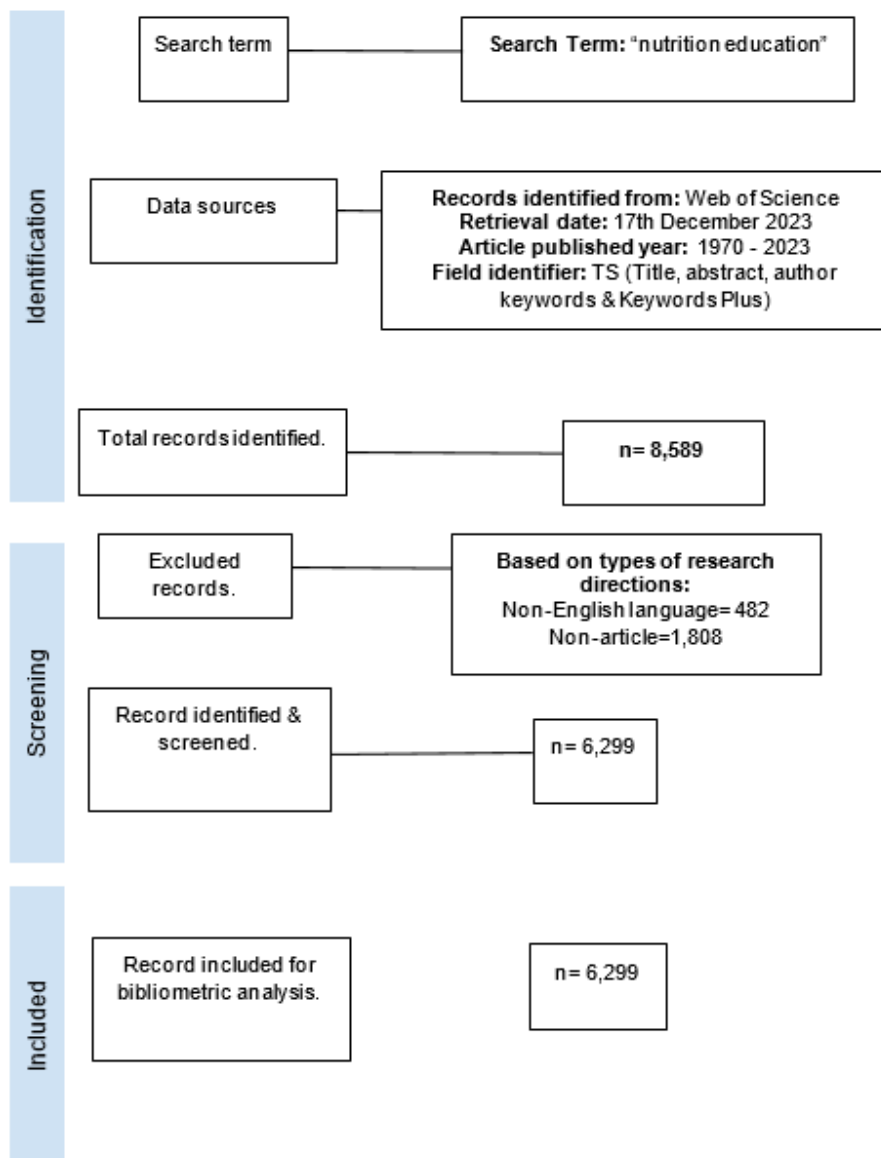


Fig. 1: Methodological framework for the current study

Results

Countries Distribution

Figure 2 presents a comprehensive summary of the global landscape in nutrition education research, highlighting the top ten countries by their respective contributions in terms of publication volume. Leading the chart is the USA, with a remarkable 3,214 records, underscoring its dominant role in the field. Australia follows distantly, contributing 448 publications, which, while significantly lower than the USA, signifies a substantial investment in nutrition education. With 314, 297, and 173 publications, respectively, Canada, England, and Brazil continue

to occupy the middle places, demonstrating their active participation in this field of study. Notably, with over 140 articles apiece, the People's Republic of China, South Korea, the Netherlands, India, and South Africa also make the list. This diversity in the top ten underscores the global interest and varied contributions towards understanding and enhancing nutrition education. This table not only reflects the volume of research produced by each nation but also implicitly points to the prioritization of nutrition education in these countries' public health and academic agendas.

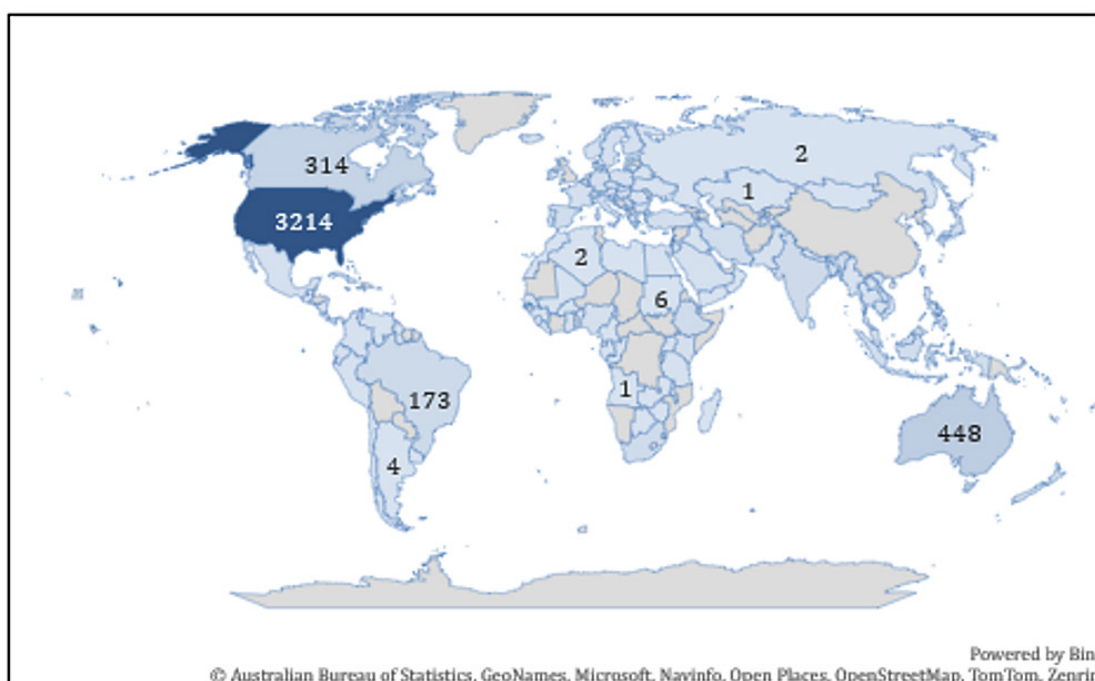


Fig. 2: Total publications by country for research on nutrition education; darker blue indicates the most articles (n = 3,214), while lighter hues indicate fewer publications

Table 1 provides a clear picture of the top 10 journals based on their sigma values for co-citation scores. The sigma value, a statistical measure, reflects how much a journal is co-cited with others in the field, indicating its influence and relevance within academic circles. At the pinnacle of this table is 'J Nutr Educ', boasting an exceptionally high sigma score of 889879.7, suggesting its pivotal role in nutrition education research. Following closely is 'J Am Diet Assoc' with a sigma score of 945.53, underscoring its significant impact in dietetics and nutrition. Other notable journals include 'Am J Public

Health' and 'Am J Clin Nutr', with scores of 267.11 and 256.63, respectively, highlighting their influence in public health and clinical nutrition research. The table also features journals with more specialised focuses, such as 'Health Educ Quart' and 'Am J Epidemiol', indicating their specific but crucial roles in health education and epidemiology. Towards the lower end, we find 'Jama-J Am Med Assoc', 'Public Health Rep', 'Prev Med', and 'Brit Med J', each with scores below 6, reflecting a more modest, yet still noteworthy, level of co-citation in the broader medical and public health research community.

Table 1: Top 10 sigma-value-based journal co-citation scores

Journal	Category Quartile	Impact Factor	Degree	Centrality	Sigma
J Nutr Educ	Q2	0.745	101	0.06	889879.7
J Am Diet Assoc	Q1	3.922	116	0.05	945.53
Am J Public Health	Q1	12.7	152	0.06	267.11
Am J Clin Nutr	Q1	7.1	183	0.1	256.63
Health Educ Quart	Q1	1.219	106	0.03	10.77
Am J Epidemiol	Q1	5	134	0.04	8.68
Jama-J Am Med Assoc	Q1	120.7	119	0.03	5.49
Public Health Rep	Q2	3.3	89	0.04	5.29
Prev Med	Q1	5.1	114	0.03	4.62
Brit Med J	Q1	107.7	113	0.04	3.95

Figure 3 presents an insightful analysis of the most impactful journals in nutrition education based on their citation bursts—a metric indicating a sudden and significant increase in citations over a specific period. The journal "J Nutr Educ" leads the list with an impressive burst score of 235.1, highlighting its pivotal role in advancing nutrition education research. Following closely are "Nutrients" and "J Am Diet Assoc," with burst scores of 172.21 and 140.91, respectively, underlining their substantial contributions to disseminating nutritional knowledge. Notably, "Am J Public Health" and "Int J Env Res

Pub Health" also feature prominently, with scores of 95.76 and 90.59, showcasing their influence in the intersection of public health and nutrition. Other notable journals such as "PLOS One," "Health Educ Quart," "JAMA-J Am Med Assoc," "Am J Epidemiol," and "Prev Med" also demonstrate significant citation bursts, ranging from 71.94 to 57.72. This table underscores the dynamic nature of nutritional education research and highlights the key publications driving the discourse and understanding in this essential field.

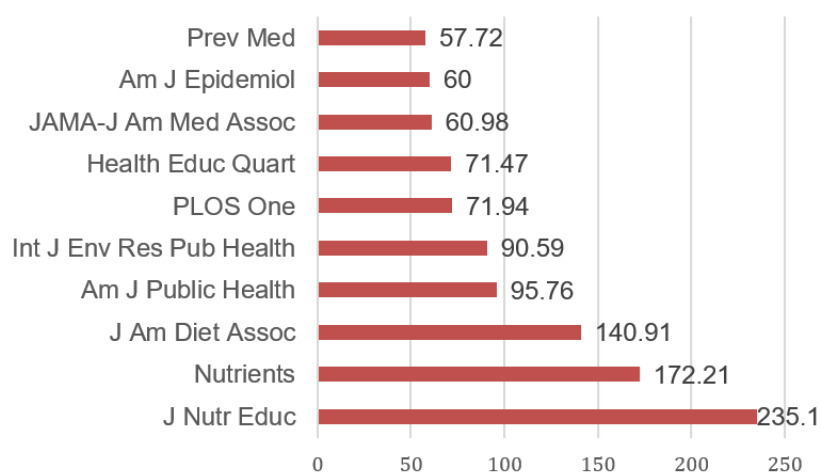


Fig. 3: The top ten journals with the strongest citation bursts

Evolved landscape

Figure 3 presents a study of nutrition education research over the last 50 years, offering a thorough picture of how this area has changed over time. From 1970 to 2023, the time span has been segmented

into five discrete phases, each distinguished by a particular pattern of research endeavours and advancements. This field division into phases makes it possible to see how the field has grown and changed over time.

Initial Phase (1970-1980)

This decade marked the inception of structured nutrition education research. During this time, the field was nascent, with a foundational establishment of theories and principles. The research was primarily exploratory, laying the groundwork for future studies. The burst articles (red dots) in this phase were relatively few, reflecting the emerging nature of the field.

Development Phase (1981-1990)

The subsequent decade witnessed a significant increase in research activities. This phase was marked by the development and refinement of methodologies and an expansion in the scope of nutrition education research. The burst articles increased, increasing interest and investment in the field.

Expansion Phase (1991-2000)

The third phase saw a further escalation in research activities, with a notable diversification in topics and approaches. This period was characterised by a broader application of nutrition education principles across different demographics and a deeper

exploration of the impact of nutritional knowledge on public health. The increase in burst articles during this phase signified the expanding reach and influence of the field.

Phase of Integration (2001–2010)

During this time, there was a greater intersection between nutrition education and other fields like psychology, sociology, and public health policy. A more comprehensive approach to nutrition education was reflected in the research's increasingly interdisciplinary nature. The increase in burst papers persisted, demonstrating the field's increasing importance and complexity.

Advanced Phase (2011-2023)

The most recent phase demonstrates advanced development in nutrition education research. Incorporating cutting-edge technologies, data analytics, and innovative educational strategies has been prominent. This phase is characterised by a high density of burst articles, indicating a peak in research activities and a robust engagement with contemporary nutrition and public health education issues.

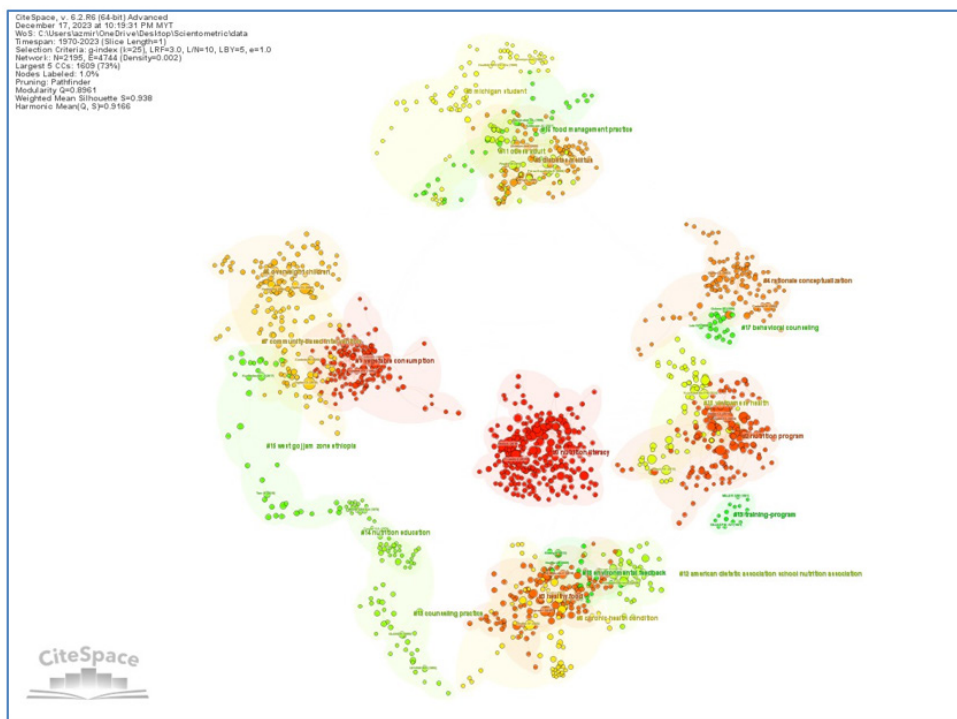


Fig. 4: Top 10 clusters of nutrition education research

Table 2 thoroughly summarises the top 10 clusters found by document co-citation analysis, emphasising their importance in health and nutrition. The study's foundation is the sigma value, a cluster strength and significance gauge. Cluster ID 0, with 249 documents, shows a high silhouette value of 0.875 and is labelled as "nutrition literacy," indicating a

strong, cohesive research area, predominantly from 2017. This suggests a recent and concentrated interest in this topic. Cluster ID 1, labelled "vegetable consumption" from 1995, comprises 150 documents and has the highest silhouette value of 0.951, pointing to a well-defined and significant research area from earlier.

Table 2: The top 10 clusters that the document co-citation analysis revealed

Cluster ID	Size	Silhouette	Label (LLR)	Average Year
0	249	0.875	Nutrition literacy	2017
1	150	0.951	Vegetable consumption	1995
2	137	0.887	Nutrition program	2013
3	130	0.907	Healthy food	2013
4	99	0.956	Rationale conceptualisation	2002
5	93	0.937	Diabetes mellitus	1999
6	81	0.926	Overweight children	2004
7	72	0.911	Community-based intervention	2008
8	70	0.952	Chronic health condition	2006
9	70	0.991	Michigan student	1990
10	63	0.958	Vietnamese health	2013

Similarly, clusters 2 and 3, focusing on "nutrition program" and "healthy food", respectively, both from 2013, reflect substantial research interest with high silhouette values (0.887 and 0.907). These clusters hint at a growing academic focus on programmatic and food-specific aspects of nutrition

in the early 2010s. The cluster labelled "rationale conceptualisation" from 2002, despite its smaller size (99 documents), shows a high silhouette value (0.956), indicating a strong, distinct research focus during that period.

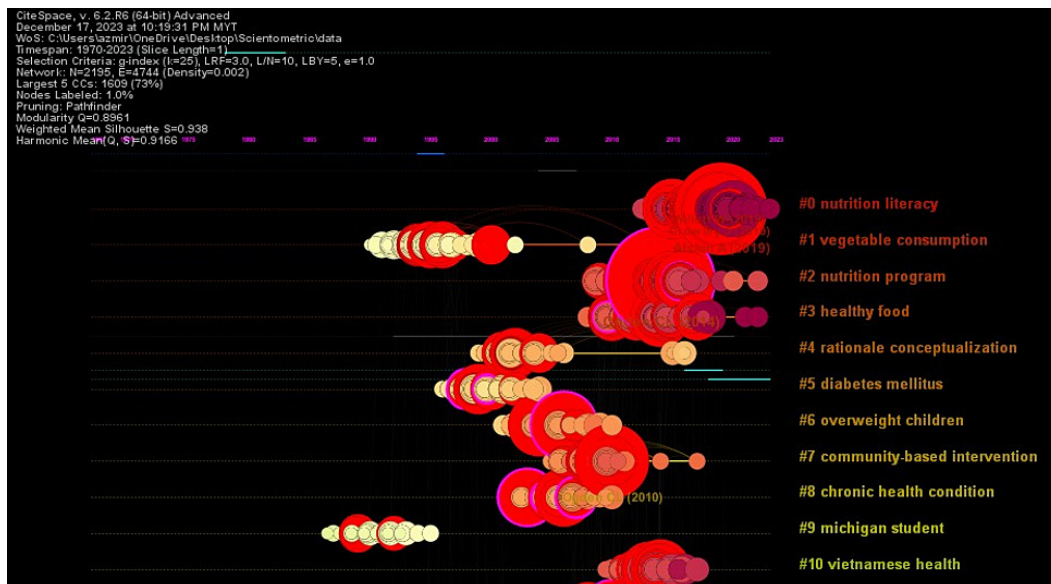


Fig. 5: Top 10 clusters' lifetimes (solid lines)

Notably, clusters dealing with "diabetes mellitus" (1999), "overweight children" (2004), and "chronic health condition" (2006) each show high silhouette values and moderate sizes, reflecting focused research interests in these specific health challenges at different times. The cluster labelled "Michigan student" from 1990, with a silhouette value of 0.991, suggests a highly specific and cohesive body of research from this period, possibly focusing

on a localised study or demographic. Lastly, the "Vietnamese health" cluster from 2013, though smaller in size, exhibits a high silhouette value, indicating a strong, distinct research interest in health issues about the Vietnamese population at that time. Overall, Figure 5 effectively highlights the evolving and varied research interests in nutrition and health over time and the cohesiveness and distinctiveness of these research clusters.

Table 3: The top 10 articles with the most citations in the nutrition education research area

Title Article	Cluster ID	Citation Count
Prevalence of childhood and adult obesity in the United States, 2011-2012 ¹³	2 (nutrition program)	83
Health effects of dietary risks in 195 countries, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017 ¹⁴	0 (nutrition literacy)	62
Prevalence of high body mass index in US children and adolescents, 2007-2008 ¹⁵	7 (community-based intervention)	43
Nutrition in medical education: a systematic review ¹⁶	0 (nutrition literacy)	40
Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems ¹⁷	0 (nutrition literacy)	36
Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010 ¹⁸	2 (nutrition program)	33
Prevalence of overweight and obesity in the United States, 1999-2004 ¹⁹	6 (over-weight children)	32
Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 y ²⁰	2 (nutrition program)	29
Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002 ²¹	6 (over-weight children)	28
A systematic review of randomized trials on the effectiveness of computer-tailored education on physical activity and dietary behaviours ²²	8 (chronic health condition)	27

Table 3 presents a compelling overview of the most influential research in nutrition education, as measured by citation counts. Notably, the table reveals a strong emphasis on studies related to obesity, both in children and adults, underscoring

the global concern over this health issue. With 83 citations, the most cited article is "Prevalence of childhood and adult obesity in the United States, 2011-2012," highlighting the increased interest in obesity research and treatment among academics

and public health professionals. Cluster ID 2, including this article, seems to focus heavily on nutrition programs, highlighting the importance of educational interventions.

Several high-impact articles, including "Health effects of dietary risks in 195 countries, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017" and "Nutrition in Medical Education: A Systematic Review," both from Cluster ID 0, represent nutrition literacy as another important theme. These articles, with citations of 62 and 40, respectively, suggest a growing recognition of the need for comprehensive education on dietary risks

and nutrition principles, not just among the public but also within the medical community.

Systematic reviews and meta-analyses highlight the academic pursuit of evidence-based strategies to address diet-related issues, such as "Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 years." The table also reflects a trend towards community-based and school-based interventions, indicating a shift towards more localised and practical approaches in nutrition education.

Table 4: Top 10 papers in nutrition education research between 1970 and 2023 with the highest citation burst (strength)

Article Title	Year	Strength	Begin	End
Prevalence of childhood and adult obesity in the United States, 2011-2012 ¹³	2014	36.29	2015	2019
Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the global burden of disease study 2017 ¹⁴	2019	28.51	2020	2023
Prevalence of high body mass index in us children and adolescents, 2007-2008 ¹⁵	2010	21.96	2010	2015
Prevalence of overweight and obesity in the United States, 1999-2004 ¹⁹	2006	19.2	2008	2011
Nutrition in medical education: a systematic review ¹⁶	2019	18.32	2020	2023
Prevalence of obesity and trends in body mass index among us children and adolescents, 1999-2010 ¹⁸	2012	18.08	2013	2016
Prevalence of overweight and obesity among us children, adolescents, and adults, 1999-2002 ²¹	2004	2117.11	2006	2009
Food in the anthropocene: the EAT–Lancet commission on healthy diets from sustainable food systems ¹⁷	2019	16.48	2020	2023
A systematic review of randomized trials on the effectiveness of computer-tailored education on physical activity and dietary behaviors ²²	2006	15.69	2007	2011
Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 y ²⁰	2012	15.26	2014	2017

Table 4 highlights the most impactful publications in nutrition education research from 1970 to 2023,

focusing on those with the strongest citation bursts. An article's importance and relevance in the field are

demonstrated by the number of times it is mentioned, represented by a citation burst. With a maximum strength of 36.29, the 2014 paper "Prevalence of Childhood and Adult Obesity in the United States, 2011-2012" leads the table and indicates its significance in the academic community from 2015 to 2019. The publication "Health Effects of Dietary Risks in 195 Countries, 1990–2017," released in 2019, comes next. It displays a strength of 28.51 and a sustained surge from 2020 to 2023. The list includes articles on obesity prevalence in different

demographics and periods in the United States, systematic reviews on nutrition education, and broader analyses of dietary risks and sustainable food systems. The duration of citation bursts varies, but notably, several articles from 2019 show ongoing influence up to 2023, underscoring the evolving nature of nutrition education research. This table reflects the historical significance of these publications and indicates current trends and focal areas in the field.

Table 5: The ten most significant papers in nutrition education research, arranged in descending order of sigma score

Article Title	Degree	Centrality	Sigma	Cluster ID
Prevalence of childhood and adult obesity in the United States, 2011-2012 ¹³	16	0.14	100.69	2
Past, present, and future of computer-tailored nutrition education ²³	11	0.3	34.41	8
Prevalence and trends in obesity among US adults, 1999-2008 ²⁴	10	0.25	8.51	11
Prevalence of overweight and obesity in the United States, 1999-2004 ¹⁹	15	0.11	7	6
Have Americans increased their fruit and vegetable intake? The trends between 1988 and 2002 ²⁵	15	0.29	5.95	8
The impact of computer-tailored feedback and iterative feedback on fat, fruit, and vegetable intake ²⁶	21	0.22	4.06	5
Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002 ²¹	13	0.07	3.29	6
Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010 ¹⁸	9	0.06	2.88	2
Trends in obesity prevalence among children and adolescents in the United States, 1988-1994 through 2013-2014 ²⁷	9	0.07	2.34	2
A systematic review of randomized trials on the effectiveness of computer-tailored education on physical activity and dietary behaviors ²²	16	0.05	2.25	8

Based on their sigma score, Table 5 offers a persuasive summary of the ten most important

studies in nutrition education research. This metric is a sophisticated blend of the study's degree

(reflecting the number of times it's been cited in other research) and centrality (indicating its importance within the network of related research), culminating in the sigma score that denotes overall influence.

At the apex of this list is 13 publications in JAMA focused on obesity prevalence in the U.S. during 2011-2012. Its towering sigma score of 100.69 and a degree of 16 underscore its monumental impact in the field. Following this, 23 research studies, with a significant sigma score of 34.41, published in the American Journal of Clinical Nutrition, explore computer-tailored nutrition education's development and future possibilities.

Other notable publications include 24 studies in JAMA on U.S. adult obesity trends and 19 explorations of

U.S. obesity prevalence, each contributing uniquely to our understanding of nutritional trends and public health challenges. The diversity of topics, ranging from obesity trends to the effectiveness of nutritional interventions, illustrates the multifaceted nature of nutrition education research. This table highlights seminal works in the field and guides emerging researchers to understand pivotal studies shaping contemporary nutrition discourse.

Table 6 presents a fascinating insight into the evolving landscape of nutrition education research from 1970 to 2023, highlighting the top 10 keywords that experienced significant citation bursts. A citation burst represents a period when a keyword gained notable prominence in academic literature.

Table 6: Top 10 terms in nutrition education research published between 1970 and 2023 with the largest citation burst

Term	Year	Burst	Burst Begin	Burst End
Fat	1992	24.28	1992	2011
Coronary heart disease	1994	17.42	1994	2009
Cholesterol	1992	17.2	1992	2009
Women	1991	11.45	1996	2004
Pregnant women	2018	11.11	2020	2023
Food insecurity	2003	10.77	2019	2023
Behavior	1990	10.4	1994	2001
Growth	1992	10.23	2005	2011
Cooking	2011	9.93	2019	2023
Food security	2003	9.74	2018	2023

The keyword "fat" tops the list, with a burst strength of 24.28, spanning from 1992 to 2011. This indicates a heightened focus on fat in nutrition during these years, likely correlating with increased research into dietary fats and their health implications. Following closely, "coronary heart disease" and "cholesterol" had bursts starting in the early 1990s, reflecting growing concern and research in heart health and its dietary connections.

Interestingly, the focus on specific demographic groups is evident with the keywords "women" and "pregnant women." The burst for "women" began in 1996 and ended in 2004. In contrast, the burst for "pregnant women" is more recent, starting in 2020 and continuing through 2023, suggesting a

growing recognition of the unique nutritional needs of these groups.

The rise of "food insecurity" and "food security" as major research topics in the 21st century, with bursts starting in the late 2000s and continuing through 2023, underscores the increasing attention to global food challenges. The keyword "behaviour," peaking between 1994 and 2001, indicates a period when behavioural aspects of nutrition were a key focus.

Finally, the keywords "growth" and "cooking," with citation bursts in the 2000s and 2010s, reflect an evolving interest in the developmental aspects of nutrition and the practicalities of food preparation, respectively. These trends provide valuable insights

Epidemiol" with notable sigma scores reflects the integration of nutrition education into broader health and epidemiological studies. This aligns with the trend towards a more holistic understanding of health education, as articulated by.³¹

Citation Bursts as Indicators of Emerging Trends

Leading Role of "J Nutr Educ": With a burst score of 235.1, this journal's significant impact can be attributed to its role in introducing and disseminating new concepts and methodologies in nutrition education, as suggested by.³²

Diverse Contributions Across Journals: The varying burst scores of journals like "Nutrients," "Am J Public Health," and "Int J Env Res Pub Health" highlight the dynamic nature of the field. These scores indicate periods of heightened scholarly attention, often aligning with the introduction of innovative research or paradigm shifts, as noted by.³³

The prolific nature of these journals and their varied impact, as measured through record counts, co-citation scores, and citation bursts, underscore the richness and diversity of nutrition education research. This analysis not only serves as a roadmap for researchers in identifying key sources and trends but also reflects the evolving priorities and methodologies within the field. The prominence of these journals in disseminating critical research underscores their role in shaping the future directions of nutrition education, public health policy, and clinical practice.

"Fat" (1992-2011): The prominence of "fat" as a keyword with the highest burst strength (24.28) aligns with pivotal research during this period. Studies like those by 34 significantly contributed to understanding the diverse roles of dietary fats in health, particularly their association with cardiovascular diseases and obesity). This era marked a paradigm shift from generalised fat reduction to differentiating between types of fats, emphasising the health implications of saturated and unsaturated fats.

"Cholesterol" and "Coronary Heart Disease" (early 1990s): The concomitant surges in citations for these terms are indicative of the increasing amount of research that links heart health with dietary practises. Prominent investigations, like those conducted by

35, examined the correlation between cholesterol levels, dietary consumption, and the likelihood of coronary heart disease, impacting dietary guidelines and public health advice.³⁵

Demographic Focus - "Women" and "Pregnant Women" (1996-2004; 2020-2023): The focused attention on "women" and "pregnant women" during these periods reflects an increasing recognition of gender-specific nutritional needs. Research by 36 emphasised the unique dietary requirements of women and pregnant women, including micronutrient needs and caloric adjustments, to support maternal health and fetal development.³⁷

"Food Insecurity" and "Food Security" (Late 2000s-2023): The sustained interest in these topics underscores the growing global concern over access to adequate and nutritious food. The work of 38 brought attention to the complex interplay between food security, socio-economic factors, and health outcomes, particularly in developing countries. 39 "Behaviour" (1994-2001): The peak in research on behavioural aspects of nutrition highlights the era's focus on understanding how individual choices and habits impact nutritional health. Studies by 40 examined factors influencing dietary behaviours, contributing to developing more effective nutrition education strategies.⁴¹

"Growth" and "Cooking" (2000s-2010s)

These keywords reflect an expanded scope of nutrition research, encompassing developmental nutrition and practical aspects of food preparation. The works of 42 on growth and nutrition in early childhood and 43 on cooking and its impact on dietary habits illustrate the diversification of research topics during this period.

Obesity Research

A greater emphasis on obesity in academia and public health is indicated by the popularity of studies on the topic, especially the 2014 publication "Prevalence of Childhood and Adult Obesity in the United States, 2011-2012," which has 83 citations and a burst strength of 36.29. This emphasis is not surprising, given the alarming rise in obesity rates globally. The study's significant citation count and burst strength indicate its critical role in shaping public health policies and education programs to combat obesity. This trend is consistent with

literature such as 44, which highlights the increasing prevalence of obesity and its implications for public health.

Nutrition Literacy

The high-impact publications "Health Consequences of Dietary Hazards in 195 Countries, 1990-2017" and "Nutrition in Medical Education: A Systematic Review" demonstrate how nutrition literacy is becoming increasingly important. These articles highlight this trend. This trend is in line with the findings of 45, who argue for the integration of nutrition education in medical curricula to improve health outcomes. The significance of these articles, as evidenced by their citation counts, underscores the need for a broader and more informed understanding of nutrition among the public and medical professionals.

Evidence-Based Strategies

The inclusion of meta-analyses and systematic reviews in the tables—like the one on children's intake of fruits and vegetables—indicates that researchers are strongly emphasising evidence-based methods for nutrition education. This aligns with the research of 46, who advocate for data-driven approaches to dietary interventions. The focus on such research underscores the academic commitment to identifying and implementing the most effective strategies in nutrition education.

Community-Based and School-Based Interventions
The cited literature suggests a trend towards community-based and school-based interventions, suggesting a shift towards more localized and practical approaches in nutrition education. Studies like 47 demonstrate the effectiveness of school-based nutrition programs. These approaches are increasingly recognised for their potential to create sustainable changes in dietary habits and health outcomes at a community level.

Evolving Nature of the Field

The ongoing influence of several articles from 2019 up to 2023, as seen in Table 4, highlights nutrition education research's dynamic and evolving nature.

The varied duration of citation bursts and the diverse topics covered, from obesity prevalence to sustainable food systems, suggest a field continually adapting to new challenges and discoveries. This observation aligns with scholars like 48, who note the necessity of adaptive research strategies in changing dietary patterns and health challenges.

Conclusion

In conclusion, nutrition education has evolved significantly over the past fifty years, driven by themes such as obesity, nutrition literacy, evidence-based strategies, and localised interventions. These themes, far more than mere academic topics, have actively guided efforts to tackle complex nutritional challenges, reflecting the field's commitment to individual health literacy and global health policies. The frequent citation of these keywords underscores the vibrancy and adaptability of the discipline, demonstrating its ability to stay abreast of emerging health challenges and societal shifts. The review traces this evolution from foundational principles to a modern, interdisciplinary approach incorporating advanced technologies, emphasising the field's resilience and dedication to improving public health through informed strategies. Ultimately, this scientometric review serves as both a retrospective analysis and a forward-looking guide, illuminating critical focus areas for future research to enhance global nutritional health and well-being.

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Conflict of interest

The authors declare that they have no competing interests.

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