Review

Global trends and hotspots in nutritional risk screening, assessment, and diagnosis: A bibliometric and visual analysis (1991–2024)

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Background and Objectives: Nutrition is important in promoting health and preventing disease, while malnutrition can exacerbate disease symptoms and lead to adverse clinical outcomes in patients. The process of nutritional diagnosis and treatment includes nutritional risk screening, nutritional assessment, and nutritional therapy. This study aims to understand the number of publications, cooperation of research subjects, progress of research content, and research hotspots of nutritional risk screening and assessment, and then identify the future trends and directions of global nutritional screening. **Methods and Study Design:** Articles on nutritional risk screening, nutritional assessment and application of nutritional diagnostic tools were identified from the Web of Science and the collected data were analysed using bibliometrics and information visualisation with the help of CiteSpace software. A total of 10632 articles published between 1991 and 2024 were selected. **Results:** The country with the highest number of articles was the United States; two institutions, the University of São Paulo and the Karolinska Institutet, had higher centrality and number of articles. Keyword emergent analysis revealed that global leadership initiatives on malnutrition, diagnosis, criteria, myasthenia gravis, and clinical nutrition were the five emergent terms that lasted until 2024 and were the most popular hot topics among experts and scholars. **Conclusions:** We describe the characteristics of the development of nutritional risk screening and assessment studies and their trends. Currently, there is not a close collaboration between institutions and authors in the research process, while the field is trending towards more specific research and a greater focus on the disease progression in patients.

Key Words: nutritional risk screening, nutritional assessment, nutritional diagnosis tools, CiteSpace, visual analytics

INTRODUCTION

Nutrition is a fundamental need for life and plays an important role in promoting health and preventing disease. Malnutrition can be caused by starvation, disease or advanced age (e.g. >80 years), either alone or in combination.[1] European Society for Parenteral and Enteral Nutrition defines malnutrition as "a state in which the lack of nutrient intake or consumption results in altered body composition (decreased lipid removal) and body cellularity leading to reduced physical and mental functioning, as well as impaired clinical outcomes due to disease". Malnutrition, as an independent risk factor, adversely affects patients' clinical outcomes, quality of life, physical functioning and autonomy, as well as being an important factor influencing their disease prognosis. It has been suggested that the prevalence varies according to the population and the diagnostic criteria used, with estimates of the prevalence of malnutrition ranging from 15 to 60 %.[2] Studies have shown that about 20-50 % of patients are malnourished prior to admission, and it is noteworthy that 49 % of malnourished patients who are hospitalised for more than a week maintain or face a deterioration in their previous nutritional status. In addition, about one-third of the patients with good nutritional status prior to admission develop malnutrition during hospitalisation.[3] Data

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from the United States and Europe in 2021 showed that at the time of hospitalization, up to one-third of patients were at risk of malnutrition or malnourished.[4] A 2021 study showed that malnutrition affects the onset and progression of the coronavirus disease in children as well as adults.[5] The prevalence of malnutrition among hospitalised patients is reported to be as high as 50 % in African countries.[6] Hospital-acquired malnutrition is a prevalent problem in the older population (65 years and older), with about one-quarter of older persons malnourished or at risk of malnutrition. This problem will become increasingly acute as the population ages.[7] A cohort study on Colombian patients with cardiopulmonary disease shows that malnutrition defined as a positive result using a nutritional risk screening tool is associated with longer hospital stays, higher mortality rates and higher hospital costs.[8] Not only that, but malnutrition also increases the rate of complications in patients with poor gastric cancer, leading to longer postoperative hospital stays, which adversely affects patients.[9] Also, malnutrition is a risk factor for chronic obstructive pulmonary disease patients.[10] Early identification of the risk of malnutrition is essential to provide safe and effective nutritional support to patient promptly. Patients should be screened and counseled upon admission to adjust their nutritional status in time for recovery. Therefore, the nutritional diagnosis and treatment of patients has become an essential part in modern medical comprehensive treatment.

Nutritional risk screening is the first step in nutritional diagnosis and treatment, and also the foundation of nutritional treatment for patients. The Nutritional Risk Screening Scale , a simple and rapid screening tool for detecting patients at risk of malnutrition, should be systematically applied to admitted patients. So far, the main nutritional screening tools used in clinical practice include the Nutritional Risk Screening-2002 (NRS 2002),[11, 12] Malnutrition Universal Screening Tool (MUST),[13, 14] and Mini Nutritional Assessment short-form (MNA-SF).[15, 16]

Patients found to be at nutritional risk after screening for nutritional risk should subsequently undergo a more detailed nutritional assessment to identify and quantify specific nutritional problems. This assessment includes subjective and objective parameters such as medical history, current and past dietary intake (including energy and protein balance), physical examination and anthropometric measurements, functional and psychiatric assessments, quality of life, medications and biochemical indicators. Nutritional assessment is a subsequent step in nutritional risk screening, which provides a more in-depth understanding of the nutritional status in patients.[17] The main methods used for nutritional assessment and nutritional diagnosis include tools such as the Mini Nutritional Assessment (MNA),[20,21] and the Subjective Global Assessment(SGA).[22-24]

Following nutrition risk screening and nutrition assessment, we can make a diagnosis of malnutrition. The diagnostic criteria for malnutrition have not been universally standardized, which may be related to the lack of a clear definition of malnutrition. The Global Leadership Initiative on Malnutrition (GLIM) criteria represent a consensus approach for diagnosing malnutrition in adults across global clinical settings.[18,19] The introduction of the GLIM criteria has standardized the diagnostic process, making it simpler and more convenient, and has gained recognition from major clinical nutrition societies. Currently, the most commonly used diagnostic tools for malnutrition internationally include the American Society for Parenteral and Enteral Nutrition (ASPEN) Malnutrition Diagnostic Criteria,[1] the European Society for Clinical Nutrition and Metabolism (ESPEN) Malnutrition Diagnostic Criteria,[25] and the GLIM criteria.[26]

The aim of this study is to utilize a bibliometric and visual analysis approach to collate and analyze the number of publications, cooperation of research subjects, the progress of research content and research hotspots of nutritional risk screening and assessment, and then to identify the future trends and directions of global nutritional screening and assessment-related research, to provide a reference for the future development of clinical nutrition-related research.

METHODS

Data sources and search strategies

The data for this study were extracted on 24 January 2024 for the period 1991 - 2024 from the Web of Science Core Collection (WoSCC). To avoid database update bias, we completed all data extraction and data downloads within the same day. We retrieved relevant publications using the following search strategy: "nutritional risk screening" OR "nutrition screening" OR "nutritional assessment" OR "nutrition diagnosis" OR "NRS 2002" OR "nutritional risk assessment 2002" OR "malnutrition universal screening tool" OR "mini nutritional assessment" OR "MNA" OR "Mini Nutrition Assessment-Short Form" OR "MNA-SF" OR "global leadership initiative on malnutrition" OR "GLIM" OR "subjective global assessment" OR "Nutrition Risk in Critically Ill Score" OR "NUTRIC" AND Language= English and Document type = Article AND Review. The raw data were then downloaded from the WoSCC as text files containing the full transcripts. After the initial data retrieval, a screening process was conducted by LQ and WJ to eliminate non-thesis and non-review documents as well as documents that did not fit the topic under study to ensure that they were all relevant to the topic of this study. Our study ultimately analysed 10,632 articles.

Analysis of the bibliometric online platform

We processed the data systematically through Web of Science (https://wcs.webofknowledge.com) and the information visualisation and analysis software CiteSpace (https://CiteSpace Home.podia.com). Web of Science (WoS)was used to retrieve targeted data CiteSpace can quickly and accurately process large volumes of bibliographic information data and show unique correlations, combine macro- and micro-measurements to provide references for scientific discoveries, and display annual publication trends in different countries and regions, and collaborations between countries/regions.

CiteSpace software analysis

Complete records of retrieved articles and cited references were downloaded from the WoSCC database for further analysis with CiteSpace software (version 6.2.R6).

With the help of CiteSpace 6.2.R6 software, the literature was analysed in terms of the number of publications and growth trends, research subjects and collaborations, progress of research content, and research hotspots. In this study, we mainly mapped the co-occurrence of countries, regions, institutions, core authors and co-cited literature co-occurrence, and performed cluster analysis of co-cited literature, keyword salience, and cluster analysis.

RESULTS

Publication volume and trend analysis

The search results were obtained in the WoS database according to the search method and literature type requirements of this paper, and a total of 10,632 articles were screened for inclusion in the study. As shown in Figure 1, the annual number of publications in the WoS database has been generally on an upward trend since 1991, and the exponential trend line of the annual cumulative number of publications versus time, R^2=0.989, indicates that the annual cumulative number of publications conforms to the exponential distribution. On this basis, according to the four-stage theory proposed by Price, the publication of English literature can be roughly divided into three stages: 1991-2007 is the budding stage, with an average of 77 articles per year and a maximum of 179 articles per year; 2008-2019 is the stage of rapid development, with an upward trend, though fluctuating. The period 2008-2019 belongs to the stage of rapid development, with fluctuations but generally in an upward trend, with an annual average of 428 articles and a maximum of 791 articles; the period from 2020 to the present belongs to the stage of stable development, with little change in the annual number of articles and maintained at a relatively high level, with an annual average of 836 articles and a maximum of 1,135 articles. Meanwhile, from the rapid development stage, i.e. 2008, the annual cumulative number of articles has shown rapid growth, indicating that the field of nutritional risk screening and assessment has been developing well and attracting more and more attention.

Research subjects and co-operation

Country co-occurrence analysis

We used CiteSpace software to analyse the collaboration between countries. As shown in Figure 2, there are 129 nodes, 591 connecting lines, and a network density of 0.072, of which the United States has the highest number

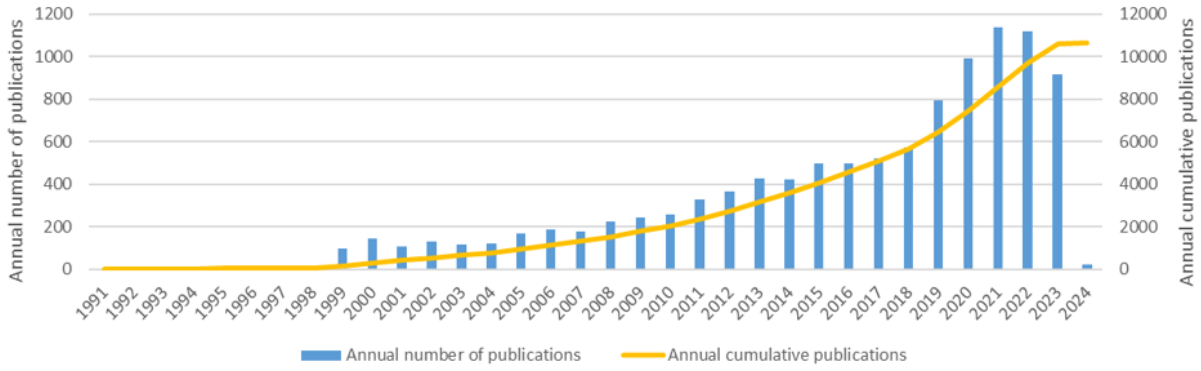

Figure 1. Annual publications and cumulative annual publications for nutritional risk screening and assessment from 1991-2024

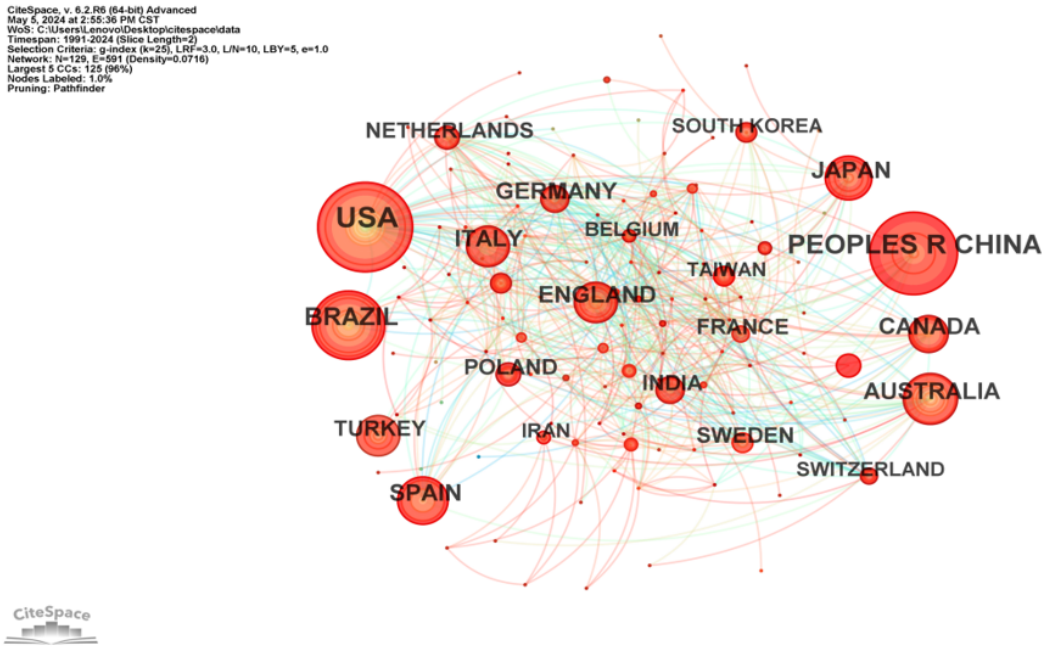

Figure 2. Co-occurrence mapping of country for nutritional risk screening and assessment from 1991-2024

of articles with 1,816, followed by China with 1,435 and Brazil with 811. The mediated centrality of a node in the network mapping reflects the importance and influence of that node in the overall cooperation network. The United States has the highest mediated centrality of 0.3, followed by the United Kingdom (0.22) and France (0.16), suggesting that the United States collaborates more closely with the United Kingdom and France with other countries. Although China has the second highest number of publications, the mediational centrality is only 0.01, indicating that China has less cooperation with foreign countries in nutritional risk screening and assessment, and the influence of China is not high despite the large number of publications.

Inter-agency co-occurrence analysis

In order to clarify the inter-institutional collaboration in this area, we used Citespace software for the analysis. In Figure 3, the nodes of institutions with more publications are darker in colour. The network density is 0.005. The top 5 institutions in terms of postings are the University of São Paulo, the University of Queensland, Karolinska Institutet, the University of Alberta, and the Commonwealth University of Minas, with a total of 589 posts, or about 5.5% of the total number of posts. In the centrality ranking, Brigham and Women's Hospital has the highest centrality (0.11), and the top 5 institutions in terms of both volume and centrality are the University of São Paulo and Karolinska Institutet.

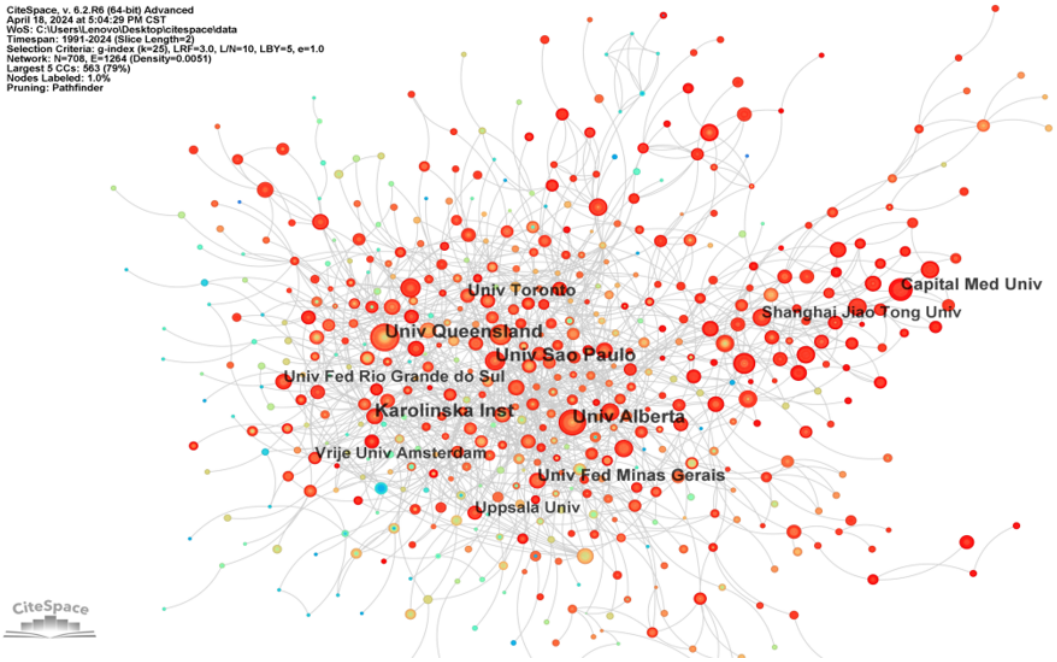

Figure 3. Co-occurrence mapping of inter-agency for nutritional risk screening and assessment from 1991-2024

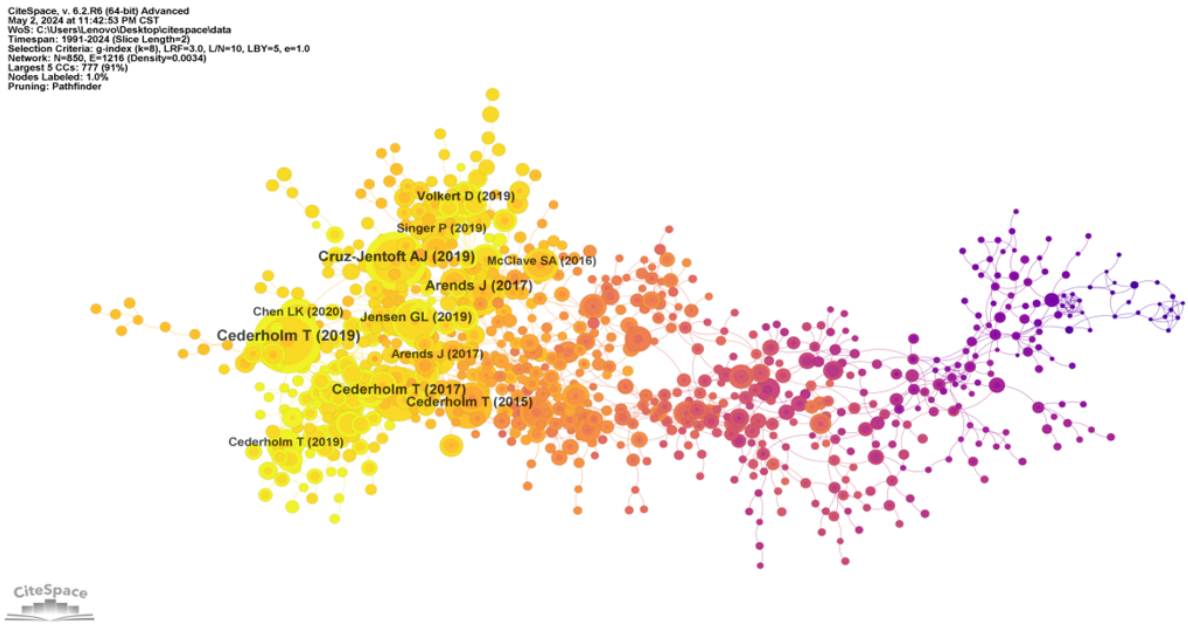

Figure 4. Co-occurrence mapping of core authors and co-cited literature for nutritional risk screening and assessment from 1991-2024

Core authors and co-cited literature analysis

CiteSpace software was used to analyse the relevant literature, and the results are shown in Figure 4, with a total of 850 nodes, 1,216 links, and a network density of 0.003. The authors of the most highly co-cited publications were Cederholm T, Uppsala University, Sweden; Cruz-Jentoft AJ, Ramon Cahal University Hospital; Arends J, University of Freiburg, Germany; and Cederholm T published four and Arends J published four of the top 10 highly co-cited publications in the field of nutritional risk screening and assessment, in order of prevalence. The main co-cited publications with high centrality of individual mediators are: Ozkalkanli MY et al in 2009 compared 256 consecutive orthopaedic surgical patients admitted for nutritional screening using SGA and NRS 2002 and showed that malnourished patients had longer hospital stays and higher morbidity and mortality rates.[28] White JV et al in 2012 proposed an aetiology-based approach to the diagnosis of malnutrition that incorporates the current understanding of the role of the inflammatory response on the incidence, progression and resolution of malnutrition.[29]

Progress in research

Through the cited literature clustering, we obtained a total of 18 keyword cluster identifiers, and the top 10 cluster identifiers and their main keywords can be seen in Table 1. Different colour modules represent different clustering modules. The overlapping of multiple clusters in Figure 5 means that the clusters are closely related to each other and the research topics are more focused. Modularity Q (Q) = 0.831, with Q > 0.3 indicating a significant cluster structure. The average silhouette value of the clusters Silhouette(S) = 0.936, S > 0.5 means the clustering results are reasonable, and S > 0.7 means the clustering results

Table 1. Top 10 cluster identifiers and main keywords

ClusterID	Silhouette†	Year	Main keywords
#0 global leadership initiative	0.952	2019	global leadership initiative; predicting survival; diagnosing malnutrition; malnutrition criteria; reduced muscle mass
#1 malnutrition criteria	0.877	2013	global leadership initiative; malnutrition criteria; global clinical nutrition community; consensus report; oncology patient
#2 hospital admission	0.937	2004	hospital admission; screening method; acute care patient; exploring issue; australian hospital
#3comparative analysis	0.921	2010	comparative analysis; screening tool; predicting length; global leadership initiative; risk prediction
#4 covid-19 patient	0.914	2018	covid-19 patient; secondary analysis; coronavirus disease; effort trial; orthopedic patient
#5 controlled population study	0.926	2000	controlled population study; uremic malnutrition; chronic uremia; protein catabolism; hospital admission
#6 elderly taiwanese	0.977	2009	elderly taiwanese; national cohort study; mini-nutritional assessment; nursing home; nursing home resident
#7 physical frailty	0.934	2017	adverse outcome; physical frailty; malnutrition frailty; pen-3s study; high prevalence
#8 ill patient	0.938	2016	ill patient; nutric score; nutrition risk; ill score; intensive care unit
#9 lean body mass	0.922	1997	lean body mass; c-reactive protein;malnutrition-inflammation complex syndrome; hemodialysis patient; malnutrition inflammation

†"Silhouette" is a metric used to evaluate the quality of clustering.

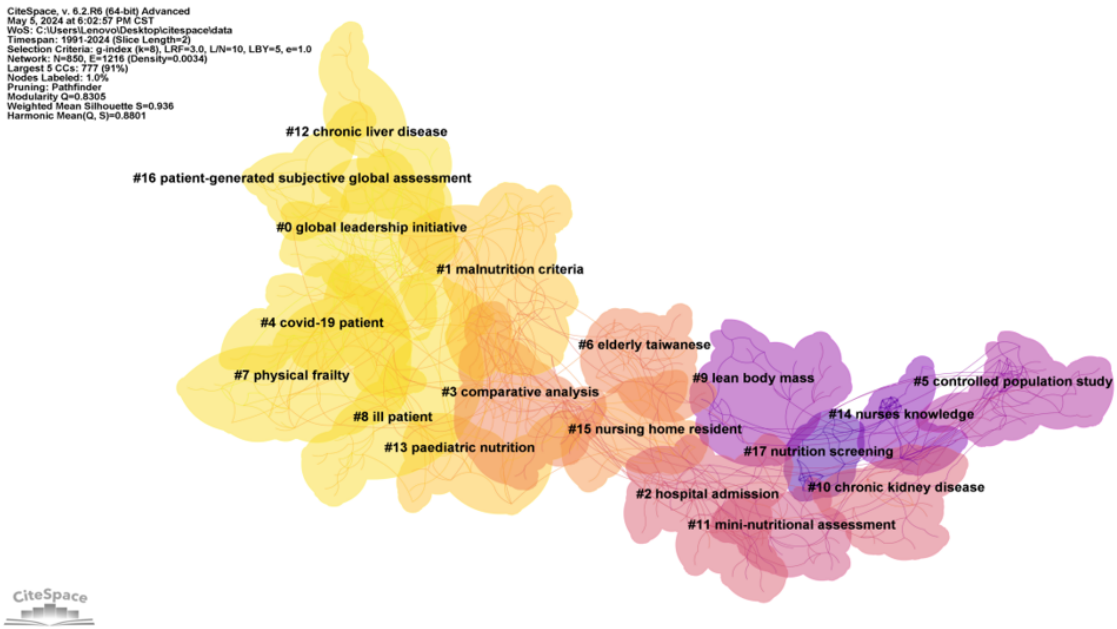

Figure 5. Cluster mapping of co-cited literature on nutritional risk screening and assessment from 1991-2024

are convincing, which indicates that this clustering map can well reflect the research content in the field of nutritional risk screening and assessment. The smaller the cluster label number, the more literature the cluster contains. The first 10 clusters include #0 global leadership initiative, #1 malnutrition criteria, #2 hospital admission, #3 comparative analysis, #4 covid-19 patient, #5 controlled population study, #6 elderly taiwanese, #7 physical frailty, #8 ill patient, #9 lean body mass.

Research hotspots

Co-occurrence analysis of keywords

As shown in Figure 6, the co-occurring node information shows that the literature in the field of nutritional risk screening and assessment mainly focuses on keywords such as 'malnutrition', 'nutritional assessment', 'nutrition', 'imbalance', 'simple nutritional assessment', 'subjective and comprehensive nutritional assessment method' and so on. The research subjects included 'elderly people' and 'end-stage renal disease', and the contents of the study were divided into 'diet', 'body composition', 'Body mass index', 'Bone density' and 'body weight'.

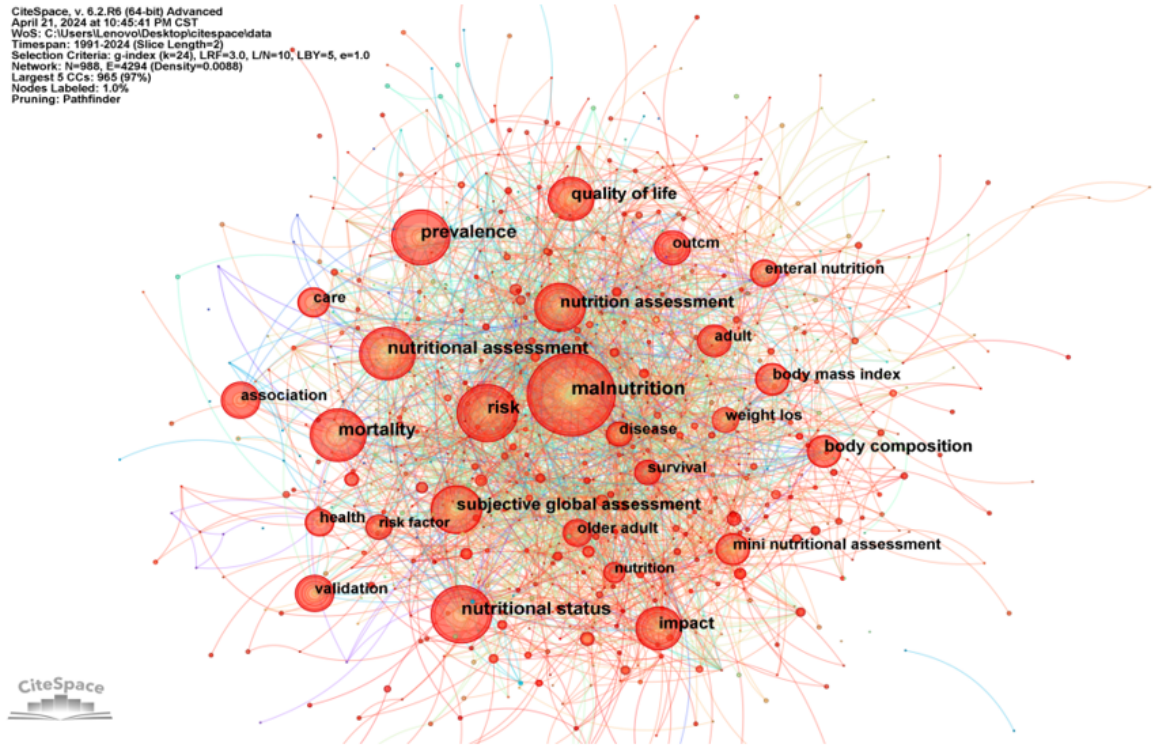

Figure 6. Co-occurrence mapping of keyword for nutritional risk screening and assessment from 1991-2024

Table 2. Top 20 high frequency keywords

Rank	Frequency†	High frequency keywords
1	2167	Malnutrition
2	1606	nutritional status
3	1357	risk
4	1332	mortality
5	1292	prevalence
6	1289	nutritional assessment
7	1076	subjective global assessment
8	1015	nutrition assessment
9	826	quality of life
10	770	impact
11	682	body composition
12	643	body mass index
13	637	older adult
14	612	association
15	585	outcm
16	571	weight lo
17	568	mini nutritional assessment
18	553	adult
19	548	validation
20	511	health

†"Frequency" refers to the number of times a particular item appears in the data set being analyzed.

'Malnutrition', 'Nutritional risk' and 'Nutritional assessment' were used as central nodes, and more links were distributed to connect other nodes to form a tandem relationship between the keywords. Table 2 shows the top 20 high-frequency keywords, of which the first high-frequency keyword is 'malnutrition'. Malnutrition, as a result of nutritional risk screening, is the main topic of concern for scholars in the field of nutritional risk screening and assessment. The articles are often based on the keyword, and the keywords with a frequency of more than 1,000 times include 'malnutrition', 'nutritional status', 'risk', 'mortality', 'prevalence', 'nutritional assessment', and 'subjective global nutritional assessment methods'. Hot keywords include nutrition assessment methods such as "simple nutrition assessment" and "subjective comprehensive nutrition assessment method", nutrition assessment indicators such as "nutritional status", "quality of life", "body composition" and "body mass index", and research object classification such as "adults" and "elderly people".

Keyword cluster analysis

In order to clearly describe the evolution of hotspots in the field related to nutritional risk screening and assessment, through keyword clustering, we obtained a total of 8 keyword cluster identifiers, as shown in Table 3. Meanwhile, the clustering modularity value Q = 0.453, and the clustering average profile value S = 0.715, indicate that this cluster mapping can well reflect the research content in the field related to nutritional risk screening and assessment. Various scholars have contributed to the field by focusing on areas related to nutritional risk screening and assessment from both nutritional management aspects and patient aspects. Converting the keyword clustering map into a TimeLine graph, Figure 7 shows a clearer view of the development of nutritional risk screening and assessment-related fields over time. On the left side of the graph, the year nodes represent the time when the cluster labels started to appear; on the right side of the graph, the names of the cluster labels are represented, and the horizontal axis represents the time interval. The results show that in 1991-1995, scholars began to focus on this area: 'body composition', 'body mass index', 'nutri-

Table 3. The first eight keyword clusters and their main keywords

ClusterID	Silhouette†	Year	Main Keywords
#0 older adults	0.653	2009	older adults; frailty; elderly; mini nutritional assessment; nutrition assessment
#1 nutrition assessment	0.635	2006	nutrition assessment; diet; obesity; children; overweight
#2 enteral nutrition	0.612	2013	enteral nutrition; parenteral nutrition; critical illness; nutrition support; intensive care unit
#3 cancer	0.69	2011	cancer; gastric cancer; chemotherapy; quality of life; head and neck cancer
#4 mucoadhesion	0.724	2013	mucoadhesion; neuroblastoma; expression; thiomers; 1-methylnicotinamide
#5 hemodialysis	0.777	2006	hemodialysis; chronic kidney disease; inflammation; peritoneal dialysis; subjective global assessment
#6 malnutrition	0.796	2005	malnutrition; nutritional status; hospital malnutrition; nutritional screening; length of stay
#7 body composition	0.798	2008	body composition; phase angle; bioelectrical impedance analysis; sarcopenia; bioelectrical impedance

†"Silhouette" is a metric used to evaluate the quality of clustering.

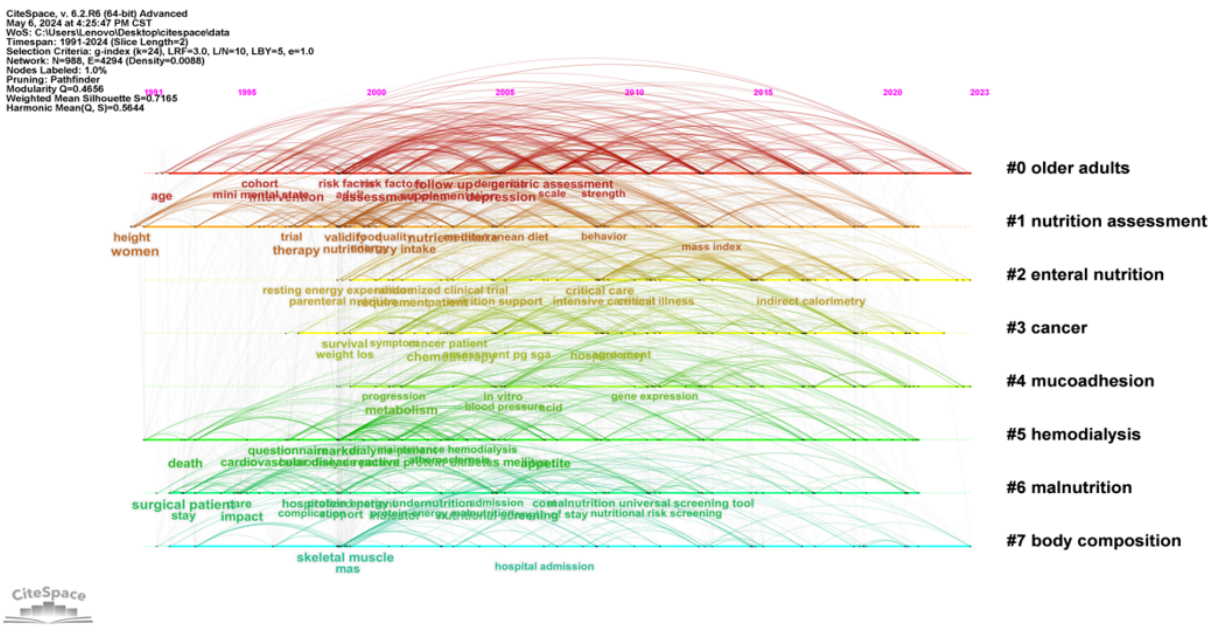

Figure 7. Timeline mapping of keywords for nutritional risk screening and assessment from 1991-2024

tional status', 'malnutrition', etc. In 1996-2000, scholars began to focus on: 'children', 'the elderly','adolescents', 'simple nutritional assessment', 'subjective and comprehensive nutritional assessment methods', etc. From 2001 to 2005, various scholars began to pay attention to: 'overweight', 'nutritional intake', 'cancer patients', 'nutritional risk', 'nutritional support' and so on. In 2006-2010, scholars began to focus on: 'Vitamin D', 'Calcium', 'Clinical Practice', 'Nutrition Support' etc. From 2011 to 2015, various scholars began to pay attention in this field: 'gastric cancer', 'dietary assessment', 'comprehensive nutrition assessment' and so on. 2016 - 2020 Scholars in this area will focus on: 'Nutritional Risk Scoring for Critically Ill Patients,' 'International Community,' 'Functional Recovery,' 'Indirect Calorimetry' etc. 2021 - 2024 Scholars in this area will begin to focus on : 'Public Health', 'New Crown Pneumonia', 'Postoperative Recovery','Adjuvant Chemotherapy' . This shows that research in the area of nutritional risk screening and assessment has changed over time.

Keyword emergence analysis

Comprehensively analysing the emergence of keywords in a certain period of time can get the latest research dynamics of the subject area and identify the research frontiers of this subject area. The emergent terms in the literature were identified and ranked in order to obtain Figure 8. There are 25 emergent keywords between 1991 and 2024, starting as early as 1993 and ending as late as 2024. The three terms with the highest intensity of emergence are 'nutritional assessment', 'diagnosis', and 'chronic renal failure'. Words with a duration of more than 10 years include 'nutritional assessment', 'ethnic group', 'serum albumin', 'body weight', 'surgical patient', 'disease', 'chronic renal failure', 'haemodialysis patient', 'protein', 'men', 'food frequency table', 'Plasma', 'peritoneal dialysis', 'protein-energy malnutrition', 'total parenteral nutrition' and 'atherosclerosis'. It shows that since the emergence of these sudden words, they continue to become the forefront of the research field. 'Global Leadership Initiative on Malnutrition', 'diagnosis', 'criteria', 'sarcopenia' and 'Clinical Nutrition' are five emergent terms that will continue to be used until 2024 and can be considered to represent topics at the forefront of the field related to nutritional risk screening and assessment. Among these five emergent terms, 'diagnosis' has a higher intensity of mutation and the longest duration of mutation, and is the most popular and cutting-edge topic that experts and scholars are most concerned about.

DISCUSSION

General information

In this study, we searched 10,632 articles from the Web of Science database that met the inclusion criteria. The overall number of articles in the field maintains a steady growth trend, which can be divided into three stages, namely, the budding stage, the rapid development stage and the stable development stage, and is currently in the stable development stage. A possible explanation for this is that, as society has developed and medical technology has advanced, there has been an increase in awareness and interest in nutritional risk screening and assessment.[30] The overall number of publications in the nascent stage is low, and most of the research on nutritional risk screening and assessment by scholars in various countries is in the exploratory stage. Scholars have devoted more attention to malnutrition's negative effects and the study of nutritional risk screening and assessment tools.[31] They have

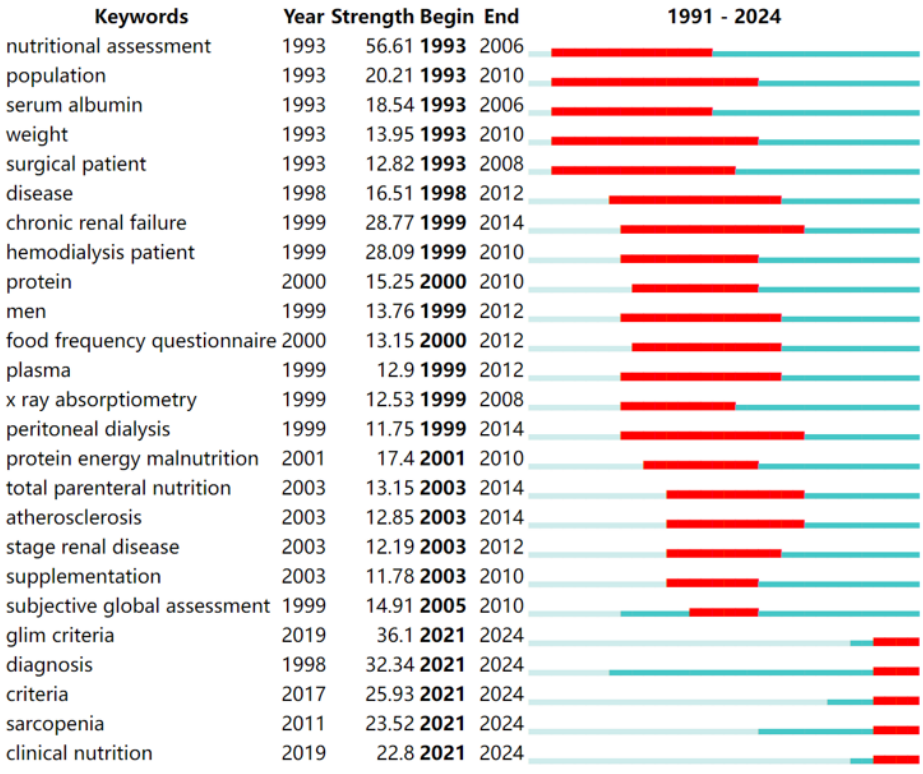

Figure 8. Highly emergent keywords for nutritional risk screening and assessment from 1991-2024

proposed methods such as MUST,[13] NRS 2002,[11] SGA.[22] The cross-sectional survey of Nutrition Days conducted in 2007-2008 revealed that only half (53%) of the 325 hospitals in 25 European countries and in all regions had routine screening available.[32] The field has entered a phase of rapid development since 2008, with the annual cumulative number of articles showing rapid growth. This may be due to the fact that scholars are becoming aware of the lack of nutritional risk screening and assessment in hospitals,[32] and have started to continuously explore the application of nutritional risk screening and assessment tools in different diseases and actively explore the diagnostic criteria for malnutrition.[18, 25] From 2020 to the present, the field is in a stable development phase, with a consistently high number of annual publications. The development of the field of nutritional risk screening and assessment during this period has shown a positive trend and has attracted a lot of attention, which also demonstrates the significant increase in the value of its practical application. Studies have shown that individualised nutritional support improves important clinical outcomes in patients, so screening for nutritional risk on admission and providing nutritional assessment and individualised nutritional support to patients at nutritional risk is necessary.[33] Scholars in various countries have not only enriched the theoretical system of nutritional risk screening and assessment but also explored and optimised the methods and tools of nutritional screening and assessment through clinical practice to improve their accuracy.[34]

Research subjects and co-operation

Analysing the cooperation between countries in the literature reveals that the United States leads the international development of the field related to nutritional risk screening and assessment, both in terms of the number of publications and the centrality of the literature. This may be due to the strong economic power of the United States and the continued high level of investment in healthcare.[35] The study notes that the U.S. spends more than $4.4 trillion on health in 2022 for the entire year, and $10,805 per capita on health care. These investments provide a solid foundation for U.S. institutions and scholars to innovate and develop in the field of nutritional risk screening and assessment.[36] Although China ranks second in terms of the number of articles issued, it has a low centrality, indicating that China has less cooperation with foreign countries and should appropriately strengthen its cooperation with other countries or regions. Extensive international cooperation not only helps to improve the researchers' scientific level but also facilitates the sharing of resources and the output of high-quality research results, which can improve the overall level of research in this field. In terms of institutions, the University of São Paulo and Karolinska Institutet have high centrality and volume of publications, with the top 5 institutions accounting for 5.5% of the total volume of publications. The highest centrality of institutions is the centrality of the Brigham and Women's Hospital (0.11), but only one institution has a centrality of more than 0.1, which is a good indication of the lack of inter-institutional cooperation. The centrality of a research institution reflects not only its influence and control of resources in the research network but also indirectly its ability to promote interdisciplinary and inter-institutional collaboration.[37] So although some institutions (e.g. University of São Paulo, Karolinska Institutet) excel in terms of the volume and centrality of publications, as a whole, the level of inter-institutional cooperation still needs to be improved, and different modes of inter-institutional cooperation can be explored according to research needs.

Progress in research

We obtained a total of 18 keyword cluster labels through cluster analysis of co-cited literature, of which the top 10 clusters included: #0 global leadership initiative, #1 malnutrition criteria, #2 hospital admission, #3comparative analysis, #4 COVID-19 patient, #5 controlled population study, #6 elderly Taiwanese, #7 physical frailty, #8 ill patient, #9 lean body mass. Nutritional assessment methods, nutritional assessment indicators, patient characteristics (e.g., disease suffered, region, physical condition), and survey research methods were covered in the first 10 clusters. Scholars around the world are researching the field of nutritional risk screening and assessment from different aspects, actively enriching the research content of the field and filling the research gaps in the field from multiple perspectives. Scholars have been continuously exploring and optimising nutritional assessment methods and indicators to improve their accuracy and provide a theoretical basis for individualised nutritional interventions.[38] The high level of attention to patient characteristics while optimising methods and indicators reflects the importance scholars place on individual differentiation. Nutritional needs may vary from patient to patient depending on the disease they suffer from, their physical condition and the region they live in. This view is consistent with the study of Ruan X et al. who compared the sensitivity, specificity and likelihood ratios of MNA, NRS 2002, and SGA in adult cancer patients and concluded that PG-SGA is more convenient and has the best diagnostic efficacy in the diagnosis of malnutrition in cancer patients.[39] The results of a cross-sectional study in Taiwan also suggest that MNA performs well in predicting functional decline in older adults and that this nutritional risk screening tool can be used over time in clinical, long-term care and community settings.[40] Scholars have used a variety of research methods to identify more convenient and accurate nutritional risk screening and assessment tools for each disease. The aim is to quickly and easily provide patients with nutritional risk screening and assessment, to provide accurate nutritional interventions for patients and to reduce the negative impact of malnutrition on patients.[41]

Research hotspots

Keywords such as "malnutrition" and "nutritional status" are more frequent in the literature. The keyword timeline chart shows that the focus of scholars in this area has shifted from the broad concepts of nutrition management, such as ‘malnutrition’, ‘nutrition assessment’ and ‘nutritional status’ to methods of screening and assessment of nutritional risk, such as ‘simple nutritional assessment’, ‘subjective comprehensive nutritional assessment methods’ and so on. Then it was gradually refined to ‘adoles-

cents', 'the elderly', 'cancer patients', and 'vitamin D' etc. for patients with specific physical conditions and different diseases. Nutritional management for patients with different health conditions and diseases.[42-44] Over time, research in this area has crystallised, focusing more on screening and assessing nutritional risk in the progression of a patient's disease versus in different disease categories. This result is consistent with trends in the field of nutritional risk screening and assessment. While expert clinical judgement is one of the reference standards for diagnosing malnutrition, the use of simplified nutritional risk screening tools can contribute to better and faster screening and assessment of nutritional risk.[42] 'GLIM', 'Diagnosis', 'Standards', 'Sarcopenia' and 'Clinical Nutrition' are five emerging terms that will last until 2024 and can be considered to represent cutting-edge topics in areas related to nutritional risk screening and assessment. The study concluded that the GLIM criteria accurately identify the occurrence of malnutrition in hospitalised patients can detect higher prevalence and severity of malnutrition, have high sensitivity and specificity, and are in good agreement with other nutritional risk screening tools and assessment methods.[45] However, ZHOU L et al. concluded that when comparing the prevalence of malnutrition among four instruments (GLIM, SGA, PG-SGA, PNI) among oncology patients, although PG-SGA had a high concordance with GLIM but GLIM showed the lowest prevalence of malnutrition.[46] The GLIM criteria and their accuracy in screening malnourished patients have been described from several perspectives, but they have limitations for different diseases.

Our study also has some limitations. First, the data we analysed were extracted only from the WoS core database and did not incorporate data from other databases, which may lead to an underrepresentation of the literature. Second, since English is still the language of choice for academic journals, our study focuses only on papers published in English, thus leaving out articles published in other languages.

Conclusion

In summary, we have shown other researchers the trends and their characteristics in the field of nutritional risk screening and assessment through CiteSpace software and bibliometric analyses. Currently, researchers continue to pay keen attention to this field, but there is not a close collaboration between institutions and authors in the process of research. As research has progressed, the field has become more specific, focusing more on trends in patients' disease progression. We also analysed topics at the forefront of research, representing future research trends.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURES

All authors declare no conflict of interest.

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