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Original Research

Analysis of hotspots and emerging trends in school foodservice research using CiteSpace

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ABSTRACT

BACKGROUND/OBJECTIVES: The school foodservice is a facility that offers catering services to students and exerts a significant influence on their well-being and academic performance. Hence, it is crucial to comprehend the present global research status and development trends of school foodservice over the last decade, investigate their future direction of progress and enhancement strategies, offer guidance to school canteen managers and policymakers, and foster the wholesome advancement of school foodservice.
MATERIALS/METHODS: The Web of Science™ (WoS) core collection was utilized as the data source to search for publications pertaining to the topics of school foodservices, school meals, and school foodservice/cafeterias. Subsequently, the CiteSpace software, a widely used tool for the visual exploration of scientific literature, was used for a visual study of the literature published on the topic.
RESULTS: A total of 1,500 papers published between the years 2013 and 2023 were selected from the WoS core collection and analyzed using CiteSpace. The research findings indicated that the primary areas of interest since 2013 in overseas research on school foodservice were centered around concerns regarding food quality, food waste, operational models including new methods and the correlation between coronavirus pneumonia and other related factors.
CONCLUSION: Future studies should focus on the utilization of emerging technologies, global efforts, and the development and implementation of policies and regulations on food safety in school foodservice. This will offer both theoretical backing and practical direction for advancing the sustainable development of school foodservice.

Keywords: Food; schools; trends

INTRODUCTION

The school foodservice is an essential component of school logistics support and an integral part of the life of students, with teachers and students gathering here for their regular meals. When a food safety problem occurs on campus, it has a negative impact not just on the health

Conflict of Interest
The authors declare no potential conflicts of interests.

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of the children but also on the school's progress, in addition to diminishing its credibility as well as that of the government [1,2]. Consequently, it is critical to maintain control over the meals provided in school canteens to ensure hygiene management and prevent disease. Food safety incidents occur when there are problems in the procurement of raw materials and food processing in the canteen [3].

According to the Food Hygiene Monitoring Report of China's State Administration for Market Regulation, 70% of public health emergencies occur on school campuses in China, many of which are related to food hygiene and infectious diseases [4]. For instance, in November 2021, diarrhea and vomiting were reported, affecting over 30 pupils at a middle school in Fengqiu, Henan Province [5]. A food safety incident involving a 'rat head and duck neck' occurred at a school in Jiangxi in June 2023. In October of the same year, a student at a university in Tangshan, Hebei Province, found a foreign object in his meal that was thought to be a rat head. These incidents provoked significant public concern for the safety of the students. Consequently, the Food Safety Office of the State Council of China interviewed the chief executives of the Tangshan and Nanchang People's Governments, and they assured the public that the Party Central Committee and the State Council gave great importance to food safety work in schools and that ensuring food safety is an important people's livelihood project.

Furthermore, in 2019, the State issued the "School Food Safety and Health Management Regulations" to improve the overall quality of school foodservice in China. The "Nutrition and Healthy School Construction Guidelines" were released in 2021 by the Ministry of Education, the National Health Commission, and 4 other departments. It is thus clear that China values school food quality and safety, and many representative studies have shown this. Nevertheless, recurring food safety incidents in various school foodservice have raised significant concerns among the general public. Consequently, a thorough examination of the hotspots and global trends in school foodservice-related research is crucial and would go far in supporting research and development regarding school foodservice in China, in conjunction with the conditions there.

Based on this background, this study used the CiteSpace software to conduct a visual analysis of relevant research documents related to school foodservice retrieved from the Web of Science™ (WoS) core collection database. This analysis aimed to provide guidance for future research in this field and to systematically identify the relevant research hotspots and development trends in the field of school foodservice globally, and provide guidance and direction for project implementation.

MATERIALS AND METHODS

Data sources and retrieval methods

Utilizing CiteSpace 6.1.R6 (CiteSpace V software, Drexel University, Philadelphia, PA, USA), this study visualized and analyzed the current status and emerging hotspots of school foodservice research spanning the 10 yrs from November 1, 2013, to November 1, 2023. The software, a scientometric tool, leveraged keyword co-occurrence, subject word clustering, and other methodologies to visually map the knowledge structure within this field. Drawing from the WoS core collection database, the study meticulously examined 1,500 academic publications in English related to school foodservice, encompassing topics like nutrition standards, food safety, dietary innovations, student satisfaction, and their collective impact

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on health and academic performance. To ensure data accuracy, topics not related to school food service are strictly excluded were rigorously excluded, and keywords and search strategies were refined to account for geographical nuances and compile a comprehensive and detailed literature corpus. The data acquisition process adhered to legitimate means, fostering wide accessibility, and transparency, and laid a solid foundation for further research into school foodservices.

A chart and visual graph analysis of authors, institutions, keywords, countries, cited documents, etc. of the selected literature was conducted. The global research trends pertaining to school foodservices, current status and future possibilities were analyzed.

RESULTS

Trends in the number of publications over a 10-yr period

Literature published in peer-reviewed journals across the world is an important form of recording the results of scientific research. The understanding of the trends in the development of the topic under consideration over time is facilitated by a statistical analysis of the papers published in that field during the specified period [6]. **Fig. 1** shows the number of articles published annually on school foodservices after a statistical analysis. The line depicts the general trend in the total number of articles published in English over the 10-yr period. As a whole, the number of published documents has shown steady growth, with a rapid upward trend after 2014. From 2015 to 2018, the number of published articles has been relatively stable. In 2021, there were 209 articles published.

Geographical distribution of the publications

During the study period, 519 articles on school foodservice were published by the United States of America (USA), 163 articles by Brazil, 117 articles by Australia, 110 articles by the United Kingdom (UK), and 95 articles by Spain. This demonstrates that these countries have contributed significantly to scientific research on this topic. A total of 48 articles were

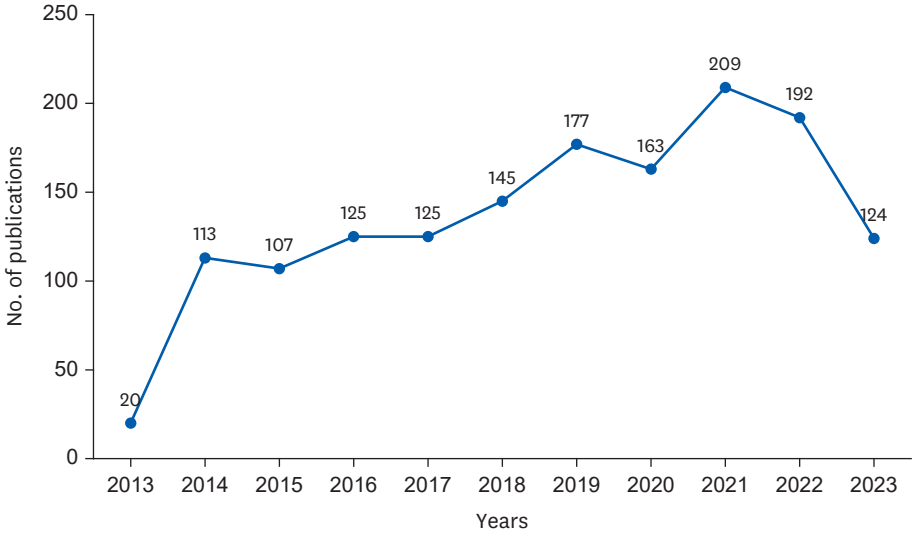

Fig. 1. Trends in the number of annual publications in the field of school foodservices from 2013 to 2023. Data as of November 2023. Based on CiteSpace ranking and plotting of the number of papers published by institutions.

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Table 1. National betweenness centrality of school cafeteria research literature from 2013 to 2023

Ranking	Frequency	Cooperation degree	Centrality	National
1	519	22	0.44	United States of America
2	163	11	0.06	Brazil
3	117	12	0.09	Australia
4	110	20	0.36	England
5	95	9	0.05	Spain

published by China. Compared to other countries, there were fewer articles published from China, and this indicates inadequate research by Chinese researchers in this field. Furthermore, the USA had a relatively high betweenness centrality (0.44) and the UK had the second highest betweenness centrality (0.36), indicating that USA and UK play a significant linking role in the study of school foodservice compared to other countries (**Table 1**).

Analysis of the collaboration network of researchers

Analyzing the author collaboration network in a field helps us understand the core research teams involved in the field and the core themes of their work. As per the author collaboration network map, each collaboration network is relatively close, with a density of 0.0029 (N = 465, E = 311), indicating a low coupling relationship and high cohesion and that researchers usually conducted their work in small groups.

The highest number of papers were published by Prof. Luke Wolfenden (23 articles), University of Newcastle, Australia, followed by Delaney, Tessa (19 articles), University of Newcastle, Australia, Yoong, Sze Lin (18 articles), Deakin University, Australia, Wyse, Rebecca (15 articles), Wyse, Rebecca (15 articles), University of Newcastle, Australia (**Fig. 2**, **Table 2**).

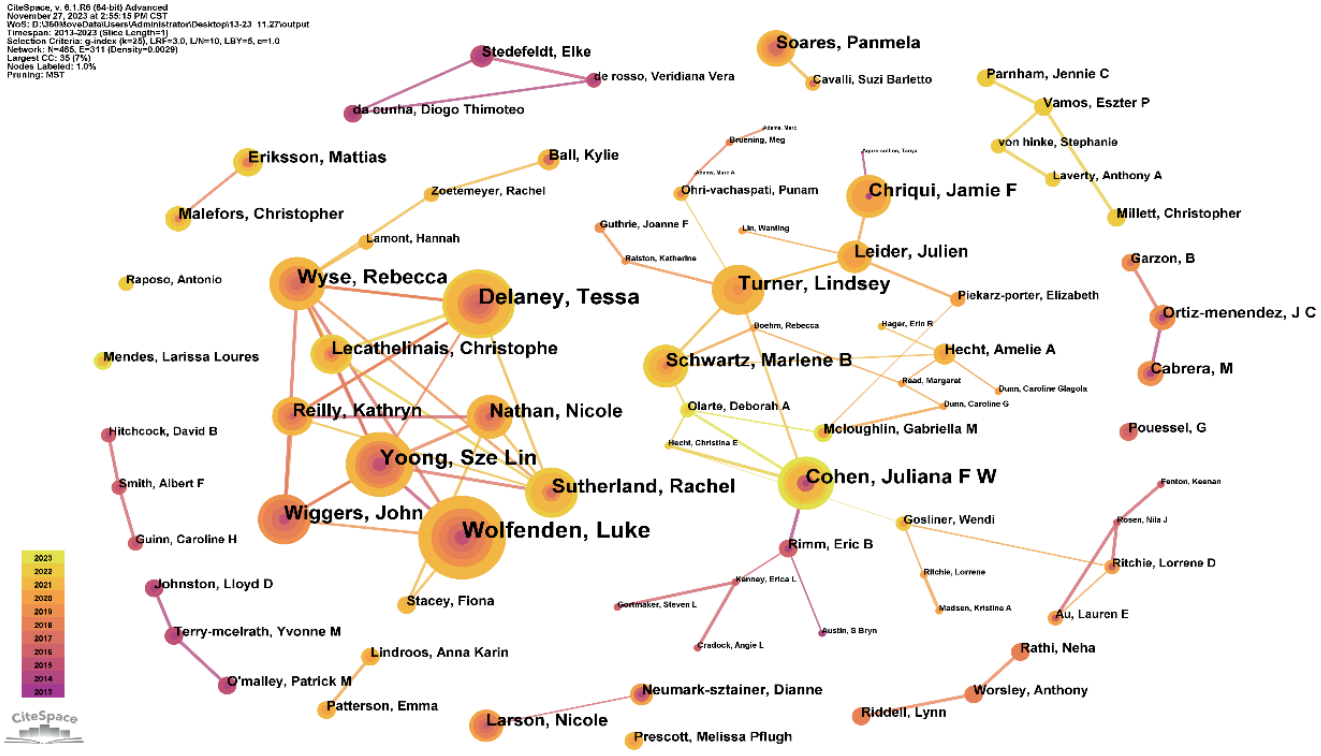

Fig. 2. Collaboration network of researchers on school canteen research literature from 2013 to 2023. 'N' is the node representing the number of keywords, and 'E' is the line representing the keywords that appear together in the same document. CiteSpace software generates a map of the co-occurrence analysis of researchers.

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Table 2. Cooperation list of researchers on school canteen research literature from 2013 to 2023

Ranking	Frequency	Cooperation degree	Years	Researchers
1	23	4	2015	Wolfenden, Luke
2	19	5	2016	Delaney, Tessa
3	18	11	2015	Yoong, Sze Lin
4	15	8	2017	Wyse, Rebecca
5	15	4	2014	Cohen, Juliana F W

Analysis based on the institutes involved in the research

The institutions researching school foodservice were mainly higher education institutions. As shown in **Table 3**, a total of 113 institutions participated in publishing research in this field. Among them, Deakin University, Australia (47 articles), the University of Newcastle, Australia (32 articles), the University of Illinois, US (28 articles), and the University Fed Santa Catarina University of Brazil (24 articles) have relatively large nodes. This indicates that these 4 institutions have invested significant resources in scientific research in this area and have published a notable number of articles. **Fig. 3** shows research institutions working on school foodservice-related research and the connections between them, which are indicative of the cooperative relationships between universities. Deakin University and University of Newcastle

Table 3. Institutional cooperation table for school canteen research literature from 2013 to 2023

Ranking	Frequency	Cooperation degree	Centrality	Institutional
1	47	9	0.25	Deakin University
2	32	5	0.03	The University of Newcastle
3	28	4	0.03	University of Illinois
4	24	3	0.05	Universidade Federal de Santa Catarina
5	24	3	0.01	Harvard T.H. Chan School of Public Health

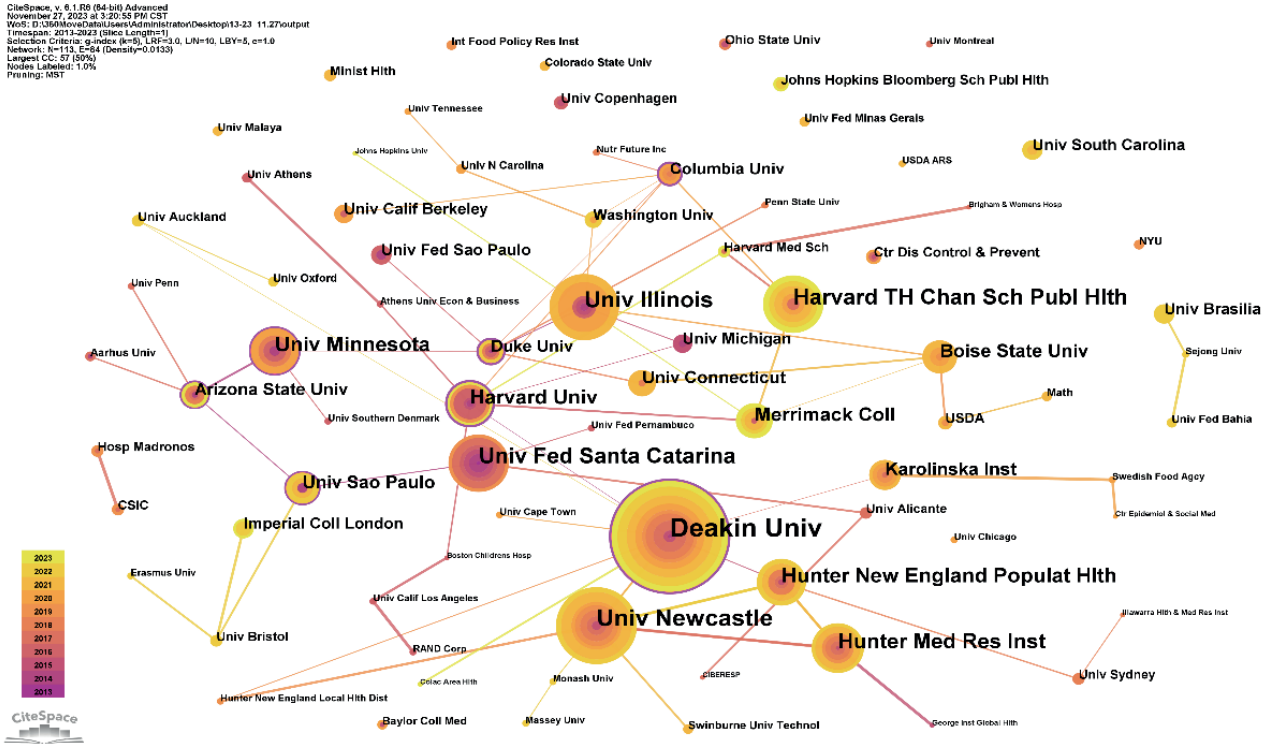

Fig. 3. Cooperation network of school canteen research literature research institutions from 2013 to 2023. 'N' is the node representing the number of keywords, and 'E' is the line representing the keywords that appear together in the same document. CiteSpace software generates a map of institutional co-occurrence analysis.

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in Australia and University of Illinois, and the Harvard T.H. Chan School of Public Health in the US appear to be working closely together, indicating that there is internal collaborative research in this area.

Analysis of frontiers and hotspots in school canteen research

Research hotspots have attracted the widespread attention of scholars over time.
The clustering of highly cited documents can reflect the most important issues related to school foodservice [6]. Keyword clustering is a collection of words related to the subject of the research, which can show the connections between the subject areas represented by the document collection [7]. Keyword cluster analysis can help further investigate hotspots and changing trends. Research fronts are composed of a collection of frequently cited documents in each cluster, which represents the current status of cutting-edge ideas in this hot field [7]. Through the clustering map analysis of co-citations of documents and keywords, one can understand the frontiers and hotspots of school foodservice research globally.

Analysis of keywords in literature on school foodservice

Cluster analysis was done on the database's core set using keywords as nodes. Seven clusters were created in all when the node measurement threshold (g-index = 10) was chosen (**Fig. 4**).

The statistical analysis as seen in the picture demonstrated that the clustering structure is considerable, with a Keyword Cluster Map Modularity (Q) value = 0.4076 (> 0.3), means that the divided structure is significant, Silhouette (S) value = 0.745 (> 0.7), indicates a measure of how similar an object is to its own cluster compared to other clusters, and total network

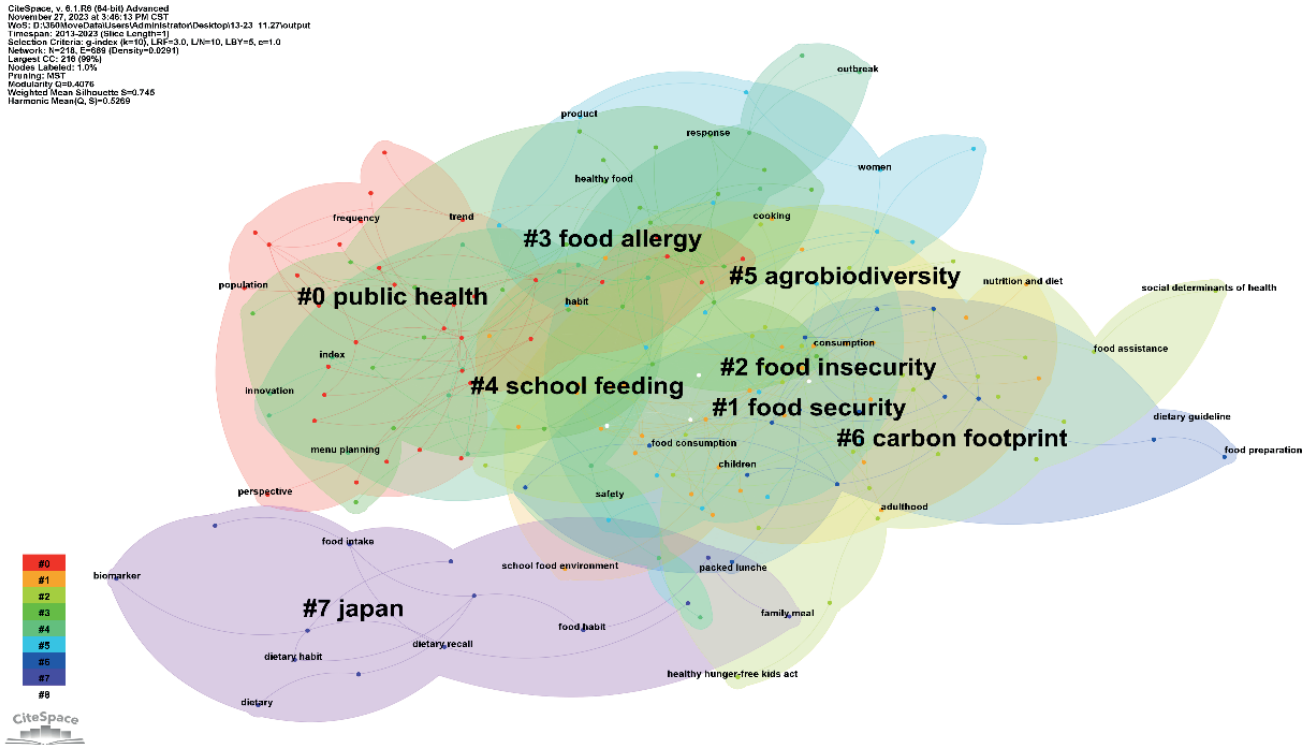

Fig. 4. Keyword map of school canteen research from 2013 to 2023. The Q value represents the module value of the Q clustering graph and the S value represents the mean silhouette value. The numbers represent cluster numbers, and the colors are used to distinguish different clusters. CiteSpace software analyzes keyword co-occurrence to form a graph.

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density = 0.0291. Additional examination of the keyword clustering map data revealed that, since 2013, the following have been the primary areas of study interest on the subject of school foodservice: #0 public health, #1 food security, #2 food insecurity, #3 food allergy, #4 school meals, #5 agrobiodiversity, #6 carbon footprint, #7 Japan. This demonstrates how several cluster groups are strongly homogeneous and how credible this cluster is. The importance of the study field increases as the number of keywords included in the cluster increases and the cluster label value decreases.

Literature co-citation timeline clustering and clustering analysis

Fig. 5 presents a co-citation cluster analysis of the literature to pinpoint important themes and research paths within a discipline. The knowledge structure of the field is revealed by this technique, which is predicated on the grouping of literature with comparable citation links [8]. Dynamic research trends are reflected in highly cited articles, and themes can be integrated and highlighted by grouping these publications. In addition to assessing the caliber of the literature, the quantum of citations indicates the level of popularity of the topic. The findings are shown as a cluster map, wherein the labels represent study directions, lines represent co-citation links, and nodes represent the body of literature. The data presented in **Fig. 5** reveals that the Q value of the map, which represents the clustering module value, is 0.730, exceeding the threshold of 0.3. Similarly, the S value, which represents the clustering average silhouette value, is 0.918, surpassing the threshold of 0.7. Additionally, the overall network density is calculated to be 0.0144. These findings indicate that the cluster structure is highly significant and possesses strong credibility.

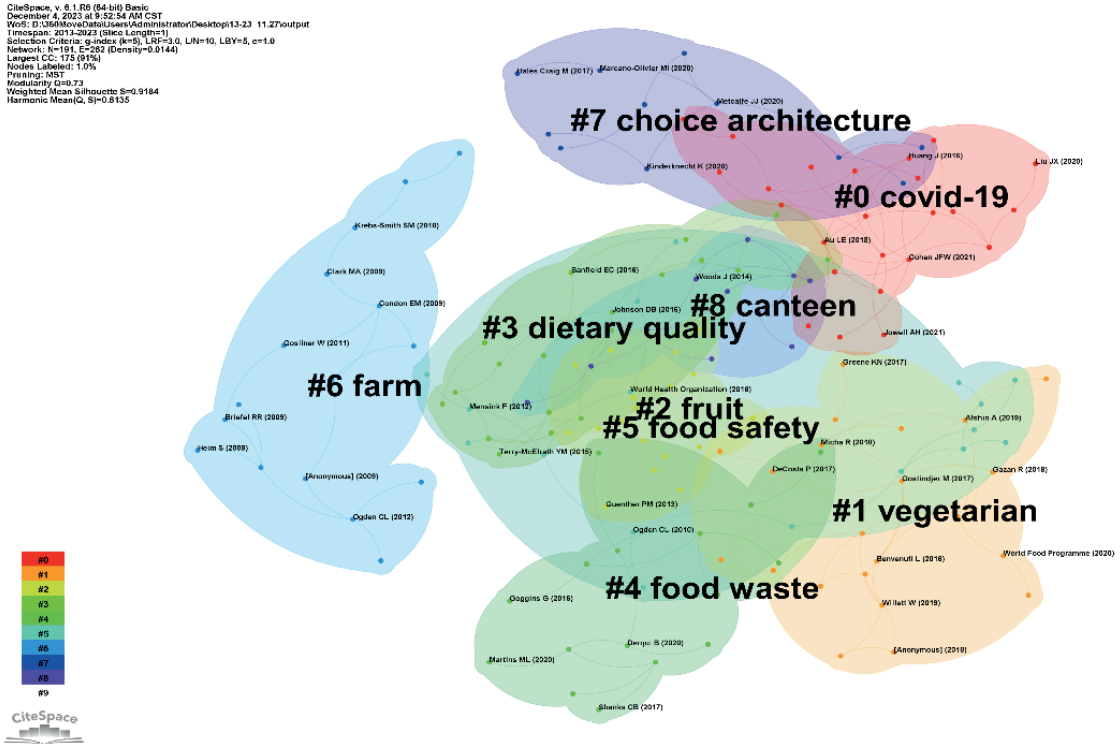

Fig. 5. Cluster diagram of co-citations of school canteen research documents from 2013 to 2023. The Q value represents the module value of the Q clustering graph. The S value represents the mean silhouette value. The numbers represent cluster numbers, and the colors are used to distinguish different clusters. CiteSpace software generates a graph for document co-occurrence analysis.

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A timeline graph of document citations, depicted in **Fig. 6**, illustrates how the popularity, impact, and direction of the field have changed throughout time. The timeline nodes show the citation time, the size shows the frequency, and the trend shows the direction of the trend. Documents within a cluster are arranged horizontally in the co-citation network timeline graph, and the cluster's relevance grows as the number of documents in the cluster increases. The changes in the color tone correspond to variations in the citation time, and each line represents a cluster that is ordered by the number of articles in descending order [9]. A more thorough grasp of the discipline's frontier dynamics and development status can be obtained by combining the document citation timeline graph and document co-citation clustering. The lines of the timeline graph and the nodes under each topic clearly show how linked papers have been cited over the years. These dynamic shifts shed light on research trends and the direction that foodservice academia is taking. **Fig. 6** shows that the history of foodservice development can be broken down into 3 phases (I to III). Phase I: Beginning and budding stage (2009–2013). This stage saw the first appearance of several novel subjects. Even though the literature citations were few, this signaled the low-key beginning of research in these areas and the academic community's steady concentration on these subjects. It is especially important to note that subjects like "#5 Food Safety" and "#6 Farm" have steady literature citations, demonstrating the ongoing research hotspot status of agricultural production and food safety in the foodservice industry. Phase II: Expansion and affluence (2014–2019). Research in several domains has sparked a period of notable expansion over time. Topics like "#1 Vegetarian" and "#2 Fruit" have become the new favorites for research due to the overall growth in health consciousness, and a significant stream of literature examining their potential for market and health benefits has emerged. The growing issue of

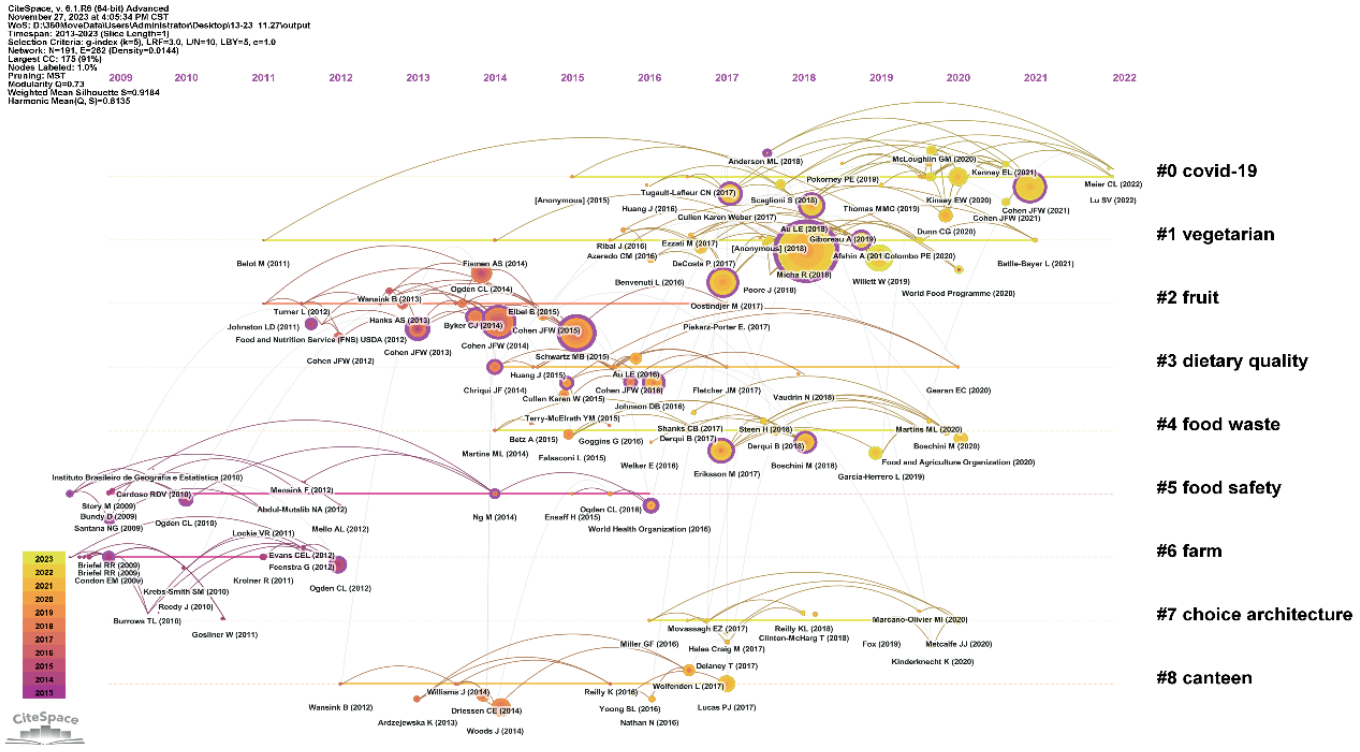

Fig. 6. Network timeline of total citations of school canteen research from 2013 to 2023. The Q value represents the module value of the Q clustering graph. The S value represents the mean silhouette value. The numbers represent cluster numbers, and the colors are used to distinguish different clusters. CiteSpace software analyzes the timeline of literature citations to form a map.

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"#4 Food Waste" has also garnered a lot of attention, and pertinent research has thoroughly examined the causes, effects, and mitigation techniques of food waste. Phase III: Focus period on hotspots (2020–2022). The coronavirus disease 2019 (COVID-19) pandemic has drastically altered the field of school foodservice research study in recent years. The significant effects of "#0 COVID-19" on the food supply chain, agricultural productivity, food safety, and eating habits have made it the subject of much discussion in academia. It has swiftly emerged as the top research hotspot. Furthermore, the growing area of "#7 Choice Architecture" has garnered a lot of attention because of the shifts in eating habits brought on by social isolation and working from home during the pandemic. The goal of research is to determine how environmental design influences people's decisions regarding healthy eating. "#3 Dietary Quality" and "#5 Food Safety" are not exclusive foci, but they nevertheless have a lot of research momentum and advance the subject of school foodservice.

Research co-citation analysis and emergence analysis

Nodes experiencing an abrupt spike or fall in utilization are referred to as emerging citations. These nodes typically indicate a shift in a particular field of study [9]. Examining the formation of document co-citation networks can help investigate the evolutionary path and growth patterns of focal areas in this area of study [10], thereby forecasting potential research areas for the future. Hence, this study performed a spontaneous examination of the referenced literature (**Table 4**) and discovered that the forthcoming research directions for school canteen services could be categorized into the initial period focused on children's dietary habits, while the subsequent phase focused on sustainable food development thereby exhibiting a discernible shift in research focus. During the initial period, the primary focus of research was on children's dietary habits, types of meals consumed by children, and

Table 4. Research co-citation analysis and emergence analysis

References	Year	Strength	Begin	End	2013–2023
Ogden CL, 2012, *JAMA*, V307, P483, DOI 10.1001/jama.2012.40	2012	8.18	2013	2015	
Briefel RR, 2009, *J Am Diet Assoc*, V109, PS91, DOI 10.1016/j.jada.2008.10.059	2009	5.99	2013	2014	
Condon EM, 2009, *J Am Diet Assoc*, V109, PS67, DOI 10.1016/j.jada.2008.10.062	2009	5.99	2013	2014	
Cohen JFW, 2013, *Am J Prev Med*, V44, P114, DOI 10.1016/j.amepre.2012.09.060	2013	7.41	2014	2018	
Cohen JFW, 2012, *J Acad Nutr Diet*, V112, P927, DOI 10.1016/j.jand.2012.01.015	2012	5.29	2014	2017	
Cohen JFW, 2014, *Am J Prev Med*, V46, P388, DOI 10.1016/j.amepre.2013.11.013	2014	12.58	2015	2019	
Ogden CL, 2014, *JAMA*, V311, P806, DOI 10.1001/jama.2014.732	2014	11.02	2015	2018	
Hanks AS, 2013, *J Pediatr*, V162, P867, DOI 10.1016/j.jpeds.2012.12.031	2013	5.45	2015	2018	
Schwartz MB, 2015, *Child Obes*, V11, P242, DOI 10.1089/chi.2015.0019	2015	11.49	2016	2020	
Hawkes C, 2015, *Lancet*, V385, P2410, DOI 10.1016/S0140-6736(14)61745-1	2015	5.84	2016	2019	
Woods J, 2014, *Health Promot J Aust*, V25, P110, DOI 10.1071/HE14009	2014	9.88	2017	2019	
Driessen CE, 2014, *Obes Rev*, V15, P968, DOI 10.1111/obr.12224	2014	8.05	2017	2019	
Chriqui JF, 2014, *JAMA Pediatr*, V168, P279, DOI 10.1001/jamapediatrics.2013.4457	2014	5.79	2017	2019	
Cohen JFW, 2016, *J Acad Nutr Diet*, V116, P123, DOI 10.1016/j.jand.2015.07.019	2016	5.34	2017	2019	
Smith SL, 2014, *Public Health Nutr*, V17, P1255, DOI 10.1017/S1368980013001894	2014	5.30	2017	2018	
Byker CJ, 2014, *J Nutr Educ Behav*, V46, P406, DOI 10.1016/j.jneb.2014.03.009	2014	7.60	2018	2019	
Falasconi L, 2015, *Sustainability (Basel)*, V7, P14745, DOI 10.3390/su71114745	2015	5.61	2018	2020	
Cullen Karen W, 2015, *Prev Med Rep*, V2, P440	2015	5.57	2019	2020	
Oostindjer M, 2017, *Crit Rev Food Sci*, V57, P3942, DOI 10.1080/10408398.2016.1197180	2017	6.83	2020	2023	
Johnson DB, 2016, *JAMA Pediatr*, V170, P0, DOI 10.1001/jamapediatrics.2015.3918	2016	6.03	2020	2021	
Cullen Karen Weber, 2017, *Prev Med Rep*, V5, P82	2017	5.44	2020	2023	
Willett W, 2019, *Lancet*, V393, P447, DOI 10.1016/S0140-6736(18)31788-4	2019	9.22	2021	2023	
Micha R, 2018, *PLoS One*, V13, P0, DOI 10.1371/journal.pone.0194555	2018	7.17	2021	2023	
Kinsey EW, 2020, *Am J Public Health*, V110, P1635, DOI 10.2105/AJPH.2020.305875	2020	6.45	2021	2023	

CiteSpace software generates a graph by clustering the co-citations of documents. 'Year' indicates the year when the co-cited document first appeared, 'Strength' indicates the emergence strength, 'Begin' indicates the initial emergence time, and 'End' indicates the emergence end time. The red line in the figure represents the specific historical stage when the document became a research hotspot, light blue indicates that the document has not appeared yet, and dark blue indicates that the document has appeared.

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childhood obesity. The primary objective of these studies had been to investigate students' dietary preferences, eating habits, and their associations with health status. Currently, researchers are mostly dedicated to finding ways to offer healthier and more nourishing meals to students. The main goal is to help students develop positive eating habits and decrease the likelihood of obesity and other health issues. A study on personal hygiene, sanitation, and the food safety knowledge of food workers at a university food shops in Indonesia showed initiatives such as removing sugar-sweetened beverages and snack bars from school food shops, increasing à la carte selections, and reducing the frequency of serving French fries. These are worthwhile, as they minimize minimizing the consumption of low nutrient, energy dense foods. The increase in the availability of fresh fruit, whole grains, and a wider range of vegetables could result in added health advantages [11].

DISCUSSION

A network knowledge graph analysis of 1,500 domestic and international articles on school foodservice-related research included in the WoS core collection from 2013 to 2023 was carried out using the CiteSpace quantitative analysis software. Based on the data published annually, there has been a consistent upward trend in the number of articles published over the past decade. The United States (US) ranked first in the number of articles published, with 519 articles, is among the countries that initiated school cafeteria operations as early as 1946 as a basic social charity initiative [12]. and implemented highly successful reforms compared to other countries. Following an extensive period of research, the nutrition services provided in primary and secondary schools in the US have established a relatively sophisticated and well-developed theoretical and practical framework aimed at promoting the nutritional and healthy growth of school pupils [13]. Research on this topic is notably prominent, as seen by the proportion of publications published, which is 34.6% of the total number of published articles. School foodservice in China were established later than those in the US. In 1987, China initiated its first school lunch program in Hangzhou [14]. However, there has been a surge in food poisoning cases in educational institutions in recent times, with school foodservice being identified as "high-risk zones" for such episodes. The recurrent incidents of collective foodborne illnesses among school pupils serve as clear evidence of significant deficiencies in the safety administration of school foodservice [13]. Hence, although there is a need to enhance the global impact of our nation's research on school foodservice, we should also strive to gain insights from valuable global findings to revamp the service quality of school, enhance school nutrition legislation, and fortify the development of pertinent laws and regulations for school foodservices. Based on our analysis, there are a significant number of researchers authoring relevant articles on the subject and there is a strong collaborative interaction among different globally. Co-citation emergent research has identified current research hotspots in the areas of eating patterns, types of diets, obesity, and the sustainable development of food. The analysis was conducted using keyword clustering, co-citation clustering, and timeline clustering techniques.

According to the keywords, the themes included in the published literature associated with school foodservices were public health, food security, food allergy, school feeding, agrobiodiversity, carbon footprint, and so on. School foodservice are public dining areas. Hence, public health issues are critical. For example, the hygiene and cleanliness of the school foodservice [15], food preservation and handling practices, and so on, all have an impact on student health. Food safety is a top priority for every catering company. The food

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served in school foodservice must be safe, wholesome, fresh, and compliant with all food safety laws [16]. Facilitating the provision of nourishing meals can enhance the cognitive abilities of students [17,18]. On the other hand, food insecurity can result in foodborne illnesses [19,20]. Some students may experience food sensitivities while consuming meals provided by school foodservices [21,22]. Consequently, this is a subject frequently discussed in the literature on school foodservice. Agrobiodiversity, which is frequently associated with food security and sustainability, may enhance crop resilience and productivity while also expanding the range of available food options [23]. Carbon footprint is a subject related to environmental conservation. School foodservice may mitigate their carbon footprints by implementing environmental conservation measures, such as minimizing food waste and using renewable energy sources [8,24,25]. The inclusion of "Japan" as a cluster in the school foodservice field analysis may indicate a specific research focus on Japanese practices, policies, or cultural/dietary differences impacting school foodservice, even if it does not dominate publications overall.

An extensive examination of the co-citation cluster analysis in **Fig. 5** and the literature citation timeline in **Fig. 6** reveals 3 central concerns in the field of school canteen research over the last 10 yrs, namely the quality of food, the issue of food waste and operational models, and the influence of the COVID-19 pandemic. These concerns collectively form a comprehensive analysis framework for studying the functioning and administration of school foodservice. The COVID-19 pandemic has brought increased public attention to the cleanliness and safety measures of school foodservice, leading to more research in this area [26-28]. Simultaneously, the correlation between vegetarianism, fruit consumption, and dietary excellence underscores the crucial function of school foodservice in fostering healthy eating habits among students. This encourages them to consistently develop new menu options and enhance nutritional equilibrium [29]. Furthermore, the utilization of terms like "choice architecture" and "canteen" indicates the deliberate planning and hands-on examination of school foodservice to enhance services and cater to the varied requirements of students [30].

Over time, the emphasis of the studies on school foodservice has progressively shifted towards the sustainable development of food. This encompasses the examination of methods to diminish food waste, enhance food use, and adopt more ecologically sustainable waste disposal practices. This alteration demonstrates the prioritization of environmental conservation and the promotion of sustainable growth in research. It also indicates that school foodservice is making efforts to fulfill society's demands for sustainability. A study on school lunch waste among middle school students in Boston, US determined that there is a significant amount of food being wasted by the students. In general, the students' intake of nutrients did not meet the guidelines set for school meals, and the items supplied were not accurate representations of the foods actually consumed [31]. The costs associated with discarded foods are high. If translated nationally for school lunches, roughly $1,238,846,400 is wasted annually in USA. Students would benefit if additional focus was given to the quality and palatability of school meals. Campus food sustainability projects in the USA have reportedly increased in recent years, spurred by campus audits that show food procurement and transportation contribute substantially to greenhouse gas emissions [32]. In Australia, student-led groups such as the Fair Food Challenge are working to create healthy, sustainable, and fair campus food systems [33]. The challenges and development path of school foodservice are reflected in the shifts in study focus during the 2 time periods mentioned above. Subsequent investigations need to continue to concentrate on these domains to furnish a more all-encompassing and profound comprehension to enhance

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school foodservice amenities and foster student health and welfare while accomplishing sustainable environmental objectives.

Given this context, this article presents a concise overview of the study patterns and future trajectories of school foodservice in the years to come, as outlined below: First, with the increasing focus on maintaining a healthy diet, there is a growing emphasis on ensuring the safety, healthiness [34,35], and nutritional value [36,37] of school foodservice. This entails offering a wider selection of nutritious food choices, such as vegetables, fruits, whole grains, and lean meats, while also tailoring menus to cater to the specific nutritional requirements of diverse students. In the future, as technology advances, we can expect to see a greater emphasis on personalized nutrition in school foodservice. This may involve the use of apps or digital platforms that recommend meals based on individual dietary needs, preferences, and health goals. Such an approach could help ensure that every student has access to a tailored nutrition plan that supports his/her well-being. Additionally, it would encompass enhancing the oversight of food safety to guarantee the cleanliness and excellence of food, as well as implementing cutting-edge techniques and technologies for quality control to enhance the caliber and effectiveness of school foodservices. Second, sustainability is a crucial focus for future study and development of school foodservice. This includes strategies such as minimizing food waste, employing eco-friendly packaging, utilizing renewable energy, and implementing other initiatives aimed at mitigating environmental harm. A previous study addressing the key challenges of the food system in the institutional catering industry agreed that a large amount of food waste occurs in school foodservice [38]. School meals also serve an educational purpose. Taking action at the school level gives the opportunity to raise awareness among young generations with regard to more sustainable food choices [39]. Furthermore, as science and technology continue to advance, the digitization and automation of school foodservice will emerge as a crucial area of development. This entails employing sophisticated food management systems to enhance the effectiveness and excellence of school foodservices, while also offering digital menu selection and ordering services to cater to the specific requirements of students. Research on the digitalization of business processes in the food services industry has emphasized that an efficient organization of these processes in food service enterprises can result in benefits in resource management, personnel, and financial and economic potential, ultimately enhancing the food security of the region [40]. Given the complexity of addressing issues like obesity and food sustainability, we can expect to see more collaboration between schools, government agencies, non-profit organizations, and private sector partners. These partnerships will facilitate the sharing of best practices, resources, and expertise, ultimately leading to more effective and impactful interventions in school foodservice.

Essentially, future research and development of school foodservice will prioritize health, safety, sustainability, digitization, intelligence, diversity, and inclusiveness. By addressing the needs of students, promoting healthy eating habits, and contributing to the sustainability of our food systems, school foodservice will continue to play a vital role in shaping the health and well-being of our youth.

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