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Food systems in higher education nutrition programs: evidence from a scoping review and a Brazilian case study

Sistemas alimentares em programas de Nutrição no ensino superior: evidências de uma revisão de escopo e de um estudo de caso brasileiro

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ABSTRACT

This paper aims to assess the evidence of food systems approaches in higher education Nutrition programs, identify knowledge gaps, and to present a case study from Brazil. We conducted a scoping review following systematic protocols and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews guidelines. To present practical evidence, we conducted a qualitative, cross-sectional, descriptive study with a national scope in Brazil, using a case study approach and an online crowdsourced mapping. The review identified 23 articles highlighting the need for systematic curriculum changes. Studies are recent and conducted in high-income countries, with a greater focus on curricula than on actual concrete practices. Integrative programs and practical applications in public health, healthcare, and food service with a systemic approach are proposed solutions. Qualitative data suggest incorporating garden-based learning, addressing food systems in internships, and promoting debates on food biodiversity and local producers. The case study identified 15 experiences, primarily extension actions. The results of the case study, based on Brazilian experiences, highlighted key debates on topics such as food security and sovereignty, food systems and sustainability, biodiversity, and planetary health. The methodologies involved integrated practices between disciplines – which are commonly configured in isolation – garden-based learning, and integrated research and extension projects with community participation. We emphasize that transdisciplinary approaches in Nutrition curricula are fundamental, as professionals must be aware of the complexities of the contemporary world, which include the development of sustainable and resilient food systems. This requires a more holistic vision of Nutrition, integrating

environmental, social, and economic dimensions to address current and future challenges. Involving faculty and students in these changes is essential for implementing systemic practices.

Keywords: Case study. Food systems. Higher education. Nutritionists. Scoping review.

RESUMO

Este artigo tem como objetivo avaliar as evidências de abordagens de sistemas alimentares em cursos de Nutrição do ensino superior e lacunas de conhecimento; e apresentar um estudo de caso do Brasil. Uma revisão de escopo seguindo protocolos sistemáticos e as diretrizes do Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews. Numa perspectiva prática, nós conduzimos um estudo qualitativo, transversal e descritivo, com escopo no Brasil, utilizando abordagem de estudo de caso com mapeamento online colaborativo. A revisão identificou 23 artigos destacando a necessidade de mudanças sistemáticas no currículo. Os estudos são recentes, desenvolvidos por países de alta renda, com foco mais em currículos do que em práticas concretas. Cursos integrativos e aplicações práticas em saúde pública, assistência médica e serviços de alimentação com abordagem sistêmica são soluções propostas. Dados qualitativos sugerem incorporar o aprendizado baseado em hortas, abordar sistemas alimentares em estágios e promover debates sobre biodiversidade alimentar e produtores locais. Um estudo de caso identificou 15 experiências, principalmente ações de extensão. Os resultados do estudo de caso, com base em experiências brasileiras, destacaram debates importantes sobre tópicos como segurança e soberania alimentar, sistemas alimentares e sustentabilidade, biodiversidade e saúde planetária. As metodologias aplicam práticas integradas entre disciplinas, comumente configuradas em isolamento, aprendizagem baseada em jardins e projetos integrados de pesquisa e extensão com participação da comunidade. Enfatizamos que abordagens transdisciplinares em currículos de Nutrição são fundamentais, pois os profissionais devem estar cientes das complexidades do mundo contemporâneo, o que inclui o desenvolvimento de sistemas alimentares sustentáveis e resilientes. Isso requer uma visão mais holística da Nutrição, integrando dimensões ambientais, sociais e econômicas para enfrentar os desafios atuais e futuros. Envolver professores e alunos nessas mudanças é essencial para o desenvolvimento de práticas sistêmicas.

Palavras-chave: Estudo de caso. Sistemas alimentares. Ensino superior. Nutricionista. Revisão de escopo.

INTRODUCTION

The science of nutrition has evolved over the years, driven by advances in evidence on nutritional issues, shifts in the prevalence of diet-related diseases, and transformations in perspectives on health and nutrition [1]. In this context, the “New Science of Nutrition” emerges as an alternative to traditional biomedical approaches, proposing guidelines that integrate sustainability and social determinants of health, while simultaneously incorporating a comprehensive view of food systems [2].

Food systems are essential for human and global well-being and are central to achieving the Sustainable Development Goals [3]. The United Nations (UN) Conference on Sustainable Development (Rio+20) in 2012 and the Food and Agriculture Organization (FAO) panel of experts on Food and Nutrition Security (FNS) pointed out the need to transform food systems worldwide, to ensure sustainable food security and nutrition for all [4]. In the context of the global syndemic, food systems involve aspects of malnutrition, food insecurity, and environmental degradation, particularly given vulnerable socio-economic and environmental scenarios. This perspective also points out unhealthy patterns in different populations, inequity, and greenhouse gas emissions, all pressing issues that require transformation of food systems [5]. Developing sustainable and resilient food systems demands actions based on broad knowledge and complex skills [6].

Food systems concepts within nutrition programs are therefore necessary to guide policies and research initiatives that align with current world demands. However, many gaps exist in the implementation of curricular changes to address this challenge. Although experiences regarding where and especially how to develop capacity in nutrition training can provide useful examples, cases

reported in scientific studies are scarce and dispersed. Despite this recognition, a central research problem persists: how to effectively integrate food systems perspectives into nutrition to prepare professionals capable of addressing these multifaceted global challenges. The state-of-the-art shows that some international experiences exist in higher education. For instance, Brekken et al. [7] provided examples of pedagogical transformations in educational programs on food systems, identifying successful practices in the curricula at three North American universities. The authors claim that programs that address food systems in their curricula better prepare students to seek solutions to complex problems related to food production and consumption. These programs impact a range of students, equipping them with knowledge and tools on food systems and broadening the training of professionals, while empowering them to be better citizens and advocates for change. These actions certainly break paradigms, norms, and institutional rules within the university education system.

This study dialogues with the history of the nutrition program in Brazil, highlighting the unique trajectory of the profession, which is marked by the strong interplay between health, education, and public policies. Studies emphasize that, since the creation of the first programs in the 1930s, the Brazilian nutritionist has consolidated a reputation as a generalist professional, whose work goes beyond clinical practice and diet therapy, encompassing collective feeding, public health, teaching, research, and the food industry. This feature distinguishes Brazil from other countries, where nutritionists' roles are usually directed toward a single specific area of practice. In this way, the Brazilian nutritionist emerges as a strategic actor for the promotion of food security and for the strengthening of sustainable food systems, establishing a distinctive feature that enriches the professional identity in the global context [8,9]. Gabriel et al. [10] assert that it is necessary to advance, mainly in regard to a more extended and holistic understanding of the profession.

A clear knowledge gap remains regarding how food systems perspectives are integrated into nutrition curricula worldwide and in Brazil. Despite curricular guidelines promoting holistic and sustainable approaches, little systematic evidence exists on their practical implementation and impact on professional training.

This scoping review offers an overview of the food systems approach in nutrition professional training. We also present a case study with successful experiences in the implementation of food systems initiatives in Brazilian universities. Our study aims to assess the evidence of food systems approaches in higher education nutrition programs. To achieve this goal, we adopted the following strategies: (1) identify the main countries and periods in which food system-related practices have been implemented and documented; (2) organize the predominant concepts and methodologies in these practices, both globally and through a detailed analysis of the Brazilian case; (3) describe the main formative scenarios, such as teaching, research, extension, undergraduate, and graduate studies, where such practices occur; and (4) highlight the existing gaps in the current approach to food systems in food and nutrition education. We expect this review to contribute to promoting evidence, especially practice-based evidence, for the better training of nutritionists and dietitians.

METHODS

Scoping review

Protocol

The protocol comprises five steps: (i) identification of the research questions, (ii) sources and search strategy for identification of relevant studies, (iii) study selection, (iv) charting or mapping

of the data, and (v) summarizing and reporting the results. This review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines [11]. The protocol is registered with the Open Science Framework (OSF) under Doi 10.17605/OSF.IO/SRJFQ.

Sources and search strategy

We framed our research question using the PCC mnemonic (Problem, population; Concepts of interest, and Context). The primary research question driving this study was: How is the food systems field addressed in higher education in nutrition? The literature was searched without time constraints. This strategy allowed for the largest number of possible finds on the subject. The search was performed in May and June 2023, using six databases: PubMed, Scopus, Science Direct, ERIC (Education Research Information Center), Embase, and Google Scholar. The search terms were “food systems” AND “Nutrition” AND “Nutritionist” AND “higher education” AND “teaching” OR “learning” OR “capacity building”. Chart 1 presents the search strategies for each database.

Chart 1 – Identified contributions for future studies in the theme food systems in nutrition programs.

Study	Future studies to advance nutrition programs
Wilson et al., 2015 [16]	Studies that lead the way in recognizing that learning about Indigenous health is relevant for all dietitians and nutritionists, by focusing on the training of dietitians.
Hartle et al., 2017 [17]	Metrics for food-related academic programs should evaluate both curricula and job attainment. This evaluation could involve assessing employment fields of graduates; determining if training adequately prepares students for complex career paths; using graduate insights to improve and adapt curricula; and understanding the alignment between academic training and job market requirements.
Carino et al., 2019 [44]	The collaboration between universities and nutrition councils supports the development of policies, programs, and practices that are both environmentally and economically sustainable. Food and nutrition professionals can actively lead in advocating for, educating about, and governing food systems. Programs can provide insights into recommending changes in competencies and making modifications to curricula.
Knobloch et al., 2019 [24]	Future research should involve interdisciplinary teams. This approach aims to enhance the interdisciplinary skill sets of agricultural and extension educators. Additionally, it seeks to develop critical thinking, complex problem-solving, systems thinking, and the application of integrated knowledge through collaborative interdisciplinary learning partnerships.
Burkhart et al., 2021 [18]	Future research is needed to describe more explicitly what sustainability looks like in practice, providing specific examples to assist educators in framing sustainability authentically.
Mahn and Ded, 2021 [19]	Future research should expand findings by conducting an investigation of community garden interaction time, comparing transient and long-term learning, and analyzing discourse within laboratory curricula and discussions.
Spiker et al., 2021 [25]	Incorporating systems thinking and interdisciplinary food systems education as a core element within programs would provide educators with an opportunity to assess this complex skill more comprehensively at the program level.
Higgins et al., 2022 [47]	Future research should confirm this through multilingual translation capacity.
Maher et al., 2023 [51]	Recommendations include exploring the global perspectives of nutrition professionals worldwide to uncover potential synergies.
Goodridge et al., 2022 [46]	Actions should be promoted with dietitians to increase their confidence and ensure they feel adequately equipped to determine what evidence is well-supported, what to recommend to their clients and patients. While supervisors should have food systems competence to support trainees, inserting more mandatory content into the curriculum is challenging. Future research is needed to explore innovative models and establish effective approaches for integrating food systems into dietetic training programs.
Boak et al., 2022 [43]	Current and future workforce education and development must address the effects of climate change, increasing inequities, the democratization of knowledge, and disruptions in health and food systems.

Study selection and eligibility criteria

Inclusion and exclusion criteria were established to determine the studies to be included in the synthesis. Only papers focusing on higher nutrition education were eligible for inclusion. Regarding

exclusion criteria, we excluded materials that did not specifically focus on the field of nutrition programs, approaches unrelated to food systems, and review articles. The studies were imported to Rayyan® (2016) [12] to manage the selection process. Two reviewers independently screened the titles and abstracts, read the full articles, and extracted the results using a data extraction spreadsheet. Any discrepancies were resolved by a third reviewer.

Data extraction

The studies were analyzed and categorized based on the following variables: year of the action or publication; country of the action or affiliation; objectives of the study; type of study; methodology of the action or practice; data analysis; and main results.

Summarization of results

For the summarization of results, the articles selected in the review were described and grouped into three categories: (1) actions in undergraduate education, (2) actions in graduate education, and (3) extension and community outreach activities. The study also presents the main research gaps, as well as contributions to the advancement of the topic in the field of nutrition.

Case study

To illustrate real-world applications and provide practical insights, we present a case study, which synthesizes formative experiences within the scope of food systems conducted in Brazil.

Study design and data sources

We conducted a descriptive study using a qualitative, cross-sectional approach, with a national scope. The primary data source is an online crowdsourced mapping that we conducted between 2021 and 2022, aiming to identify actions related to training in sustainable food systems in Brazilian nutrition undergraduate programs.

Data collection and extraction: Primary data by crowd map

We collected the primary data using the Ushahidi platform (<https://www.ushahidi.com/>), a Voluntary Geographic Information (VGI) system. This web application enables collaborative visualization, sharing, and creation of map-based content. We selected this platform for its user-friendly interface and open access. The participatory nature of this crowdsourced method has demonstrated potential to share information, contributing to the creation of a more diverse database [13,14].

Our research on the platform is titled “Network of Experiences in Food Systems in Nutrition Education in Brazil” and can be viewed at the following address: <https://mapa.jacob.al/views/map>. For the registration of experiences, participants answered the following questions: 1) experience title; 2) brief summary; 3) consent for the publication of the submitted data; 4) type of experience; 5) to which institution is this experience linked? 6) provide the geographic location of the experience; 7) provide three keywords that summarize your experience; 8) indicate channels (e.g., website, social media) where more information about your experience can be obtained; and finally, 9) contact email.

The participants in this research were professors of nutrition programs in public and private institutions. In order to reach these potential participants, we contacted 160 higher education institutions via email; we sent messages to three WhatsApp groups – a research network on food sovereignty and security, professors of food and nutritional education in Brazil, and professors of collective feeding in Brazil – that bring together teachers and researchers from higher education institutions potentially interested in the topic of teaching food systems in nutrition, reaching approximately 430 individuals; and we also disseminated the research through two Instagram profiles (@labnutrir and @sustentarea), totaling 10,768 members of social networks.

Our research was not submitted to the Research Ethics Committee because, according to Article 1, Sole Paragraph, of Resolution No. 510/2016, of the National Health Council of Brazil, research using publicly accessible information (item II) – which is the type of information collected and made available on the crowd map – will not be registered or evaluated by the system. To ensure that the participants were aware of the public nature of the provided data, the first question of the research form was as follows: “I am aware that all information provided in this form will be publicly accessible”. Without an affirmative answer to this question, the participant could not complete the form. Furthermore, except for the contact email, we did not collect or analyze any personally identifiable information, focusing only on those related to the experience reported.

Data analysis

The data obtained from the crowdsourced research were documented in a spreadsheet to characterize the experiences as follows: action title, start year, affiliated institution, location (state), type of higher education, application axis (teaching, research, extension), application level (undergraduate, graduate), mandatory experience/program, and the main concepts and methodologies used. We summarized the extracted data in two main ways: (1) by obtaining absolute and relative frequencies regarding the characterization criteria and (2) by using the content analysis technique through a framework approach [15]. The first step of this technique is data familiarization, to establish a thematic coding of the material (sub-themes). The second step is description, which involves synthesizing information regarding the themes elucidated through an exercise of deductive coding (sub-themes). Finally, the third step is the interpretation phase, where the data were reduced to present results at a reasonable level of abstraction. In the case of our research, this third layer (themes) of categorization was predefined based on two of the questions we want to answer: (1) which concepts are addressed by the experiences, and (2) which methods are used to address the topic of food systems? Through data grouping, the number of categories was reduced by collapsing those related to the broader category (themes).

RESULTS

Scoping review: general summary of the selected studies

Duplicates were removed from the 254 records initially found, and 227 records were identified from citations databases. Based on the screening of titles and abstracts, 203 articles were excluded. Consequently, 23 full-text articles were retrieved and assessed for eligibility, all of which were included in the qualitative synthesis of this review. A flow diagram of the studies selection procedure is reported in Figure 1.

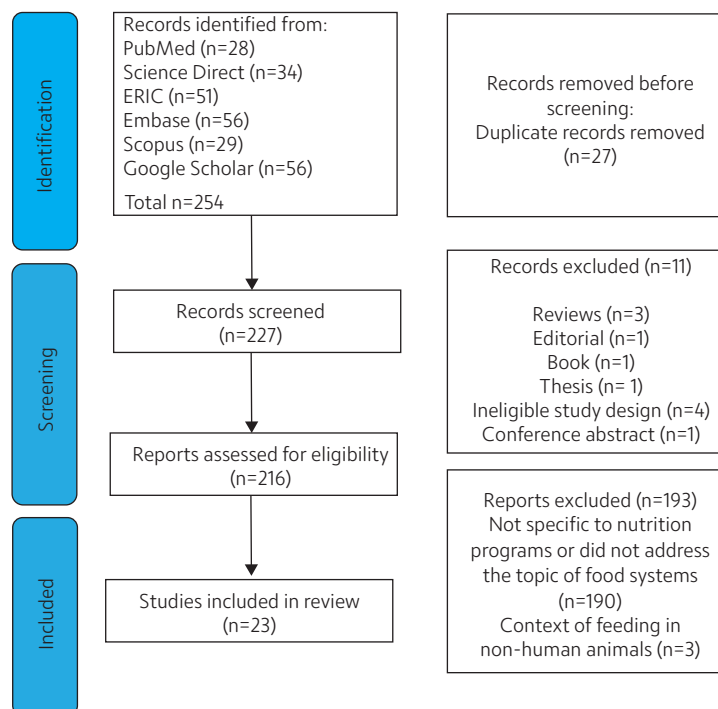


Figure 1 – Flowchart of the scoping review search process.

Source: Adapted from PRISMA protocol.

General data of the scoping review

The studies were published between 2011 and 2022, particularly concentrated in the years 2017, 2019, and 2022 ($n > 2$). These findings from the search show that research concerning practices on food systems in the higher nutrition programs has developed over recent years, with all studies published after 2015. The highest number of publications was recorded in 2019 and 2022. There was a decrease in 2020 and 2021, probably due to the impact of the Coronavirus Disease 2019 (COVID-19) pandemic on research activities. The review highlighted that there are overlooked areas for food systems studies in higher education nutrition programs, with limited data from low-income and developing countries. We observed a predominance of studies conducted in North America, particularly in the United States ($n=8$) and Canada ($n=6$), followed by Australia ($n=6$), Brazil ($n=2$), and South Africa ($n=1$) (Figure 2).

Mostly, the type of study was qualitative (69.6%), with data collection through interviews and content analysis, in addition to opinion articles (13%), exploratory studies (8.7%) and technical reports (8.7%). Didactic resources also included seminars, panels and virtual tours, and workshops.

Many studies explored ways to engage nutrition undergraduates with environmental sustainability and teaching practices. We highlight the keywords present in the studies as a communication element for identifying the dimensions addressed in the research. These dimensions are related to educational activities, curricula, methodologies, and student engagement. In line with the concepts of food systems and their social, political, and economic determinants, it is noteworthy that the term “food security” appeared in the keywords of only one study.

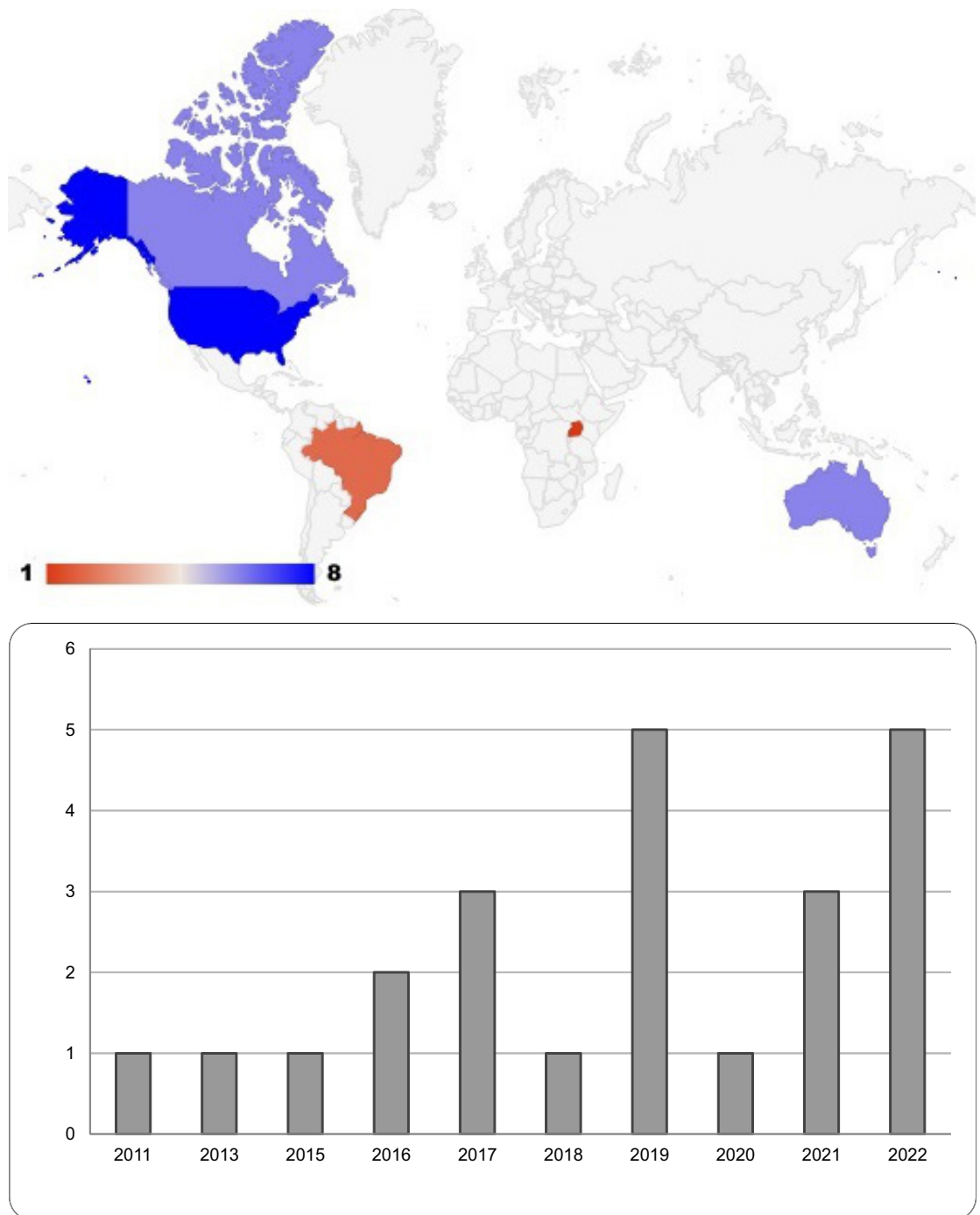


Figure 2 – Geographic and temporal distribution of the articles.

Regarding the pedagogical strategies employed, we emphasize that the present review found various methods used in the selected studies. Particular attention was given to qualitative methods such as participatory approaches, case studies, content analysis, instruments with expert evaluation, competency-based learning, and garden-based studies (Figure 3).

Overview of selected articles

A descriptive synthesis of the selected articles is available in Chart 2.

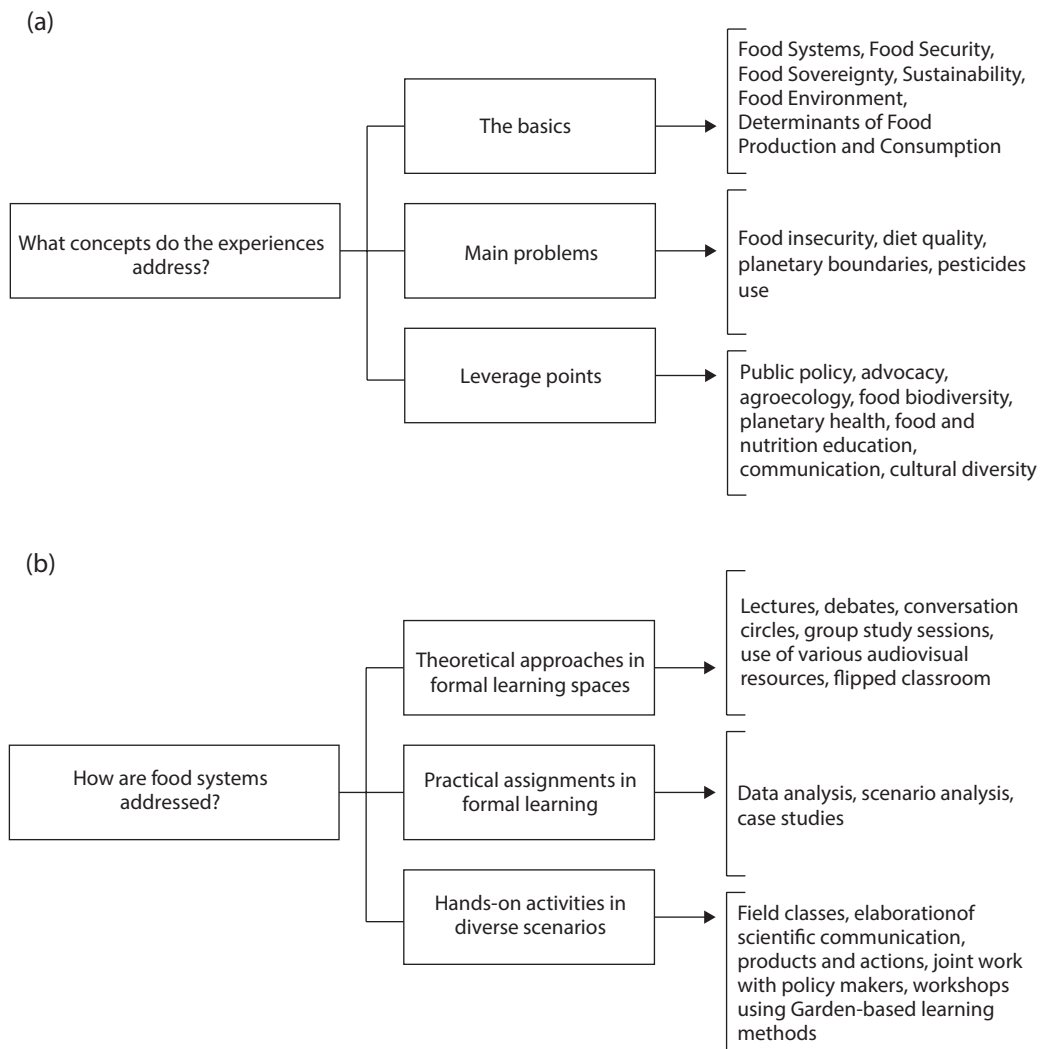


Figure 3 – Key concepts (a) and methods (b) addressed in sustainable food systems education experiences in Brazil within undergraduate Nutrition programs, 2022.

Chart 2 – Teaching, research, and extension experiences in sustainable food systems in Brazil within higher education nutrition programs.

Axis	Concepts	Methodologies
Teaching	Sustainability; sustainable food systems; food production and its environmental impacts; sustainable food consumption; food and nutritional education; food security; indicators for sustainability analysis in systems, diets, and menus; public policies for transforming food systems; communication with decision-makers; waste management; planetary health; social impacts; policies promoting family farming, traditional Indigenous and <i>Quilombola</i> communities.	• Interactive lectures. • Case studies. • Roundtable discussions. • Screening of documentaries and films; practices integrated with garden labs. • Involvement of the external community. • Guided practices at locations and food production in the territories. • Analysis of supply data in different practice areas.
Research	Food systems and their dimensions: economic, social, cultural, legal, environmental, political, and health; food environment; vegetarianism; food security; food safety; sustainable diets; healthy and sustainable menus; environmental footprints of food consumption.	• Dissemination, training, research, and practical impact. • Social extension projects. • Scientific meetings. • Organization of scientific events.
Extension	Food systems; planetary boundaries; human health; public policies; advocacy; biodiversity; unconventional food plants; food and nutritional security; agroecology; educational gardens; food and nutrition public policies; school curriculum; sustainability.	• Focus groups and roundtable discussions. • Practical agroecology workshop (soil, composting, cultural practices, harvest); culinary workshops with unconventional food plants. • Educational materials (magazines, eBooks, podcasts, recipes, social media posts).

Formative scenario of practices

The formative setting for practices refers to the environment or context in which pedagogical and learning activities take place, particularly those aimed at the development of professional and personal competencies. This setting consists of a set of elements that structure and guide the training process, such as available resources, learning objectives, methodologies employed, interactions between participants, and the relationship with the world of work. Of the 23 selected studies, 11 (47.8%) presented approaches to formative scenarios in teaching, research, and extension, highlighting teaching practices. These actions are predominantly concentrated in the teaching domain, with a particular focus on curriculum evaluation and the perceptions of academic stakeholders regarding the subject matter.

In the formative scenario of practices (teaching, research, and university extension), a variety of actions were observed in undergraduate studies. These included developing practical skills in indigenous communities [16]; programs focused on food production, sustainable agriculture, agroecology, and organic farming [17]; and engaging students in discussions about sustainability [18]. Additionally, there is an emphasis on understanding the origins of food; addressing the lack of exposure to seeing vegetables grow, and in some cases where they grew [19]. Activities in foodservice, clinical, or community settings were also integrated; learners completed the school foodservice consumer food waste and food waste audit activities within their management rotation [20]. Garden-based learning was incorporated both in programs and in professional training for nutritionists [21,22]. Finally, curricula faced challenges in integrated dietetic practices that address the social and ecological determinants of health.

In graduate studies, integrated themes of food science, public health and nutrition, government policy, and economics were essential for providing a comprehensive understanding of the complex factors influencing food systems and health outcomes [23]. Graduate students linked these areas to the community, considering food and nutritional security and sustainability as global challenges [24]. According to Hege et al. [20] and Spiker et al. [25], it is recommended the implementation of systems thinking in the curriculum through elective activities, focusing on resource efficiency and conservation across various practice settings.

In the actions at the extension levels, we found some strategies such as understanding the role of practitioners working with indigenous groups in a range of health care settings and communities [16], activities in the sustainability context for the practitioners to promote discussions about sustainability, actions for dietitians particularly in hospital settings [26], and the implementation of community gardens [22].

Research gaps identified by the studies

Through this scoping review, we identified several research gaps and suggestions for future studies related to the articles. We emphasize the importance of the scoping review in revealing these gaps and outlining future perspectives, particularly concerning current and necessary global themes in higher education. These contributions are summarized in Chart 3.

Chart 3 – Search strategy.

Database	Search equations
PubMed	“food system” AND “Nutrition” AND “Nutritionist” OR “dietitian” AND “higher education” “food system” AND “Nutrition” AND (“Nutritionist” OR “dietitian”) “food systems” AND “Nutrition” OR “Nutritionist” AND “higher education”
ScienceDirect	“food systems” AND “Nutrition” AND “Nutritionist” AND “higher education” “food system” AND “Nutrition” AND “Nutritionist” AND “higher education” AND “learning” “food system” AND “Nutrition” AND “Nutritionist” AND “higher education” AND “learning” AND “capacity building”
Embase	“food system” AND “Nutrition” AND “Nutritionist” OR “dietitian” AND “higher education” “food system” AND “Nutrition” AND (“Nutritionist” OR “dietitian”) “food systems” AND “Nutrition” OR “Nutritionist” AND “higher education”
Scopus	“food system” AND “Nutrition” AND “Nutritionist” OR “dietitian” AND “higher education” “food system” AND “Nutrition” AND (“Nutritionist” OR “dietitian”) “food systems” AND “Nutrition” OR “Nutritionist” AND “higher education” “food system” AND “Nutrition” AND “Nutritionist” AND “higher education” AND “learning” AND “capacity building”
Education Research Information Center (ERIC)	“Nutrition” AND “higher education” AND “food systems” “Nutrition” AND “Nutritional education” AND “food system” “Nutrition” AND “Nutritional education” AND “higher education” “Nutrition” AND “learning” AND “higher education” AND “food system”
Google Scholar	“Nutrition” AND “Nutritionist” AND “higher education” AND “food systems” AND “learning” AND “capacity building”

Note: The study was conducted in all languages. There was no temporal limitation.

Brazilian case study: practices in sustainable food systems

We identified a total of 15 experiences. The experiences covered in our research focus on three regions of the country: the Northeast (Rio Grande do Norte) with six experiences; the Southeast (São Paulo and Minas Gerais) with eight experiences; and the South, with one experience in the state of Santa Catarina. The oldest experience began in 2009, with almost 90% of the experiences emerging after 2014, and most of them starting after 2017. All 15 experiences are initiatives of public higher education institutions in Brazil, comprising 12 from federal universities and three from a state university. Considering the universe of the 15 experiences, about 57% are in the teaching axis, 27% in extension, and 16% in research. Chart 4 summarizes the experiences of sustainable food systems in nutrition programs in Brazil.

Chart 4 – Data extraction from the included studies.

1 of 3

Citation (Country)	Objectives	Methodology employed for the practices	Main results
Barlett, 2011 (USA) [27]	To show the capacity to contribute to transformational change toward an alternative food system in academic programs	It evaluated campus sustainability projects related to purchasing goals, academic programs, direct marketing, and experiential learning across 30 colleges and universities	Higher education institutions have transitioned from initiating a few pilot projects to broadly adopting alternative sustainable food chains. They have developed new metrics for food service practices and launched campus projects with regional, state, and national impact
Matthews, 2013 (CAN) [35]	To assist students in comprehending and valuing the complete food cycle	Case study conducted with 165 undergraduate students in a food and nutritional sciences program. Using collaborative problem-based learning. Food miles and CO ₂ emissions were calculated for foods purchased in their assigned neighborhood	Details about food production, processing, distribution, and waste were present in photographs and discussed in in-class focus groups. Students were more surprised by the travel distance of food transported globally than by the level of carbon emissions
Wilson et al., 2015 (AUS) [16]	To evaluate the Indigenous health curriculum of the Bachelor and Master of Nutrition and Dietetics	Research process to review the curricula involving stakeholders to co-create knowledge relevant to local contexts, and interviews with academic nutrition staff	Curriculum related to Indigenous health, lifestyle, and food supply/availability of traditional Indigenous peoples. Discussion of nutrition issues of Indigenous communities; and social determinants of food choice

Chart 4 – Data extraction from the included studies.

2 of 3

Citation (Country)	Objectives	Methodology employed for the practices	Main results
Hartle et al., 2017 (USA) [17]	To enhance awareness of the expanding field of interdisciplinary food-related academic programs	A comprehensive strategy to identify interdisciplinary undergraduate and graduate research and study programs related to food in the U.S.	This study identified 82 interdisciplinary undergraduate programs focused on food. Among these, 19 programs had a core focus on sustainable agriculture. A few programs were integrated, indicating traditional academic silos
Wegener, 2017 (CAN) [52]	The perspective that dietitians are increasingly recognizing sustainable food systems is being communicated, alongside advocacy for specialized education, hands-on training, and professional growth centered on sustainable food systems for both trainees and practitioners at different stages of their careers		
Maher and Burk, 2017 (AUS) [49]	To describe students' self-reported learning from engaging in an experiential learning task designed and to develop their understanding of sustainable food systems and dietary practices	143 first-year students participated in a weekly eco-friendly food challenge as part of a food and nutrition subject. They documented their experiences through content analysis and responded to reflective questions focused on actions, learning, and responses.	Students identified social barriers and time/energy constraints as key obstacles to adopting sustainable food practices and solutions. They also noted various community, government, and multi-sector efforts and initiatives supporting behavior changes.
Knobloch et al., 2019 (USA) [24]	To outline the motivations and learning experiences in a multi-institutional, interdisciplinary graduate course	Case study design with questionnaires, which included rating scales and open-ended questions. Data were analyzed and triangulated into key findings	Students who engaged in interdisciplinary learning enhanced their communication and education skills through experiential place-based learning. They gained insights into global challenges with different disciplinary perspectives, identifying similar challenges in their local communities
Carino et al., 2019 (AUS) [44]	To describe how sustainable food systems are taught to nutrition students	A cross-sectional study was conducted which involved a qualitative content analysis of documented online program outlines and an online survey with coordinators. The study was conducted in 2016	Of 130 identified degrees, only 8% included modules about sustainable food systems with the most learning outcomes. The types of assessment tasks included essays, reflection papers, policy analysis, reflective blogs, food system audits, eco-friendly food challenges, media analysis, case study presentations, analysis, and exams.
Finn, 2020 (USA) [48]	To highlight the role of the nutritionist in achieving the United Nations Sustainable Development Goals	The article was structured around the stages of achieving sustainability: knowledge, trust, and partnerships to advance the profession in sustainable food systems	Curriculum for dietetic interns focusing on sustainable, resilient, and healthy food and water systems; creating a sustainable food systems nutrition-focused framework for action
Burkhart et al., 2021 (USA) [18]	To examine the local and practice viewpoint of sustainability in a nutrition and dietetic program	Participatory action research process using an online survey, workshop, and interviews. The study was conducted in 2016	Generation of proposed sustainability statements in dietetic practice: sustainability thinking, future-oriented perspectives; stewardship and maintaining the nutrition field
Mahn and Ded, 2021 (CAN) [19]	To introduce a community garden laboratory in a foods course within a nutrition program	A descriptive survey methodology was used to explore the observations and opinions of participants	Analysis revealed four interrelated themes: connection and exposure, food preparation, benefits of using local food, and explicit learning. The garden was valued by students as a curriculum component as well as an opportunity for personal growth and development
Hege et al., 2021 (USA) [20]	To describe the nature of interest in sustainable food systems, identify facilitators and barriers to educational opportunities related to sustainable food systems, and professional skills, and to identify ways to enhance the quality of instruction to expand the availability of educational opportunities.	Description of lessons learned from the sustainable food system curriculum implementation within dietetics education programs in the United States.	Nearly 20% of respondents had a general interest in working in sustainable food systems, 15% identified they already worked in sustainable food systems, and nearly 10% of those who downloaded the curriculum were learners interested in completing the curriculum. Fifteen programs implemented the curriculum from 2018 to 2020.
Mota et al., 2021 (BRA) [21]	The garden-based learning method can play a strategic role in biodiversity education in nutrition training.	Qualitative and exploratory approach, experience report type in the laboratory community garden.	Garden-based learning method addresses biodiversity challenges by enhancing professors' skills and the institutionalization of the lab, adding the sustainable food systems course, collaborating with a multi-professional team, establishing connections and adapting tools for different cultural contexts.

Chart 4 – Data extraction from the included studies.

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Citation (Country)	Objectives	Methodology employed for the practices	Main results
Araujo et al., 2021 (BRA) [22]	To present the experience at the garden lab to exemplify how unconventional food plants can be approached based on garden-based learning	Garden-based learning method, which includes teaching nutrition through plants, explored integrating components from agronomy, botany, ecology, and nutrition	Educational experiences focused on plants enhance skills in food biodiversity. Garden-based learning is an effective method for creating pathways toward sustainable environments and food systems.
Spiker et al., 2021 (USA) [25]	To share perspectives on how food systems educators can use online learning to facilitate the development of systems thinking for future food systems professionals.	The working group conducted pilot tests of two interactive webinars covering themes such as policy, systems, and environmental issues. The webinar examined the application of systems thinking to malnutrition, and the impacts of nutrition interventions across five areas: ecological, agricultural, economic, socio-cultural, and health	Offers insights from a teaching approach that involves a varied group of stakeholders in food systems, addressing challenges like collaboration across multiple universities, sectors, and geographic locations
Higgins et al., 2022 (CAN) [47]	To evaluate the integration of sustainable food systems concepts in dietetic training standards	A content analysis of dietetic training standards was conducted on the websites of 47 national dietetics associations. Document search terms included 'sustain' or 'sustainable', 'food systems', and/or 'diets'	From the 47 associations, researchers obtained 23 dietetics training standards documents, of which 16 included food system-related content. Thirty-one of 52 mentions of content fell into the shallower depths of knowledge in understanding (n=12) and apply (n=19)
Boak et al., 2022 (AUS) [43]	To explore the future roles and capabilities of nutrition and dietetics professionals	A qualitative method was used and involved interviews with focus groups composed of nutrition and dietetics graduates	Future roles for nutrition professionals include food and diet optimizers, knowledge translators, equity advocates, food systems activists, and change-makers. Essential skills for these roles – such as adaptability, resilience, advocacy, critical thinking, embracing diversity, and solution-focused approaches – can be integrated into curricula
Gerstein et al., 2022 (USA) [26]	To provide a snapshot of how a clinical, retail, and public health dietitian supports sustainability in their local food system every day	Shared dialogue on issues and opportunities for advancing agriculture, nutrition, health, and sustainable food systems with stakeholders in the supply chain, food environments (retailers, schools, hospitals, and food banks) and providing guidance (to physicians, nurses, dietitians, fitness professionals, and culinary experts).	Themes in food production and nutrition include working with a multidisciplinary team, utilizing hospital rooftop gardens to provide ingredients for hospital meals and local restaurants, and supporting local farmers and the economy. Additionally, there is a focus on delivering dietary guidance and reducing food waste.
Goodridge et al., 2022 (CAN) [46]	To identify ways dietitians can contribute to sustainable food systems as well as opportunities for collaboration within the profession	Drawn from research capturing how dietitians define their role in sustainable food systems, reports, and the small body of peer-reviewed literature available	Canadian dietetic programs are divided into four practice areas: clinical, food service, community, and industry. Redefining these programs requires addressing health, consumer demand, and food systems. Strategic approaches include collaboration, advocacy, policy change, knowledge dissemination, research, and management
Nix 2022 (USA) [50]	To contribute to the discussion on revising nutrition curricula, it is crucial to emphasize the importance of whole foods, complex dietary behaviors, and food systems, aligning with advancements in the field of nutrition	Opinion and perspective based on the author's interpretation, reflection, and argumentation on proposed changes to nutrition curricula in higher education	Proposed models for a course on general dietary health should include personal application components, and introduce students to current issues, key actors, organizations, and systems in nutrition. This approach offers a promising opportunity to implement change, provide holistic dietary strategies, and assess the interdisciplinary and complex nature of the field
Carlsson and Callaghan, 2022 (CAN) [45]	To collectively define a vision of sustainable food systems, and discuss barriers, supports, needed actions, and roles for integrating sustainability into dietetic practice	Researchers used Delphi inquiry methods to explore how nutritionists and dietitians in 30 nations perceive sustainable food systems, their perceived roles, barriers, and support needed. They used sustainability principles in socio-ecological systems	Results show that not everyone agrees it falls within their scope of practice and highlight barriers at various levels, including an unsupportive professional culture and societal and ecological obstacles
Maher et al., 2023 (AUS) [51]	To understand the perceived opportunities for integrating a sustainability focus on nutrition and dietitian practice, from the lens of Australian professionals	Qualitative methodology using semi-structured online interviews with 10 professionals. Thematic analysis was used to understand how they perceive opportunities and barriers for integrating sustainability into practice	Future practice themes include preparing academics and practitioners for both individual-level and system-level work with a focus on policy. Barriers to implementing changes include a lack of contextual evidence, complexity, and competing priorities

In the teaching axis, the disciplines or modules have a distribution of approximately 56% of mandatory components in the curriculum, with the remaining being electives. Of the eight teaching experiences, two are in postgraduate programs. In undergraduate experiences, two are specifically focused on food systems, while the others address the topic within broader modules of disciplines related to public health and food and nutrition education. In postgraduate programs, two components address the topic of systems in an integrated manner with the general themes of nutrition, sustainability, and society. In the extension axis, the four registered experiences involve the following types: a summer course, a scientific event, a community project of a pedagogical garden, and a scientific communication platform. Finally, the three experiences in the research axis involve groups that have a strong emphasis on collaborative efforts with extension services, actively engaging in action research. One of these groups defines itself as a “think tank”. Figure 3 summarizes the main concepts addressed in the experiences.

We organized the concepts into three groups: (1) the basics, encompassing the main underlying theories addressed in these experiences; (2) main problems, synthesizing the central nodes that explain the idea of crisis in the current hegemonic food system; and (3) leverage points, highlighting pathways for transitioning food systems towards sustainability. Regarding the methodology, Figure 3 also summarizes the main methods used in the context of these experiences.

We organized the methods used to teach food systems into three groups: (1) theoretical approaches in formal learning spaces, (2) practical exercises in formal learning spaces, and (3) practical activities in different settings. In all three dimensions, there are active teaching and learning methods, such as the flipped classroom, debates, scenario analysis, case studies, problem-solving using real data, and garden-based learning.

The results indicate that sustainable food systems are mainly addressed in higher education nutrition programs in the Southeast (São Paulo) and the Northeast (Rio Grande do Norte) regions of Brazil. This geographic concentration likely reflects the prominence of these regions as centers for key textbooks, research groups, and publications on the topic. Public institutions were more involved than private institutions in addressing sustainable food systems. The primary focus was on teaching, with research integrated into extension activities, and active learning methods were the predominant pedagogical approach.

DISCUSSION

Our research question on how the topic of food systems is addressed in higher education for nutritionists can be answered by examining the implementation of actions, as well as the promotion of reflections and perspectives to advance the training of nutritionists. On one hand, there are curricular changes, and on the other, recommendations for nutritional and dietetic practice. We emphasize the strong approach to interaction among educational actors, including professors, students, and administrators, along with institutional support for implementing actions and practices related to food systems and sustainability. We also highlight the need for more practical actions to encourage nutrition programs worldwide to adopt systems thinking.

The studies are recent and focused on high-income countries. This trend likely reflects greater investment in research and resources, heightened concern for sustainability, regulatory policies, education, and environmental awareness, as well as a sense of global responsibility regarding the impacts of food practices [25]. The study by Barlett [27] highlights four key components for effective project implementation: innovations in foodservice (food procurement, menus, and kitchen processes);

academic programs focused on environmental, socioeconomic, and health issues; direct marketing for family/community agriculture; and hands-on experiences in campus community gardens. Lee et al. [28] reported that policies addressing sustainable food systems should be implemented more equitably across and within countries. Certainly, an effective strategy would be to improve the quality of formal higher education to align with the global goals of planetary health and sustainable development within academic programs.

The limited number of studies on integrating food systems into nutrition higher education suggests that the topic and related practices remain underexplored in both the literature and curricular structures. Keegan et al. [29] affirm that current curricula do not promote systemic discussions, focusing instead on fragmented solutions and neglecting broader socio-economic contexts. Nutrition programs traditionally emphasize individual dietary components, health outcomes, or specific populations. In Brazil, key issues like food insecurity, diet quality, and pesticide use dominate food systems discussions. An additional dimension comes from the sustainable food practices of family farming fostered by the National School Feeding Program (PNAE), which legally mandates a minimum of 45% of food purchases from family farming [30]. This law not only strengthens short food supply chains and promotes healthier diets in schools but also represents a concrete example of how policy can shape sustainable food systems [31]. Highlighting this case can stimulate global discussions by demonstrating how national legislation can simultaneously address food security, support local economies, and encourage sustainability.

Globally, the broader perspective that encompasses production, distribution, and consumption, is relatively recent or underemphasized. Data on food systems are often scarce or inconsistent, and standardized assessment methods are lacking, hindering comparability and reproducibility. The teaching of food systems in nutrition varies across regions, influenced by educational institutions and food policy evolution. However, a multidisciplinary approach incorporating nutrition, food security, sustainable agriculture, food culture, and sustainability is essential. Beyond technical knowledge, fostering a systemic vision among educators and students is crucial for meaningful transformation.

These conclusions emphasize the need for more empirical studies that analyze integrated academic curricula in both developed and developing countries, and that consider the complex interactions among different actors in food systems, in order to support solid learning and practices in higher education.

Regarding curriculum changes, it becomes evident the need to apply effective and innovative methodologies for teaching food systems. Studies such as Mahn and Lordly [19] carried out in Canada, and Mota et al. [21] conducted in Brazil, demonstrate that garden-based learning is a consistent method to transform curricula, building them more integrated with the sustainability dimensions and planetary health. These studies also report the satisfaction and development of students in practical activities and motivation for studies. We emphasize that quality education must go beyond traditional approaches, limited to closed classrooms. The garden approach seems to be innovative and essential for promoting connections among health, nutrition, environment, and community.

The implementation of gardens in university environments still faces logistical, structural, and financial challenges. A successful case is the LabNutrir garden at the Universidade Federal do Rio Grande do Norte (UFRN, Federal University of Rio Grande do Norte) campus in the Northeast of Brazil. The study entitled “A laboratory without walls: biodiversity education in nutrition training using a garden-based learning method” presented data about the laboratory’s conception in 2017 and showed that it plays a fundamental role in teaching, research, and extension, contributing significantly to the training of nutritionists [22]. We highlight the cultivation of Unconventional

Food Plants (UFPs) as a strategy to promote local biodiversity, sustainable diets, critical insights, and to improve mental health [32-34].

Clinical nutrition and its relationship with food systems was reported by Gerstein [26] who examined clinical hospital nutrition and sustainability. Hospitals can and should play a pivotal role in promoting locally diverse foods for their patients, as well as supporting the procurement of locally sourced produce. Additionally, noteworthy is the alteration of the physical infrastructure through the construction of green roofs and the establishment of a local and healthy products store within the hospital premises. Dietitians operating in this environment may have enhanced capabilities and opportunities to contribute to the transformation of food systems, aiming to foster communities, promote health, and provide suitable nutrition for both patients and hospital staff.

Mathews [35] argues that student engagement in higher education is vital. Professional healthcare programs often become overly competitive, which can limit positive engagement and a holistic understanding of the subject. While these programs face such challenges, participatory learning experiences have been found to boost student engagement, suggesting the potential for implementing similar projects in other university settings. Nonetheless, collaborative learning is not always immediately effective, and there may be a period of adjustment for students, especially undergraduates, when transitioning to Problem-Based Learning (PBL).

Numerous nutrition experts are already embracing the cognitive framework necessary to advocate for enhanced leadership in sustainable diets and food systems. Some are acknowledging the growing trend of complexity thinking, which highlights the significance of non-linear contexts [36]. Nevertheless, the intricacies of this field may appear daunting to many nutrition professionals. This novel approach poses challenges to conventional methods of nutrition education, which typically rely on biomedical models rooted in evidence-based practice and primarily adhere to reductionist research paradigms [2]. Expanding the scope of evidence-based practice to encompass more relational models of critical thinking for transformative learning is imperative within the field of nutrition [37].

This review highlights significant deficiencies in the inclusion of food systems within higher education. The need for more qualitative studies should be emphasized, as they can provide a deeper understanding of how food systems are incorporated into nutrition curricula. Most studies have focused on curriculum assessments and the viewpoints of students, interns, faculty, and professionals. Topics such as food policies, sustainable production, and the nexus between food systems and nutritional security are less frequently addressed.

It is also emphasized that, in Brazil, the topic of Food Security is not fully addressed across the curriculum of nutrition programs, as evidenced by Lisboa and Fonseca [38] and Vieira et al. [39]. This highlights the need for curricular adjustments in undergraduate nutrition programs to allow for greater interdisciplinarity and integration among programs. The current training is still considered to be primarily focused on technical competencies to the detriment of humanistic ones. Furthermore, it is often fragmented and poorly articulated between theoretical and practical activities, which undermines the professional preparedness of future graduates.

In line with this need for curricular integration, content related to food systems—encompassing food production, distribution, and access—must also address the influences of contemporary societal dynamics, including industrialization, technological advances, and marketing and communication strategies. These factors strongly shape food consumption patterns, encourage the adoption of new eating practices, and drive significant transformations in lifestyles.

Martinelli et al. [40] emphasize that, in the aftermath of the COVID-19 pandemic, public policy actions should focus on integrating strategies that promote food sovereignty and food and nutrition security, as well as on building healthier and more sustainable food systems. This agenda should be incorporated into nutrition curricula, highlighting the strengthening of family farming; income security for the population; access to quality food; promotion of healthier food environments; widespread dissemination of information on healthy and sustainable eating through official recommendations and food guides that address the entire food system; and the implementation of food and nutrition education practices.

As in Brazil, over more than 70 years of the nutritionist's history, there has been a significant increase in the number of academic programs and professionals, improvements in methods and working tools, a reshaping of the job market and working conditions, as well as profound and substantial changes in the consumption patterns, eating habits, and nutritional status of the Brazilian population [41]. Guided by the current and most recent National Curriculum Guidelines for Undergraduate Nutrition Programs [42], the nutritionist must be a generalist professional whose training is grounded in the appreciation of healthy and sustainable food systems. Moreover, these professionals should be trained to value the interface between nutrition science and the multiple dimensions of human eating, within the framework of the Human Right to Adequate Food (HRAF), enabling a comprehensive professional approach that considers the individual, society, and the food system. The guidelines also emphasize, as an attitudinal resource, the principle that adequate and healthy eating derives from biodiversity and from socially and environmentally sustainable food systems.

Regarding the research limitations and implications, we consider that the limited number of studies carried out in the context of training and practice, as well as the diversity of study programs and cultural backgrounds of the participating students across different universities, may represent a limiting factor for the interpretation of some results. In addition, for future research, we highlight these integrated themes as fundamental to promote food systems discussion: food security, hunger, agriculture, and sustainability, and for addressing, national and global food and nutrition issues. The results of this scoping review and the data from the case study in Brazil can provide a basis for improving higher education in nutrition programs worldwide. This approach moves toward sustainable food systems based on experiential learning and teaching methods.

CONCLUSION

We conclude from this review that practices related to food systems in nutrition programs are recent and are predominantly concentrated in high-income countries. Regarding the systematization of the concepts and methodologies used in these practices, we found that, excluding specific terms from the field (i.e., nutrition and dietetics), the concepts still tend to focus primarily on the educational approaches adopted, such as curriculum and education, rather than on concepts directly related to food systems and the broader paradigm of food security. Despite this, these topics are addressed within the developed actions and practices.

In Brazil, possibly due to the context of inequalities and complexities within food production and consumption, themes such as food security, hunger, food environments, and biodiversity promotion to ensure food sovereignty, sustainability, and food systems have been discussed in universities within the scope of teaching, research, and extension activities. Methodologies have been directed towards the interdisciplinarity of academic curricula and the implementation of garden-based learning, and the cultivation of unconventional food plants.

Regarding the educational landscape, it is evolving to offer a more collective approach rather than an individual perspective. Higher education must be contextualized within the social, political, economic, and environmental demands of the location where the institution is situated. We conclude that teaching and learning processes should be integrated with actions in both teaching and research, with continuous emphasis on dialogue with society and the community.

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