



Mapping the Past Two Decades of Nutrition and Food Security in Iran: A Co-Word Network Analysis

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ABSTRACT

Background: Food security in communities can prevent health complications, so investigators have made efforts to find its related factors through various fields. This study aims to draw a road map for nutrition and food security research in Iran. **Methods:** Web of Science, PubMed, Scopus, Embase, and Islamic World Citation Center were searched for eligible publications in nutrition and food security related to Iran for the two decades from 2001 to 2020. Content analysis was done by a co-word network technique using VOSviewer software. **Results:** Finally, 28,995 scientific publications among 50,444 search results were eligible to include in this study. The research map was drawn using 403,262 keywords obtained from the title and abstract of the papers. A 23.53% growth rate of publications was seen. Iranian articles were mainly published in scientific journals under 10 subject categories. The highly repeated keywords of "treatment", "plant", "age", "risk", and "consumption" were in publications. Moreover, the articles were categorized into thematic clusters of "environmental and climate change", "health", "food industry and food safety", and "agriculture and water resources management" which were related to nutrition and food security. An increasing trend was observed in the number of publications during the past two decades in Iran. **Conclusion:** The relation of clinical nutrition, malnutrition, diet, and in recent years, food production and climate change with food security have been extensively studied by Iranian researchers. However, they have neglected studies on public health and policy in food and nutrition security, which reveals their dominant clinical or agricultural approach.

Introduction

Improving nutrition can be considered a cost-effective approach for dealing with many social, environmental, and economic challenges that we face today around the world (Chen *et al.*, 2019,

Ohlhorst *et al.*, 2013). Among these challenges, increasing food security, defined as having access to a balanced and nutritious diet for consumption of the required amount of various types of nutrients

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to achieve a healthy life (Joulaei *et al.*, 2023), plays an essential role in the development of societies, so that the Union Nations (UN) has identified it as one of the Millennium Development Goals (Behzadifar *et al.*, 2016). Basically, maintaining local and global food security calls for an affordable supply of wholesome, secure, and sustainable foods (Fleischhacker *et al.*, 2017). Through the assistance of the national defense forces, adequate nutrition is linked to long-term national security (Fleischhacker *et al.*, 2017).

As a serious global public health concern, food insecurity has attracted the attention of health professionals and policymakers for the past two decades (Behzadifar *et al.*, 2016). It affects more than 852 million people worldwide, of whom 9 million reside in developed countries and the rest in developing ones (Behzadifar *et al.*, 2016). Moreover, food insecurity and chronic diseases have bidirectional relations, meaning that food insecurity can cause chronic diseases (Nagata *et al.*, 2019), and chronic diseases can make food insecurity more prevalent (Jih *et al.*, 2018). Therefore, as the main threat to both individual and public health, it creates a burden on nations' health economics, as shown by the difference in yearly costs of food-secure and insecure individuals (e.g. \$5527.06 for medicate and \$1826.40 for beneficiaries from other health insurances) (Berkowitz *et al.*, 2018). Improving food security will significantly reduce healthcare costs and increase economic output (Finkelstein *et al.*, 2009). In 2008, it was projected that overweight and obesity-related medical expenses in the United States cost \$147 billion annually (Finkelstein *et al.*, 2009). Furthermore, the indirect (non-medical) costs associated with absenteeism, disability, premature mortality, workers' compensation, and being at work despite illness were estimated (Trogdon *et al.*, 2008). The role of food supply and food environment in nutrition and health among populations has become more evident from recent food and nutrition research. For instance, the 2014 EU Foresight Study on Food and Health proposed moving towards a sustainable food system that produces safe, sufficient, affordable, and healthy

food (Fleischhacker *et al.*, 2017).

According to the Millennium Declaration and in line with the Millennium Development Goals, policies and programs need to be designed, implemented, monitored, and periodically evaluated to fight poverty, hunger, disease, illiteracy, environmental degradation, and gender discrimination. However, evaluating the impact of food and nutrition programs, considering their multifactorial nature, is still a challenge for researchers and health professionals, especially when it comes to measuring and addressing food insecurity (Mohammadi Nasrabadi *et al.*, 2014).

As a matter of fact, programs and policies in the health sector should be based on the robust evidence generated by researchers and experts, although other criteria should be considered by policy-makers (Rivera Dommarco *et al.*, 2019). However, there are other reasons why scientific evidence is often disregarded, including lack of knowledge or a dearth of information, lack of contact between policymakers and researchers when formulating policies, and other socioeconomic and political barriers (Rivera Dommarco *et al.*, 2019). To devising sound policies to confront food and nutrition insecurity, authorities need to develop road maps and strategic research agendas to address knowledge gaps.

Iran's investment in health care increased up to 8.9% of its Gross Domestic Product (GDP) by 2015; however, its investment in research remains restricted (around 0.6% of its GDP) (Mansoori *et al.*, 2018). Despite limited financial support and the significant increase in the number of health research publications in the international bibliographic databases during the past three decades, Iran's research activities in health are believed to not line up well with the country's disease burden and the population's health needs (Mansoori *et al.*, 2018). A key problem might lie in the absence of a research map to serve researchers and policymakers in making evidence-informed policies (Mansoori *et al.*, 2018).

Human nutrition research requires approaches that incorporate traditional health-related fields, such as agricultural science, biochemistry,

dietetics, dentistry, endocrinology, food technology, genetics, medicine, microbiology, molecular biology, physiology, and psychology (Fleischhacker *et al.*, 2017). These approaches consist of categories less traditionally engaged in health-related research, including but not limited to behavioral economics, law, mathematics, physics, political science, regional and urban planning, and sociology (Fleischhacker *et al.*, 2017). One of the foremost health problems in Iran is food insecurity, to the extent that about half of Iranians are reported to be struggling with food insecurity (Daneshi-Maskooni *et al.*, 2017). Greater investments in food insecurity research can accelerate progress in improving and maintaining health as well as reducing illness, mortality, and the economic burden associated with nutrition-related diseases and disorders (Meyer *et al.*, 2013). Thus, the National Nutrition and Food Technology Research Institute (NNFTRI) conducted a study to find Iran's nutrition and food security situation and establish a road map until 2021 (Damari *et al.*, 2018).

During the past few years, various political and environmental changes have exacerbated food insecurity. Among environmental factors, hydrological drought has impacted livestock, population growth, and agricultural products which intensifies food insecurity in the affected region (Hameed *et al.*, 2020). Political concerns like the ongoing installation and enforcement of US sanctions against Iran have also reduced Iranians' buying power and, as a result, exacerbated food shortages. Therefore, this circumstance may have the effect of increasing chronic problems (Hejazi and Emamgholipour, 2022). Besides, Iran is rapidly moving towards an aging population (Mehri *et al.*, 2020), which can lead to an increment in social costs, age-related health issues, and finally, food insecurity with the economic burden on the healthcare system (Wang and Bishop, 2019).

Therefore, to control food insecurity and its consequences, policymakers, and managers in Iran should act based on appropriate strategic plans, established on scientific evidence and field

research, not only in the design and implementation phases but also when monitored and evaluated in terms of their effectiveness to achieve the goals (Brown *et al.*, 2019). Considering the significance of food insecurity in terms of its bidirectional relationship with chronic diseases, its effect on social, demographic, political, and economic conditions, and the presence of a proposed evidence-based roadmap for food insecurity until 2021, this study aims to draw nutrition and food security research map from 2001 to 2020 to assess the nutrition research topics in Iran and to examine the thematic gaps in food security studies.

Materials and methods

Study design

Using a content analysis method with a quantitative approach, the present study mapped the nutrition and food security research of Iran in the time span from 2001 to 2020. The contents were analyzed using co-occurrence of keywords technique, a quantitative technique widely applied to discover the structures and structural changes of a scientific field, communicating scientific research fields, and scientific mapping outputs (Hu *et al.*, 2013). The technique measures the co-occurrence of keywords to show the network of a scientific field's concepts. The co-occurrence is believed to reflect the semantic relationship between two terms and thereby reveal the topics in the scientific outputs of a research field (Assefa and Rorissa, 2013).

Ethical considerations

The proposal of the present study was approved by the Institutional Review Board (IRB) and the ethics committee of Shiraz University of Medical Sciences (Code: IR.SUMS.REC.1398.1262). This article does not contain any studies with human participants or animals performed by any of the authors.

Scope of the study

The scope for the current research consisted of all scientific articles, including original works and review articles, and policy reports, but not

materials, such as letter-to-editor, conference abstracts, etc., in the field of food security in Iran. Since it is not possible to identify all the published materials in scientometric research, a cross-section of time is selected for study in reliable and field-related databases that cover most works of a field. Published journal articles indexed in five electronic databases of Web of Science (WoS), Scopus, PubMed, Embase, and Islamic World Science Citation Center (ISC) from 2001 to 2020, were selected which discussed food security in Iran. Identifying the subject of the articles was done during the following process by providing a search query and evaluation techniques. To get a comprehensive view of the investigated field, all eligible published materials retrieved from the databases were analyzed, and sampling was not done on them.

Study procedure

Making a collection of documents

Development of the search strategy: To search the electronic databases, a search query was developed with the consultation of experts in the field. During the brainstorming sessions, with the field expert panel and scientometric experts, an effort was made to identify all the important and fundamental MeSH and non-MeSH keywords and their combinations that cover the field of food security in Iran through 5 categories (both in English and Persian): “food security” category including words directly related to food security, “policy” including words related to food policies, food system, and economic, “Health” including words related to food, nutrition, and health, and diseases, “Environment” such as climate change, global warming, water and soil, “Availability”, including distribution, transportation, food import, and export.

Regarding the fact that all the aforementioned databases were not equipped with semantic tools, such as a thesaurus for searching, an effort was made to identify synonyms and related words when possible. To avoid retrieving less irrelevant documents whilst finding the highest possible relevant items, searching keywords was limited to

title, abstract, and keywords of published material, as they most represented the text. Unique search strategies and search queries in English and Persian were adopted based on the databases of interest requirements.

Search and recording documents: The above-mentioned databases were searched using the predefined search query on 06/23/2020, which was restricted from 2001 to 2020. The search was done for English publications in WoS, Scopus, PubMed, and Embase. Moreover, Persian language publications were retrieved by searching ISC database. Bibliographic information and abstracts of articles retrieved from each database were stored in an Excel file. Any documents that were not original research, review articles (narrative review, systematic review, meta-analysis), or policy reports were omitted during the first screening.

Removal of duplicate records: In this step, after retrieving the required records from the 5 mentioned databases, considering DOI and title, duplicate records were identified and removed. The title and abstract of the articles, as well as the WoS category of the journals that publish these articles, were downloaded from WoS and were prepared for further analysis in Excel.

Content analysis

To map the field of nutrition and food security, the co-word network of the field was drawn using VOSviewer software version 16.6.1. The software is widely used for visualizing and exploring bibliographic maps of all types of bibliometric networks, including citation link networks, scientific co-authorship, and cognate relationships between scientific terms and expressions (Van Eck and Waltman, 2011). It is used as a good quality tool to map science (Cobo *et al.*, 2011, Van Eck and Waltman, 2010) in various studies (Bello *et al.*, 2021). The co-word network analyses were performed at the title and abstract level, leading to the identification of the main clusters and their main keywords.

Pre-processing: VoSViewer software

automatically performs linguistic pre-processing before analysis. However, the analysis of the keywords of the obtained clusters showed that it failed to correctly perform pre-processing in some cases. Thus, there was a need for more pre-processing to control and homogenize vocabulary. Moreover, it was necessary to prevent the scattering of related words or synonyms under different written forms. For this purpose, a thesaurus was created which, in addition to determining synonyms and related words, determined the words that needed linguistic pre-processing as well as general words without thematic load such as score, group, and case study that should be removed from the clusters. Visualizing the map was repeated several times, and in the process, the thesaurus was completed. The expert panel confirmed the correctness of the words in the field in several stages.

Finally, 403,262 keywords for the title and abstract and 240 keywords for the WoS subject categories were obtained, and these keywords were used to draw the scientific map of this field. These maps contain some nodes with different sizes. The nodes' size showed the scientific map of the knowledge contained in each concept. Hence, small nodes indicated the shortage of investigations on those concepts. Besides, the color indicated different clusters of concepts. In this map, the distance and proximity of keywords showed how much the concepts were related to each other. In other words, the connection lines among the keywords indicated that these keywords were used with each other in different works, and as a result, there was more thematic similarity among them.

Visualizing map of the WoS subject categories and their weight: In the next step, WoS categories of the journals publishing the scientific articles for the field of food security were analyzed as in the previous step. For document frequency, the threshold of at least 20 documents was applied. As the analyses were conducted for titles and abstracts, the term frequency within documents was unimportant to the writers. Therefore, the

binary counting method was used instead of the full counting method to indicate the occurrence or non-occurrence of words in the document. This led to the identification of 128 out of 240 keywords. Thus, by calculating the relevance score for each keyword, 60% of the keywords (including 77 keywords) with the highest relevance score (as applied in previous studies) (Bello *et al.*, 2021, Mohammadi Nasrabadi *et al.*, 2018) were included in the analysis.

Identification of the most frequent words and comparison in different years: In this stage, based on the frequency index of VoSViewer, the most frequently used words of Iranian scientific articles in the field of food security during the years of interest were identified. The top 10 words were used in order to identify the most used words for each time period.

Drawing the scientific map and thematic clusters: In this step, the scientific map of this area was drawn like the WoS category. The result of this process was identifying thematic clusters of words and finally extracting the main research trends. This section led to the analysis of 3969 out of 403262 keywords, in which 60% of the keywords (2381 keywords) with the highest relevance score were included in the analysis.

Repetition of the previous step in five-year intervals: In this step, the drawing of the scientific map and subject clusters was repeated for 5-year intervals to determine and compare the evolution of the scientific map of this field in-year interval.

Results

The search results led to 50444 publications from 4 databases of WoS, Scopus, PubMed, and Embase, and 34419 from ISC until June 2020. After the removal of 18,943 duplicated and 34419 unrelated articles by screening the titles, and 2506 articles with no abstracts available, 28995 scientific articles were extracted from the databases.

Publication trend

Figure 1 shows the frequency of Iranian publications in the field of food security by year.

Among the total number of articles retrieved, the highest number of documents (n=3990) was related to 2019, and the lowest number of documents (n=72) was published in 2001. The frequency of

publications in the 20-year time span showed an increasing trend. The observed decreased frequency of publication was in terms of conducting the search in the middle of 2020.

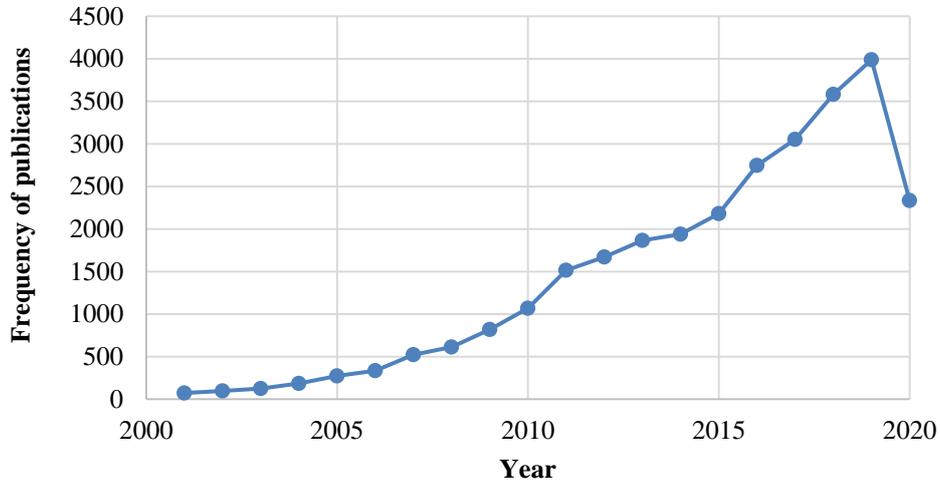


Figure 1. The frequency of Iranian publications in the field of food security by year (2001 – June 2020).

To calculate the growth rate of publications, two types of analysis were performed. First, point-to-point growth rate analysis is considered, which is shown in Figure 2. The growth rate varied ranging from 3.97% in 2014 to 55.65% in 2007. Second, in order to calculate the total average growth rate

from 2001 to 2019, Formula 1 was used. Thus, the average growth rate of publications in a 20-year time span was 23.53%.

Formula 1: Growth rate= $[(\text{frequency of published article in 2019}/\text{frequency of published article in 2001})^{1/\text{timespan}} - 1] * 100$

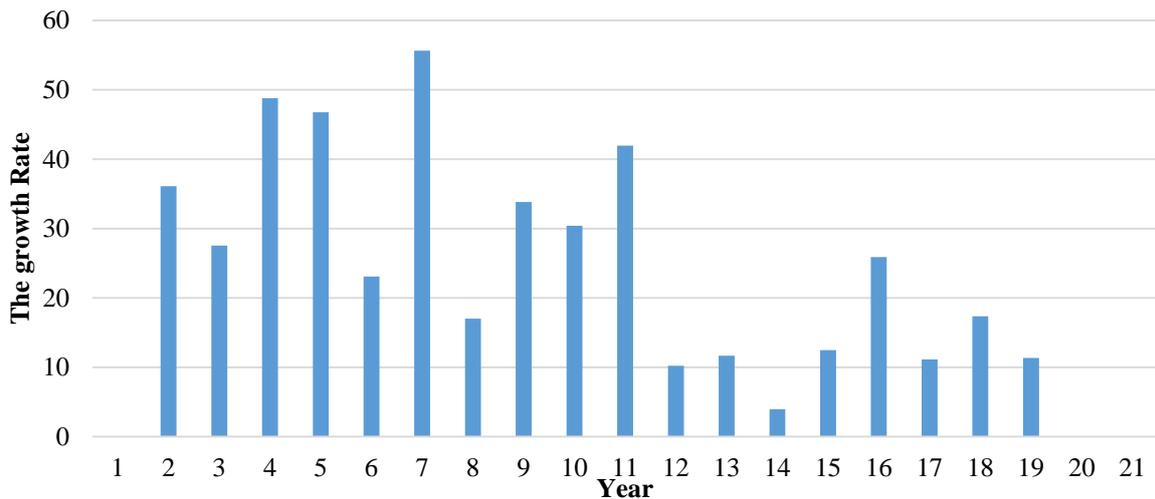


Figure 2. The growth rate of Iranian scientific articles in the field of food security during the years 2001 – June 2020.

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To model the publication growth, different regression models were checked. As observed for any well-established and yet growing scientific system, the field adhered to an exponential model (Figure 3). The exponential model can predict

approximately 96% of the frequency of Iranian scientific articles by year ($R^2=0.9596$). Moreover, the annual growth rate was 22.33% (exponent=0.2233), which was almost similar to the average growth rate calculated using Formula 1.

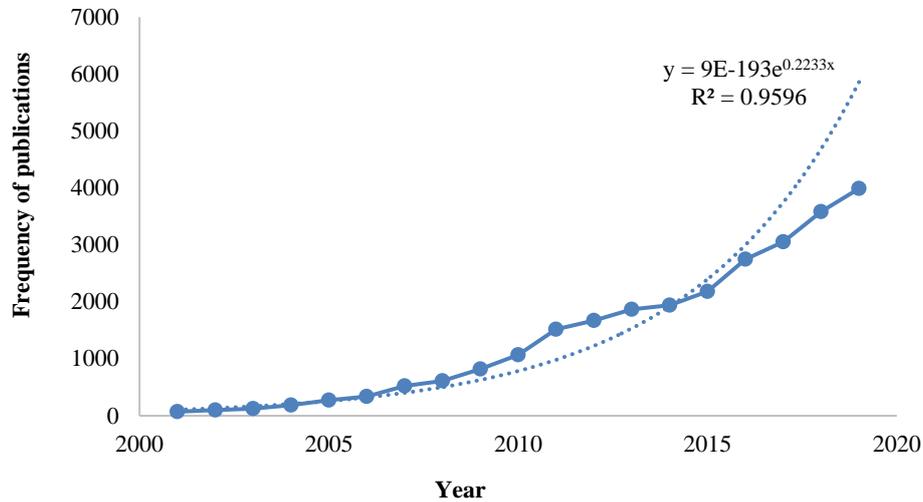


Figure 3. The growth model of Iranian scientific articles in the field of food security based on logistic regression.

The thematic categories and their weight in Iranian publications in the field of food security from 2001 to 2020

Table 1 summarizes the subject categories of the journals that have published Iranian articles in food security field and their weights. According to the results, the journals covered 10 subject categories, with agriculture, nutrition and dietetics, environmental and occupational health having the most weight, and hospitality, polymer, and thermodynamics having the least weight.

Figure 4 shows a map of the subject categories of Iranian scientific journals in the field of food security from 2001 to 2020. As it is shown, the subjects of nutrition and dietetics, and entomology were the most correlated, and the subjects of

management, thermodynamics, and hospitality were the least correlated.

Table 1. Thematic disciplines of Iranian scientific articles in the field of food security during 2001–2020.

Journal scope	Weight
Agriculture	793
Nutrition and dietetics	670
Environmental and occupational health	553
Management	408
Plant	379
Entomology	367
Fishery	137
Thermodynamics	107
Polymer	80
Hospitality, leisure, sport and tourism	20

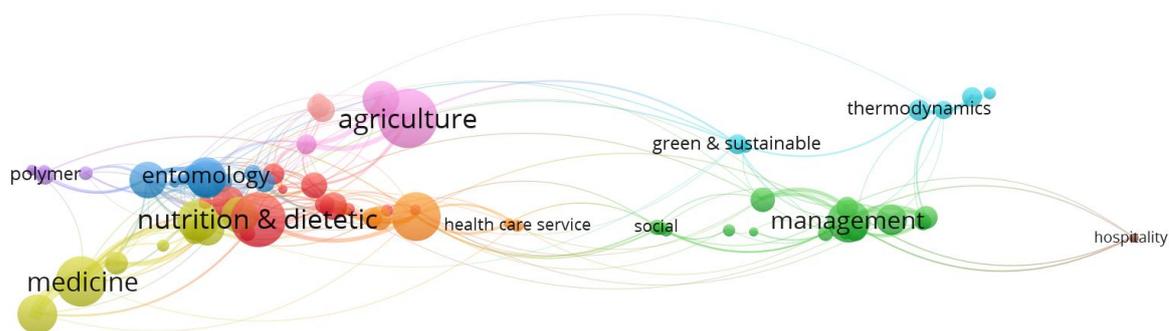


Figure 4. Scientific map of subject disciplines of Iranian scientific articles in the field of food security from 2001 to 2020.

The keywords of Iranian publications in the field of food security from 2001 to 2020

The content analysis of the articles based on the keywords used in 28,995 published documents in the field of food security by Iranian authors led to the finding of 403262 unique keywords. The keywords with the highest frequency (> 1500) are listed in **Table 2**. The most widely used keywords in the field of food security by Iranian authors in the time span from 2001 to 2020 were treatment, plant, age, risk, and consumption, and were repeated 3411, 2920, 2798, 2757, and 2273 times, respectively.

Subject areas and co-words networks of Iranian publications in the field of food security from 2001 to 2020

Following the identification and analysis of the co-words network, 4 thematic clusters were identified. The clusters are shown in **Table 3**. Each

cluster is composed of various concepts. The subject area of each cluster was specified based on the words in each cluster.

Table 2. The most repeated keywords in Iranian scientific articles in the field of food security during 2001–2020.

Keyword	Frequency
Treatment	3411
Plant	2920
Age	2798
Risk	2757
Consumption	2273
Patient	2266
Climate change	2157
Efficiency	2156
Disease	1700
Prevalence	1690
Diet	1660
Cost	1602

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field of nutrition and food security. Climate change is believed to be the most important factor affecting sustainable development. Climate change was shown to inversely affect natural resources, human health, food security, and the environment (Savari and Zhoolideh, 2021). Climate fundamentally determines what to cultivate and the extent of agriculture (Azadi *et al.*, 2019). Therefore, negative climate change can reduce rural areas' household income, consequently reducing food security among low-income families (Savari and Zhoolideh, 2021). Despite the fact that climate change affects food security (Haque and Khan, 2022), the relationship between food security keywords and climate change was not significant. There are two possible reasons for this. First, not enough research was done in these areas. Or, if so, the researchers did not explicitly discuss it. Second, the reason for the lack of relationship can be that in the present study, the study analysis was based on explicit words, and in the meantime, thesaurus as a simple type of semantic tool was used, which can be a limitation in this study. As Iran is facing climate change (Mansouri Daneshvar *et al.*, 2019), special attention should be paid to this area. In addition, agricultural studies were always conducted in the two-decade time span. Although it was well-established that a sustainable Argo-food system is able to address climate change and food insecurity (Wijerathna-Yapa and Pathirana, 2022), agricultural studies are not properly considered.

Food production is negatively affected by air pollution. Consequently, it can decrease food security (Kaur, 2022). Regarding air pollution in Iranian cities, studies between food security and air pollution are very necessary. Fortunately, in the last 5-year period, air pollution has gained concern. However, further studies are needed to find enough evidence to gain attention to air pollution and its harmful effect on health for policymakers and stakeholders

A gap in this research was assessing food and nutrition literacy among the Iranian population. Some projects were done (Doustmohammadian *et al.*, 2019, Khorramrouz *et al.*, 2020), but as a direct

relationship between these phenomena (West *et al.*, 2020), planning programs in the case of low literacy and extended research are necessary to find Iranian food and nutrition literacy,

This is the first study that surveyed nutrition and food security research amp in Iran. The researchers could not compare the growth trend and areas of study with a predefined road map in terms of the lack of a framework for nutritional research. Thus, it is necessary to develop such a research map to find needs, gaps in data, and the food insecurity situation in Iran. Moreover, studies on different ethnic, religious, and geographical groups have not been conducted frequently. It should be considered for future studies to investigate different demographic groups.

As this was the first study conducted in this field, no similar study was available to be compared to the situation in Iran, and the study analysis was based on explicit words, in the meantime, thesaurus as a simple type of semantic tool was used, which could be a limitation in our study.

Policy implications

The optimal security in food and nutrition is a key factor in improving health among families and society. Therefore, in order to provide nutrition and food security, policymakers and health authorities should have targeted strategic plans based on robust evidence. The resulting map of the present study showed that during the last two decades, scattered clinical studies along with agricultural and climate research were dominant in the field of nutrition and food security. However, community nutrition or food and nutrition policy research have been undermined by the researchers. Hence, designing a comprehensive and purposeful research roadmap to improve nutrition and food security is of vital importance in Iran.

Conclusion

Based on the present study, an increasing trend was observed in the crude number of publications on nutrition and food security and safety during the past two decades in Iran. Iranian researchers have vastly studied clinical nutrition, malnutrition, and

diet, and in recent years, food production and climate change and their relation to food security with less attention from public health and policy's point of view towards this issue. Noticeably, there was no comprehensive map and efficient collaboration among different sectors to approach nutrition and food security from different aspects. It seems that the best guideline to consider such an overarching map and define other sectors' roles would be the national nutrition and food security plan of Iran prepared periodically by the Ministry of Health. Moreover, further studies are needed to explore the distribution of food and nutritional studies in all geographical, socio-cultural, and economic clusters in Iran. Finally, new studies should be conducted to fill the research gap with a focus on public health and policy views.

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Authors' contributions

Keshani P, Mohammadi-Nasrabadi F, and Joulaei H conceptualized the study. Keshani P, Yaghtin M, Sotudeh H, and Mohsenpour MA conducted the study. Yaghtin M and Sotudeh H conducted data analysis. Keshani P, Yaghtin M, Sotudeh H, Mohammadi-Nasrabadi F, Joulaei H, and Mohsenpour MA interpreted the results. Mohsenpour MA prepared the first draft. Keshani P, Yaghtin M, Sotudeh H, and Joulaei H substantially revised the manuscript. All the authors read and approved the final manuscript.

Conflict of interest

The authors declared no conflict of interest.

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