



## Food Security Challenges for Hospital Sustainability

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### ABSTRACT

**Background:** Food security and safety are becoming major concerns worldwide. Providing food security and safety in hospitals is particularly challenging since their populations are diverse in dietary and nutritional requirements and more vulnerable to foodborne illnesses. The aim of this research is to promote hospital sustainability by addressing food security and food safety. **Method:** This study uses a quantitative method with a bibliometric study approach. This research has 212 articles from the Scopus database. All the documents were collected simultaneously in August 2022. The selected article encompassed the years from 2017 to 2021, including document type, publication stage, source type, language, and subject area. The data was analyzed using VOSviewer and NVivo analytical tools. **Results:** The results of the studies on food security and safety increased from 2017-2022 with current trends in hospital sustainability, food waste, and waste management in food. Our study has identified four clusters: hospital food services, hospital sustainability, nutrition, and food safety. Food security is positively correlated with assessment, challenges, measurement, status, and sustainability (Pearson correlation score is 1). Disease control, proper waste management, and environmental health are all associated with food safety (Pearson correlation score  $\pm 0.79-0.64$ ). **Conclusion:** Food safety and security are critical to achieve hospital sustainability, therefore awareness-raising efforts must continue. It is recommended that hospital stakeholders, food service providers; public and private sectors adopt policies and guidelines to disseminate information on food safety and security concerning hospital sustainability.

### Introduction

Food and nutrition play an essential role in the well-being and recovery of patients. Therefore, they deserve to be considered as an

integral part of patient care, rather than simply an operational cost. For most patients, hospital food services are their only source of nutrition during

hospitalization and are essential to healthcare management (Teka *et al.*, 2022). Hospitals have the potential to take the lead and serve as a model for other sectors in educating communities on the significance of fresh, local, and sustainable food. Hospital food services aim to offer patients nourishing meals that support their rehabilitation and health, as well as accommodating the patients' medical circumstances through healthy menu options (do Rosario and Walton, 2020). Several hospitals implement the HACCP (Hazard Analysis and Critical Control Points) system to guarantee nutritious meals (Osaili *et al.*, 2017). Food servings in hospitals are at risk of getting contaminated. Food handlers ensure food safety and prevent foodborne illnesses (Lee *et al.*, 2017). Inadequate food handling hygiene practices can result in unsafe serving of food to patients, which can cause a hospital-wide outbreak of the disease.

The issue of food safety and security has emerged as a significant global concern following the outbreak of COVID-19. Ensuring the safety of food service has been a significant challenge for producers, customers, and public health officials (Azanaw *et al.*, 2019). Food needs to be handled with caution throughout its value chain, from production to preparation of food for consumption to prevent contamination by biological (algae, bacteria, fungi, and parasites), chemical (additives, pesticides, microbial, and plant toxins), and physical (fragments of stone, wood, and glass) hazards. Additionally, food safety is essential for customers, restaurants, and regulatory authorities worldwide (Al Banna *et al.*, 2022). Osaili *et al.* also advocate for the importance of food safety for customers, restaurants, and regulatory bodies (Osaili *et al.*, 2017). Furthermore, the hospital's food service plays a vital role in patient care as it is necessary for patient recovery and treatment.

Sustainability in hospitals is increasingly recognized as a crucial aspect of improving social and healthcare outcomes. Sustainability can be viewed as a quality area in healthcare, extending the responsibility of health services to both current and future patients (Mortimer *et al.*, 2018). As socially impactful structures, hospitals are

responsible for their patients' food safety and security due to food purchasing, energy use, and waste generation. Hospital food services contribute significantly to environmental and food security impact because they generate a significant sign throughout the entire food supply chain (production, distribution, preparation, consumption, and waste disposal) (Carino *et al.*, 2020). Therefore, implementing sustainable approaches to decrease food waste in hospitals can minimize environmental impacts and operating expenses, and improve food security.

Bibliometric analysis is a widely used and rigorous technique for exploring and interpreting huge amounts of scientific data. In recent years, bibliometric analysis has become incredibly popular in business research (Donthu *et al.*, 2021, Khan *et al.*, 2021). Scholars utilize bibliometric analysis for various purposes, such as examining the intellectual framework of a particular area in the existing literature and identifying novel trends in the performance of articles and journals, collaboration patterns, and research constituents (Donthu *et al.*, 2021). Previous studies on food security and safety through bibliometric analysis indicates that food security has been enhanced and research findings have gradually transitioned from theory to practice and become more useful and implementable (Li and Song, 2022). Furthermore, a systematic review from Carino *et al.* mentioned that hospital food supply chains demonstrate how environmental sustainability can be emphasized and assessed and the ways that qualified nutritionists and dietitians can participate (Carino *et al.*, 2020). In the future, food security research needs to focus more on the manner of interaction and coordination among the economy, environment, and society, with the help of technological advances and policy management (Xie *et al.*, 2021). In food safety, Future research should identify and deconstruct impediments to the application of safe food handling procedures by considering the type and frequency of training and the material presented (Tamene *et al.*, 2022). This future research topic is linked with the objectives of this recent study.

This review aims to systematically identify and synthesize research on the sustainability of hospital food services across the food security and safety to improve the strategies of the hospital sustainability.

### Materials and Methods

This research utilized a qualitative approach for the literature review. Using the database (<https://www.scopus.com/>), an acknowledged peer-reviewed journal worldwide was gathered. The Scopus database was searched using the keywords “food AND security AND in AND hospital” or “food AND waste AND in AND hospital” from 2017 until 2021. The bibliometric map was subsequently created using three different analysis forms: Scopus menu search results, the analysis of software VOSviewer, and the analysis of software NVivo 12 Plus. The inclusion criteria for this research were five years from 2017 to 2021, document type select article exclusively, the publication stage was final, source type only from journal, only choose English language article, and the selected subject area were medicine, health profession, and environmental science.

Scopus search results were investigated using a descriptive approach according to year of publication, publisher, country, title of publication and research topic. Meanwhile, a bibliometric map of research progress based on the significant issue of food safety and food security in the hospital was established using VOSviewer. The obtained data were refined several times in order to obtain the best data on food safety and food security. The association between indicators, variables, and keywords utilized in previous studies was tested using the NVivo 12 program.

This correlation was concluded to assess the food safety and security in the hospital. The VOSviewer software was also applied to map the most prevalent terms used in research on hospital food safety and food security. Based on the keyword of the author or title, the context of food safety and security in the hospital was determined. Ultimately, the following inquiry was made: (TITLE-ABS-KEY (food AND security AND in

AND hospital) OR TITLE-ABS-KEY (food AND waste AND in AND hospital)) AND (LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012)) AND (LIMIT-TO (SUBJAREA, "MEDI") OR LIMIT-TO (SUBJAREA, "ENVI") OR LIMIT-TO (SUBJAREA, "HEAL")) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j")). This search turned up 212 documents.

The investigation sorted the dimensions of analysis, the units using bibliometric searches, and mixed citations were implemented for the bibliometric study-co-authorships assisted in examining the social structure of the research field. Bibliographic coupling which employed multiple references shared by the two documents as a measure of comparison, co-occurrences to comprehend the patterns of document sets supporting the research, and co-citations, which may aid in identifying the conceptual framework of the study's subject were among the citations. The authors applied co-occurrence analysis of keywords, co-authorship analysis of significant authors and country distribution, co-citation analysis of cited sources, citation analysis of documents and organizations, and co-citation reference network analysis in food safety and security in the hospital research to generate and produce the figures and data from the cited articles.

### Results

#### *Collected articles*

To eliminate any bias introduced by the expansion of the database, all data were collected at the same time frame, in August 2022. **Figure 1** illustrates the processes used in this research to provide a comprehensive study image. Data were exported in the RIS export file





hazardous waste on land, in water, and in the air, including APIs (Active Pharmaceutical Ingredients), medical waste will also affect the general population's health and the state of the country's economy (Chisholm *et al.*, 2021). Furthermore, if general waste is adequately separated from healthcare waste, it can be collected for biofuels, boosting the nation's economy, and providing a wealth of sustainability options (Chisholm *et al.*, 2021).

**Geographical distribution**

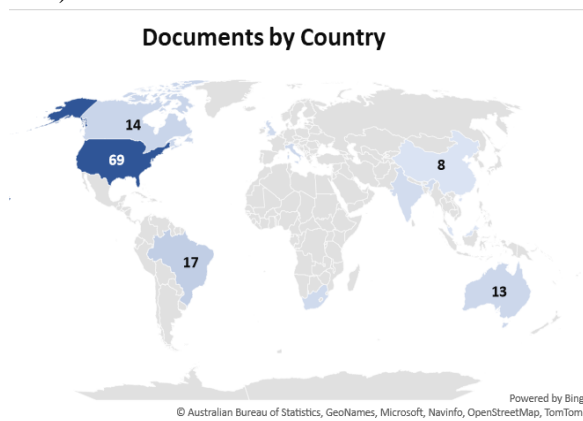
Different shades of black represent various levels of productivity. Therefore, the greater the production, the darker the shade of black would be. The top three countries producing the most documents illustrated in **Figure 4** were the United States (n=69), Brazil (n=17), and Canada (n=14).

According to the report, the United States ranked first as the nation with the most research on food safety and food security initiatives in hospitals compared to other nations. It ranked first in terms of citations. Meanwhile, Brazil came in second with regard to documents by country and became the last in terms of citations (Figure 5). Studies on food safety and food security in the hospitals in 71 countries were based on several articles. Using "Microsoft Excel 365" to create the map, the United States, Brazil, Canada, Australia, Italy, South Africa, the United Kingdom, India, China, and Malaysia were geographically divided to manifest scientific production by country (**Figure 4**). The top 10 nations by documents are displayed in the figures below, arranged by documents (**Figure 4**) and citations (**Figure 5**).

**Trending topics**

According to the bibliography periodicity

parameters of at least five words each year, the size or diameter represents the frequency of the author's keyword phrases. **Table 1** presents the prevalence of terms including food (n=17378), health (n= 14164), care (n= 7770), waste (n= 7478), and hospital (n= 7295) from 2017 to 2021. In terms of trending topics, recent research has also highlighted that in response to this research, researchers have discovered food safety (Moreno *et al.*, 2018, Shalowitz *et al.*, 2017), food security (Badri-Fariman *et al.*, 2021, Sackey *et al.*, 2018, Shalowitz *et al.*, 2017), and hospital food waste (Alshqaqeeq *et al.*, 2020, Carino *et al.*, 2021, Eriksson *et al.*, 2020, Gomes *et al.*, 2020, Malefors *et al.*, 2019, Papargyropoulou *et al.*, 2019, Rathnayake and Dalpatadu, 2020, Simzari *et al.*, 2017)

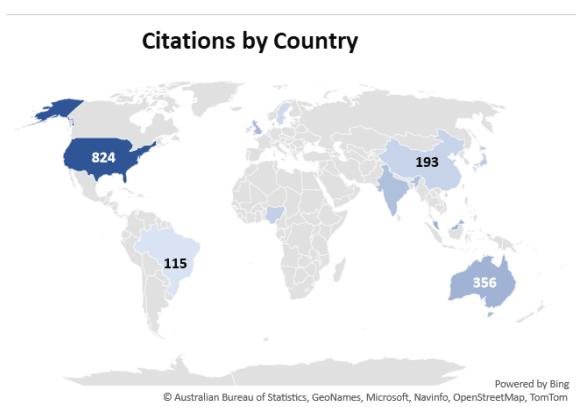


Country by Documents	Citations
United States	824
Malaysia	366
Australia	356
United Kingdom	328
India	291
Japan	231
Nigeria	214
China	193
Sweden	163
Brazil	115

Figure 5. Citations by Country.

Table 1. Trending Topics of Keywords.

Word	Length	Count	Weighted Rate (%)	Word	Length	Count	Weighted Rate (%)
Food	4	17378	2.5	Diet	4	1703	0.25
Health	6	14164	2.04	Malnutrition	12	1522	0.22
Care	4	7770	1.12	Environmental	13	1506	0.22
Waste	5	7478	1.08	Covid	5	1446	0.21
Hospital	8	7295	1.05	Quality	7	1401	0.2
Human	5	3637	0.52	Household	9	1388	0.2
Service	7	3486	0.5	Patients	8	1350	0.19
Insecurity	10	3366	0.48	Dietary	7	1331	0.19
Nutritional	11	3250	0.47	Factors	7	1327	0.19
Security	8	3054	0.44	Cost	4	1322	0.19
Management	10	2974	0.43	Emergency	9	1320	0.19
Intake	6	2944	0.42	Research	8	1255	0.18
Risk	4	2838	0.41	Education	9	1190	0.17
Nutrition	9	2701	0.39	Community	9	1168	0.17
Social	6	2231	0.32	Population	10	1130	0.16
Humans	6	2187	0.31	Data	4	1121	0.16
Public	6	1958	0.28	Major	5	1097	0.16
Medical	7	1871	0.27	Primary	7	1094	0.16
Assessment	10	1850	0.27	Infection	9	1053	0.15
Water	5	1792	0.26	Department	10	1034	0.15



Country by Documents	Documents
United States	69
Brazil	17
Canada	14
Australia	13
Italy	13
South Africa	12
United Kingdom	12
India	11
China	8
Malaysia	8

Figure 4. Documents by Country.

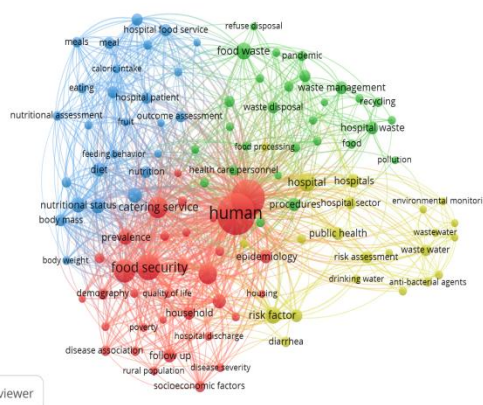


Figure 6. Network Visualization.

**Keyword analysis**

The obtained keywords were analyzed using VOSviewer (Figure 6). VOSviewer is a program for the creation and visualization of bibliometric networks. The network visualization of each cluster is observed by differentiating the color code for each cluster (Figure 6). In this study, the employed colors are red, green, blue, and yellow. The network visualization represents all the articles with underlying themes that appeared frequently in our investigation in Figure 6 of this report. The

bibliometric mapping of food safety and food security in hospitals was divided into four clusters using VOSviewer (Table 2). In Table 2, the four clusters are divided into four themes: cluster one (red color) discusses food service in hospitals

(31%), cluster 2 (green color) introduces hospital sustainability (25%), cluster 3 (blue color) considers nutrition (24%), and cluster 4 (yellow color) discusses food safety (20%).

Table 2. The Themes' Cluster of Keywords Analysis.

Themes' Cluster	Items	Total	Rate
Cluster 1: Food service in hospital	Catering service, child nutrition, demography, disease association, disease severity, epidemiology, follow-up, food insecurity, food security, food supply, health care access, health care delivery, health care facility, health status, hospital discharge, household, household income, housing, human, humans, multicenter study, poverty, prevalence, primary health care, primary medical care, public hospital, quality of life, rural area, rural population, social determinants of health, social status, social support, socioeconomic factors, socioeconomic	34	31%
Cluster 2: Hospital Sustainability	Climate change, coronavirus disease 2019, covid-19, economics, food, food waste, government, health care, health care cost, health care personnel, health care policy, health care system, health care utilization, hospital waste, organization and management, pandemic, pollution, procedures, recycling, refuse disposal, sars-cov-2, sustainability, sustainable development, traffic and transport, university hospital, waste disposal, waste management, world health organization	28	25%
Cluster 3: Nutrition	Body mass, body weight, caloric intake, diet, dietary intake, eating, feeding behavior, food assistance, food intake, food service hospital, fruit, hospital food service, hospital patient, hospitalization, hunger, malnutrition, meal, meals, nutrition, nutritional assessment, nutritional status, nutritional value, outcome assessment, patient satisfaction, plate waste, vegetable	26	24%
Cluster 4: Food safety	Anti-bacterial agents, anti-infective agent, diarrhea, drinking water, environmental monitoring, food contamination, food processing, hospital, hospital administration, hospital sector, hospitals, microbiology, public health, risk assessment, risk factor, risk factors, statistics and numerical data, waste water, wastewater, water pollutant, water pollutant chemical, water pollution	22	20%

**Keyword relation**

Table 3 exhibits the Pearson correlation between food security and food safety with assessment, challenges, measurement, status, sustainability, health care access, disease control, proper waste management, environmental health, health promotion, health education, and public health service. Pearson correlation coefficients ranged from 1 to 0.55. According to the top results, the point-biserial correlation coefficient revealed a positive association between the overall food security scores for assessment, challenges, and measurement, with a total value is 1. Moreover, the point-biserial correlation coefficient disclosed that food safety scores were positively associated with healthcare access, disease control, and proper

waste management, with correlation values ranging from 0.86 to 0.78.

**Discussion**

Nutrition is an essential element of the patient recovery in hospitals. In an acute care setting, meeting patients' nutritional needs can be challenging due to several extenuating factors, containing patient appetite and clinical symptoms, food accessibility and availability, menu quality, food choices, and specific patient preferences (Keller *et al.*, 2015). Credentialed nutritionists and dietitians are in an excellent position to positively influence all facets of the hospital food system positively (Carino *et al.*, 2020). The leading cause of malnutrition in hospitals, and one factor which can exacerbated it, is reduced dietary intake during

a hospital stay paired with increased energy requirements (Simzari *et al.*, 2017). The provision of high-value malnutrition care needs to be treated as a severe health concern and appropriate measures need to be taken to promote government policies needs to be taken (Simzari *et al.*, 2017).

**Table 3.** Relation of Hospital Sustainability Keywords.

Code A	Code B	Pearson correlation coefficient
Food security	Assessment	1
	Challenges	1
	Measurement	1
	Status	1
	Sustainable	1
	Health care access	0,868
Food safety	Disease control	0,791
	Proper waste management	0,787
	Environmental health	0,64
	Health promotion	0,563
	Health education	0,557
	Public health service	0,557

The established models of care support interdisciplinary teams and systemic methods. Numerous nutrition care procedures can be systematized to enhance efficiency, as they can be performed by operational and support employees, nurses, doctors, allied health professionals, administrators, and volunteers (Bell *et al.*, 2021).

The staff that provides nutritious food for patients plays an essential role in hospital food safety. Food handlers are crucial in ensuring strict adherence to the process requirements for food safety (Al Banna *et al.*, 2022, Asmawi *et al.*, 2018). Poor hygiene among food handlers can make it hazardous to serve patients food, which can result in an outbreak of the disease throughout the hospital. Therefore, it is essential to maintain food safety in hospitals. Food safety is fundamental for hospital food service to patients, food service establishments, and regulatory agencies (Al Banna *et al.*, 2022, Osaili *et al.*, 2017). Unsatisfactory behavior at food service

establishments is critical in developing foodborne illnesses (Al Banna *et al.*, 2022).

During the COVID-19 period, additional steps must be considered to ensure food safety and protect the integrity of the food chain (World Health Organization, 2020) Workers are advised to wear gloves, to change them regularly, particularly after doing a task unrelated to food, and wash their hands whenever the gloves are changed or removed since human interaction with food is a significant factor determining the risk of food product contamination (Ceniti *et al.*, 2021). The Food and Drug Administration (FDA) recommends four basic food safety processes: cleaning, segregating, cooking, and chilling (Food and Drug Administration, 2020). All surfaces that come into contact with food, containing dishware, utensils, and drinking equipment, need to be washed, rinsed, and sanitized. Protecting food workers from COVID-19 infection, preventing exposure to or transmitting the virus, and improving food hygiene and sanitation procedures are the greatest challenges confronting the food industry (Ceniti *et al.*, 2021).

Public concerns about food safety and food security in the post-COVID-19 period are significant, and knowledge of the instruments to address them is restricted. Multiple protocols are needed to avoid unnecessary health risks. Protecting consumer health and safety requires effective food control systems (Han *et al.*, 2021). The COVID-19 crisis is initiating to focus authorities' attention on important food security and health issues, including food security hazards and measures to reduce them and better communication with the public and the private food sector (Han *et al.*, 2021). Moreover, the stakeholders, including the food industry, legislators, governments, and consumers, must all actively participate in implementing any alterations towards a more resilient future for food safety (Han *et al.*, 2021). The pandemic's severe disease transmission and diverse patient needs have significant implications for hospital capacity and general efficiency. National healthcare systems must adapt to the novel situation in order to meet



the challenges of the COVID-19 pandemic and remain viable in such circumstances (Pamučar *et al.*, 2020). As the COVID-19 pandemic has all the specific characteristics, it is mandatory to continuously assess the strengths and weaknesses of healthcare systems. A comprehensive analysis should be conducted to develop a plan based on adaptive models of healthcare system organization.

Healthcare facilities are critical to the management, prevention and treatment of disease and contribute to sustainability. Hospital food services are still associated with hospital sustainability. It is critical to collect and utilize individual's viewpoints in managerial roles and throughout the food supply chain for shifting towards to sustainable hospital food services (Carino *et al.*, 2021). The hospital food supply chain can have an impact on environmental sustainability. In order to achieve permanent change, it is essential to have a thorough comprehension of how food service systems operate within the embedded healthcare and policy frameworks (Carino *et al.*, 2021). In particular, the environmental impact of hospitals is significantly influenced by the foodservice industry (Carino *et al.*, 2021). In a cost-constrained and patient-centered healthcare environment, hospital food services are under increasing scrutiny to reduce costs and the environmental impact of food waste (Goonan *et al.*, 2014, Ofei *et al.*, 2014, Williams and Walton, 2011). Alharbi *et al.* recognized that waste from government hospitals Saudi Arabia includes paper (27,000 tons), plastic (15,000 tons), food (10,000 tons), glass (8000 tons), and metal (7000 tons) each year. Unfortunately, none of the produced materials are recycled and wind up in landfills instead (Alharbi *et al.*, 2021).

Hospital food services are still linked to hospital sustainability. Given the potential of health professionals contain as sustainability champions and the widespread communication of the relationship between environmental sustainability and health, hospitals are appealing for sustainability activities (Hubbert *et al.*, 2020). The health system of each country uses a significant proportion of its financial and human resources,

reflecting the economy's sustainability (Alharbi *et al.*, 2021). Environmental sustainability allows hospitals to focus more resources on patient care and reduce operating expenses. Sustaining successful interventions in practice is crucial to intensify practitioners' confidence in the benefits of implementing novel interventions, improving health outcomes, and facilitating research waste (Cowie *et al.*, 2020). By improving hospital's surroundings and general impression and encouraging loyalty among patients concerned about the environment, sustainability can contribute to a better overall patient experience.

From the results of this study, it was identified that food security and food safety are components which support hospital sustainability. Assessment, challenges, measurement, status, sustainability, and access to healthcare are positively correlated with food security. The concept of food security is widely acknowledged in the extensive literature as being based on sustainability (Béné, 2020, Béné *et al.*, 2019). Food security and nutrition must embrace sustainability in light of emerging trends including climate variability and the natural resource deterioration (Food and Agriculture Organization, 2020). Food safety considerations should be incorporated into sustainable and food security solutions from the outset (Vågsholm *et al.*, 2020). In order to attain food security, needs food safety, public health, and sustainability must all considered as selecting the methods and tactics.

Meanwhile, food safety correlates with disease control, appropriate waste management, environmental health, health promotion, health education, and public health services. The value of training and retraining as a technique for improving staff knowledge and attitudes towards food safety and hygiene in healthcare facilities (Eslami *et al.*, 2022). The hospital management must ensure that service providers comply with legislation and implement the necessary criteria for the food safety management system. Megatrends on a global scale, such as climate change, population growth and aging, urbanization, and increasing affluence, will impose new difficulties on the food safety industry and generate novel

expectations on producers, manufacturers, marketers, retailers, and regulators (King *et al.*, 2017). Despite numerous competing agendas and obstacles to change, there is a shared desire for ecologically friendly hospital food services. It was obvious that ideas for quick-fix practice modifications could be implemented, and stakeholders now have the opportunity to support these "quick wins" within their organizations (Carino *et al.*, 2021). Policymakers can provide precise direction and support through policy and governance.

### Conclusion

To support patients' recovery in the hospital, hospital food services must not only supply nutritious food, but also ensure that the provided food is harmless for patient consumption and does not lead to food-borne illness. Food safety considerations include disease control, appropriate waste management, environmental health, health promotion, health education, and public health services. Focusing on the implementation of risk-based food safety assessments, these findings demonstrate that challenges, measurement, status, sustainability and access to health care were part of food security. In conclusion, food safety and food security are essential to achieve hospital sustainability and need to continue the discussion and awareness. The recommendation for hospitals, food service stakeholders, government, and the private sector is to enact policies and guidelines to provide information on food safety and security for hospital sustainability. To make progress in finding solutions to these challenges, the researchers must continue to utilize foundational scientific research to inform regulations and practices to increase food safety and food security to improve hospital sustainability.

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### Conflict of Interest

The authors declare that there is no conflict of interest in this study.

### Authors' contributions

Ulfa M: Wrote the paper, conceived and designed the analysis, performed the analysis. Aktas N: Study conception and contributed data. Rajikan R: Study conception and designed the analysis. Quoc Anh N & Reza Sobhani S: Interpret the results. All authors reviewed the results and approved the final version of the manuscript.

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