

Hospital Food Waste Trends: A Bibliometric Analysis

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Abstract:

Objective: Food waste in hospitals has a significant impact on environmental sustainability. The effect of food waste includes the potential for pollution, eutrophication, and global warming, all of which are highly destructive to the Earth's ecology. This study aims to determine the trends of hospital food service based on hospital waste to achieve a sustainable hospital.

Material and Methods: This study examined 137 articles from the Scopus database using the descriptive-analytic method. The records issued between 2018 to 2022 that were gathered based on the keywords "hospital," and "food," and "waste" were used in this exploration investigation.

Results: The result indicated that the three-year (93 papers) analysis trend of hospital food waste has been toward developing sustainable hospitals. The top three keywords are waste (3.3%), food (3.09%), and hospital (2.06%). The hospital food waste was positively associated with the food, food service, and hospital assessment, with correlation values ranging from 0.76 to 0.85 (p -value \geq 0.70). The cluster's themes on hospital food were waste food contamination (36.13%), environmental sustainability (34.45%), and hospital food services (29.4%).

Conclusion: Addressing hospital food waste is crucial for achieving sustainable hospital development. Managing food waste is essential to achieve sustainability in hospitals as it produces the highest amount compared to other sectors.

Keywords: environmental impact, food, hospital food service, sustainability, waste management

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Introduction

Hospitals play a crucial role in connecting human health with the environment. Food waste has historically been a larger issue in hospitals than in other food supply chain sectors¹. A study found that food waste contributes between 20–30% of total hospital waste, which ranges from 17 to 74%². According to Van Bokhorst et al. (2012), when food is wasted in hospitals, patients may consume less food, leading to a decline in their nutritional status³. This reinforces the importance of reducing food waste in healthcare facilities to ensure patients receive the necessary nutrition for recovery³. The root cause of this situation has negative impacts on health, the economy, society, and the environment⁴.

Numerous factors contribute to the increase in food waste within hospital settings. These factors encompass the patient's clinical status, the availability and type of servings offered, the food production system, food preferences, and the food quality⁵. Research conducted in Italy reveals that a staggering 41.6% of the food served to patients in three hospitals goes to waste daily⁶. There are two significant outcomes resulting from the issue: economic and environmental setbacks. This situation necessitates allocating financial resources to manage waste effectively, leading to increased carbon dioxide (CO₂) emissions⁷.

The issue of hospital food waste profoundly impacts the environment and sustainability. It is a matter of concern since this waste contributes to the adverse effects of global warming, acidification, and eutrophication. These environmental challenges are highly detrimental to the overall health of our planet and need to be addressed with immediate attention and action⁸. Hospital food waste is caused by food preparation and many unaddressed patient meals. A concerning rise in food waste has become apparent and necessitates immediate attention⁹. Hospitals must adopt a sustainable food service system to reap

financial and social benefits. This is crucial for promoting sustainability in the healthcare sector and developing sustainable hospitals¹⁰. Many healthcare organizations have advocated for eco-friendly health practices, prioritizing sustainable development and balancing social, economic, and environmental concerns¹¹. To achieve sustainable hospitals, healthcare establishments must enforce food waste management¹². Achieving a sustainable hospital environment requires a holistic approach that involves policymakers, governmental and non-governmental organizations, and the community. This approach must prioritise the conservation of available resources and the enhancement of waste management efficiency. Multiple stakeholders must be involved to ensure that this goal is achieved¹³. This study examines the relationship between hospital food waste and sustainable development. The manuscript is organized into the following sections: introduction, materials and methods, results, discussion, and conclusion.

Material and Methods

A qualitative literature review study was used in this research strategy. The Scopus database (<https://www.scopus.com/>), a widely used database of peer-reviewed journals, was searched to gather research data. Using the terms “hospital”, “food”, and “waste”, with publication dates ranging from 2018 to 2022, searches were done in the Scopus database. Due to the growing interest in the study of hospital food waste over the past five years, many scholars have devoted their attention to this issue. The authors aim to capture the development trend in the hospital food waste research field. It is crucial to incorporate the latest references to gain a fresh perspective. The researcher chose the Scopus database due to its meticulous inclusion process. Articles undergo a rigorous selection process, making it a curated database that is highly reliable and

accurate. Published articles are submitted for possible review and selection based on quality and scientific rigour criteria. The selection process is carried out by an external Content Advisory and Selection Board (CSAB) consisting of editorially independent scientists, each of whom is an expert in their respective field. This ensures that only high-quality curated content is indexed in the database and confirms Scopus' credibility¹⁴. Another thing to consider is that many studies on hospital food waste are published in the Scopus database.

All data were collected over the same timeframe in January 2023 to eliminate the bias brought on by the database expansion. The inclusion criteria are the year 2018–2022, selected subject area, document type “Article” Publication stage “Final” source type “Journal” and language “English”. From the data searches and data screening results, 137 documents were analysed (Figure 1). The data were exported to RIS file format to gather information for the study map. Subsequently, the bibliometric leadership map was established using Scopus menu search results analysis, VOSviewer software analysis, and NVivo 12 Plus software analysis¹⁵. The steps in selecting articles were adapted from Page et al. (2021)¹⁶.

The researchers searched a Scopus database to analyse hospital and food waste research and look into the relevant factors such as publication year, publisher, and country. The authors also utilised VOSviewer to create a bibliometric map and track research progress on hospital food waste. We frequently reviewed the data to identify important information and tested relationships between variables, indicators, and keywords using NVivo 12 Plus. Moreover, we employed VOSviewer to visualise the most frequently occurring keyword, "hospital food waste". We gained insight into the context of hospital food waste by analysing author and title keywords.

The researcher used various methods to study their research field. They analysed social structure using co-authorships, compared references using bibliographic

coupling, identified patterns using co-occurrences, and determined the conceptual framework using co-citation. They generated figures and data by analysing keywords, influential authors and country distribution, cited sources, documents and organisations and food waste hospitals.

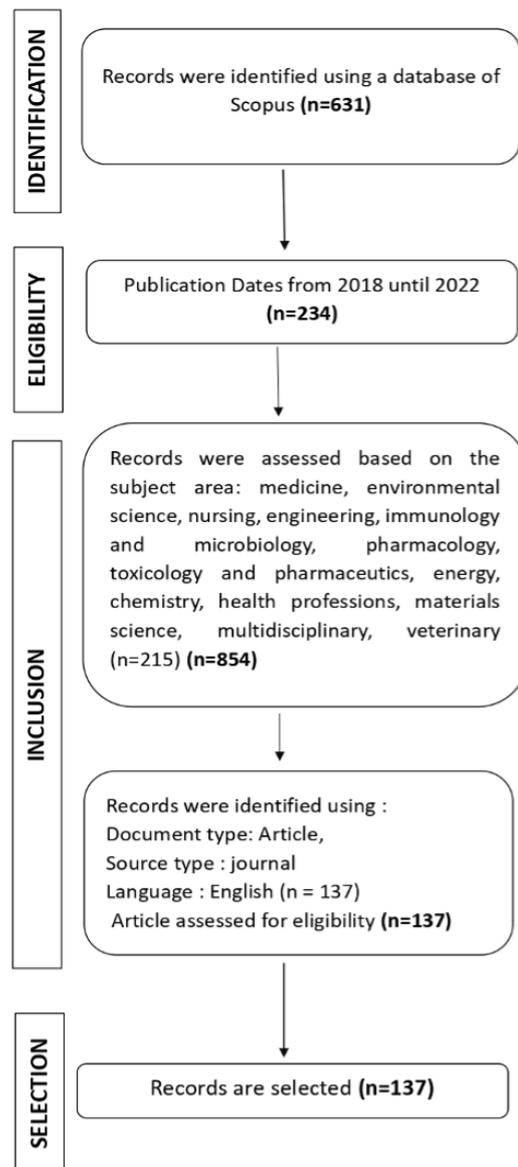


Figure 1 Searching and selecting articles¹⁶ (adapted from the reference 16)

Results

Figure 2 clearly shows a consistent yearly increase in articles concerning hospital food waste. Between 2018 and 2022 137 documents were published, with 33 papers released in 2021 indicating a significant increase in interest. This remarkable development can be directly linked to the impact of the Coronavirus Disease 2019 (COVID-19) pandemic on people's lives, including their dietary patterns¹⁷. The COVID-19 pandemic has caused a significant waste increase, adversely affecting hospitals' food services departments¹⁸. Reducing food waste is essential in hospitals as it can make up to 50% of total waste volume¹⁹.

It is interesting to note that the top five nations in terms of scientific production are the United States (29 documents), Australia (18 documents), the United Kingdom (12 documents), India (12 documents) and Italy (9 documents). Research conducted in the United States

concerns sustainability and food safety to reduce food waste²⁰. Apart from that, research conducted in Australia was on factors influencing food service and food waste in hospitals²¹.

These nations seem to have followed a consistent procedure for measuring food waste. Significant gaps exist in data for low-income countries, small island states, Central Asia, and Northern Africa. There are also food service and retail gaps in low-income, lower-middle-income, and upper-middle-income nations. This makes it challenging to estimate food waste in countries without statistics. Household food waste has been extensively studied across the globe, including Europe, the Americas, Asia, Australia, New Zealand, and Sub-Saharan Africa. Therefore, it is possible to estimate household food waste in countries without data by extrapolating from neighbouring countries²².

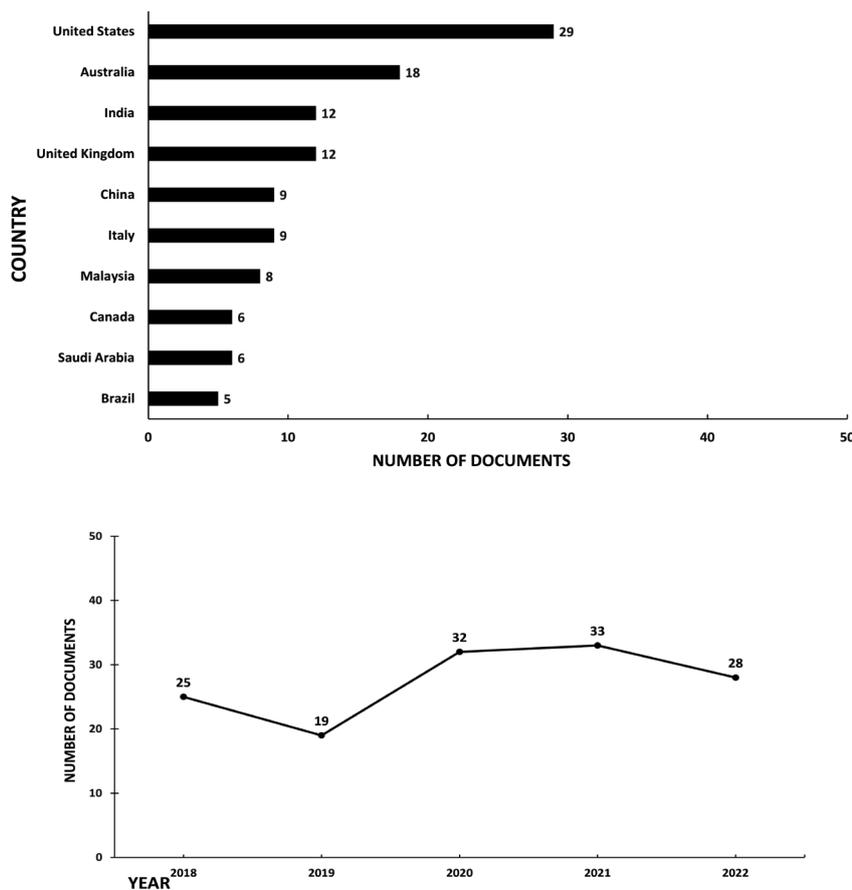


Figure 2 Publication by year (below) and publication by country on hospital food waste (source: Scopus)

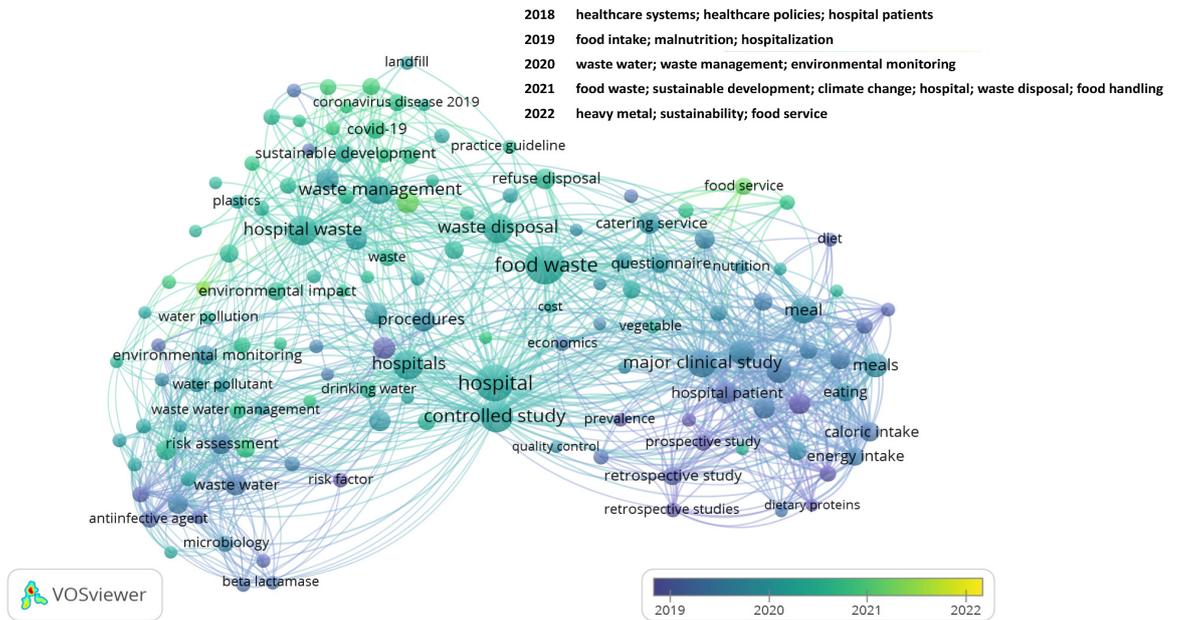


Figure 3 The keywords trend of hospital food waste by year using VOSviewer

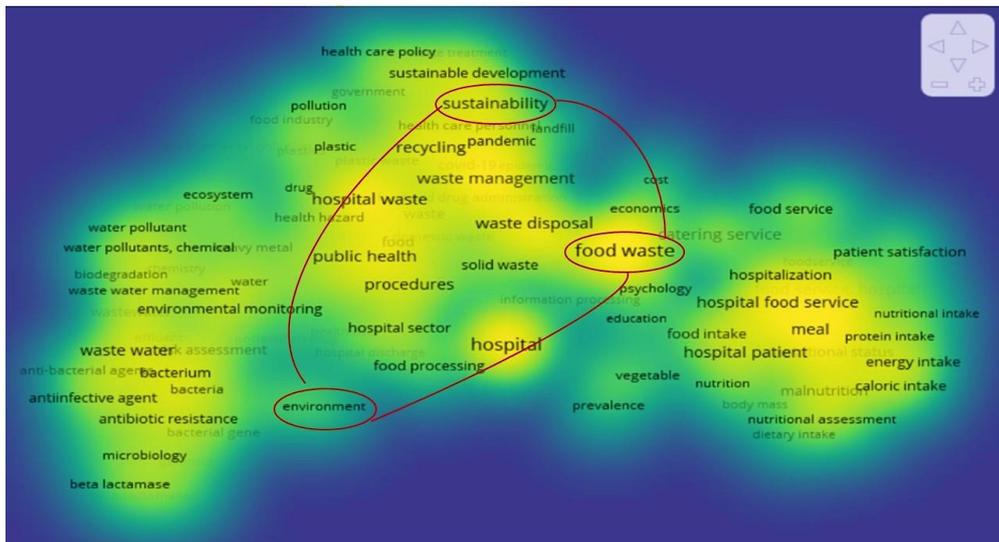


Figure 4 Density visualization (source: VOSviewer)

The VOSviewer analysis on the documents revealed notable yearly keyword trends (Figure 3). The findings indicate a shift in focus toward creating sustainable hospitals in hospital food waste studies over three years. In 2020 "wastewater", "waste management" and

"environmental monitoring" were prominent keywords. In 2021, frequently used keywords included "food waste", "sustainable development", "climate change", "hospital", "waste disposal" and "food handling". The trend for 2022 included "heavy metal", "sustainability" and "food services"

Table 1 Trending topics of keywords using Nvivo 12 Plus

Word	Length	Count	Rate (%)	Word	Length	Count	Rate (%)
Waste	5	9,766	3.3	Environmental	13	2,118	0.72
Food	4	9,116	3.09	Nutritional	11	2,006	0.68
Hospital	8	6,070	2.06	Assessment	10	1,638	0.56
Health	6	4,924	1.67	Energy	6	1,110	0.38
Care	4	3,126	1.06	Hospitals	9	1,060	0.36
Management	10	2,818	0.96	Disposal	8	1,056	0.36
Intake	6	2,774	0.94	Diet	4	1,018	0.35
Service	7	2,740	0.93	Nutrition	9	1,006	0.34
Water	5	2,666	0.9	Satisfaction	12	1,006	0.34
Patient	7	2,176	0.74	Quality	7	998	0.34

Table 2 Relation keywords of hospital food waste

	Code A	Code B	Pearson correlation coefficient
Hospital Food Waste	Hospital food waste	Food	0.853
	Hospital food waste	Food waste	0.850
	Hospital food waste	Catering service	0.796
	Hospital food waste	Hospital	0.764
	Hospital food waste	Food quality	0.759
	Hospital food waste	Food service	0.751
	Hospital food waste	Food Intake	0.734
	Hospital food waste	Nutritional value	0.725

Table 3 The cluster's themes of keywords analysis

Clusters' theme	Items	Total	Rate (%)
Cluster 1: Food contamination	anti-bacterial agents, antibiotic resistance, anti-infective agent, bacteria, bacterial gene, bacterium, beta-lactamase, beta-lactamases, biodegradation, bioremediation, chemistry, drinking water, drug effect, ecosystem, affluent, environment, environmental impact, environmental monitoring, Escherichia coli, food processing, genetics, health risk, heavy metal, hospital discharge, hospital sector, isolation and purification, klebsiella pneumoniae, microbiology, municipal solid waste, potable water, pseudomonas aeruginosa, risk assessment, risk factor, sewage, unclassified drug, wastewater, waste water management, wastewater, wastewater treatment, water, water pollutant, water pollutants, chemical, water pollution	43	36.13
Cluster 2: Environmental sustainability	carbon footprint, climate change, cost, covid-19, disease transmission, disinfection, domestic waste, drug, environmental health, environmental pollution, epidemic, food, food and drug administration, food industry, food packaging, government, health care, health care personnel, health care policy, health care system, health hazard, hospital waste, information processing, landfill, medical waste, pandemic, plastic, plastic waste, plastics, pollution, procedures, public health, recycling, refuse disposal, solid waste, sustainability, sustainable development, waste, waste disposal, waste management, waste treatment	41	34.45
Cluster 3: Hospital food service	body mass, caloric intake, catering service, diet, dietary intake, dietary proteins, eating, economics, education, energy intake, food intake, food quality, food service, food service, hospital, food waste, food service, hospital, hospital admission, hospital food service, hospital patient, hospitalisation, malnutrition, meal, nutrition, nutrition assessment, nutritional assessment, nutritional intake nutritional status, outcome assessment, patient satisfaction, plate waste, prevalence, protein intake, psychology, vegetable	35	29.40

Pearson's correlation coefficient. The top results in Table 2, measured by the point biserial correlation coefficient, clearly demonstrate that total hospital food waste scores were positively associated with assessments of food, food waste, catering service, and hospital, with correlation values ranging from 0.76 to 0.85 (p -value ≥ 0.70). Any conclusions drawn from the study must be viewed with scepticism as they are solely based on the authors' expertise and chosen subject matter. These topics are relevant in the context of hospital food waste review and are linked by their relationships, with the strength of the relationship being the sole differentiating factor. The strongest relationship is between hospital food waste and food quality, followed by hospital food waste and food waste. The weakest relationship is between hospital food waste and nutritional value (Table 2).

In Figure 5, the network visualisation of each cluster is displayed by using different colour codes for each one. The colours used in this study are red, green, and blue. The network representation of this report presents all the articles with underlying themes that frequently emerged during our investigation. Hospital food waste is closely related to hospital food service²⁴. Apart from that, hospital food waste and food contamination can affect the sustainable condition of the hospital environment. VOSviewer divided the bibliometric mapping of hospital food waste for hospital sustainability into three clusters (Figure 5 & Table 3). Cluster 1 (red colour) focuses on food contamination, cluster 2 (green) covers a sustainable environment, and cluster 3 (blue) discusses hospital food service.

Discussion

Food waste is one of the most essential things in hospitals to save hospital finances and build sustainable hospitals²⁵. In this study, the discussion is centred around hospital food waste, which includes waste generated from food processing and patient consumption. High levels of hospital food waste significantly negatively impact food security, the economy, and the environment^{4,5}. Therefore,

hospital food waste is one part of sustainable hospital development¹⁹.

The literature review article entitled "Hospital Food Waste: Review" presents an in-depth analysis of 35 articles published between 1945 and 2015. The articles were sourced from electronic reference databases, such as PubMed, ScienceDirect, and Web of Science, using the keywords "food waste" and "plate waste". The review offers valuable insights into the issue of food waste in hospitals, providing knowledge that can benefit professionals and stakeholders in the healthcare sector. This article shows the amount of food waste in hospitals and the solutions implemented to reduce the amount of food waste in hospitals^{25,26}. Meanwhile, the second article is entitled "A systematic review of food waste audit methods in hospital food service using seven electronic databases". The hospital food waste audit method results showed that 12 articles used electronic scales to measure food waste in hospitals²⁷. This study analysed 137 articles retrieved from the Scopus database using "hospital", "food" and "waste" as keywords. VOSviewer and NVivo, 12 Plus applications, were used for the analysis. In this article, we will discuss one of the challenges facing hospitals: food waste. This issue needs to be addressed to promote sustainable hospital development. This study reveals that the top five trending keywords are waste, food, hospital, health, and care, and the keyword analysis revealed three primary themes: sustainable environment, hospital food service, and food contamination. This article aims to analyse trends in hospital food waste for sustainable hospital development.

The most significant percentage was for food contamination, which is closely linked to food safety. This global issue requires immediate attention from governments and health organisations. Hospital food safety has been a major concern, affecting patient confidence. It's crucial to address this matter promptly to prevent further harm²⁸. Food handlers are essential in the upkeep of food safety and the prevention of contamination throughout all phases

of food production, processing, storage, and preparation²⁷. Most food waste in hospitals is thrown away, and only a small portion is recycled²⁴. Food waste can cause new problems, including damaging the environment and can also cause food contamination. The contamination that occurs can be physical or organic. Therefore, food hygiene must be considered to prevent food contamination²⁰.

Food hygiene refers to the measures implemented to guarantee food safety from production to consumption. It is imperative to prioritise cleanliness when consuming meals outside the home to evade contaminated food items that can lead to various infections, especially in underdeveloped regions²⁴. This significantly strains healthcare systems, which must deal with new diseases that arise as a result. However, good hygiene management is crucial in preventing these issues. Hygiene control covers several types of contamination, including food-to-food, equipment-to-food, and operator-to-food contamination²⁹. The issue of food safety in hospitals cannot be ignored, mainly due to the susceptibility of patients to foodborne illnesses, commonly referred to as nosocomial infections. Negligence on the part of hospital food handlers regarding personal hygiene can result in the transmission of harmful microorganisms³⁰. Hospital food handlers are more responsible than their restaurant counterparts as they must provide nutritious and safe meals for patients with weakened immune systems. Any contaminated food can have severe and potentially life-threatening consequences. Hospital food handlers must prioritise food safety to avoid such risks³¹.

This research focuses on hospital food service and its impact on sustainability. A recent study by Carino et al. (2021) found that food service significantly influences the environment and the economy³². To promote sustainability, it is crucial to implement effective strategies for providing high-quality food services^{19,33}. Conversely, the food service in hospitals can positively affect both the healthcare and local food systems³⁴. Designing hospital menus for medical food service is a complex task that demands careful

consideration of several interconnected parts. Clinical criteria, patient preferences, and essential elements such as food variety, quality presentation, and flavour must all be considered. It is imperative to ensure that all these factors are met to provide the best possible experience for patients²¹. One part of hospital food service is food waste management. The hospital food service system consists of menu services, serving times, menus, patient eating needs, and food quality. It has a significant impact on reducing food waste³⁴.

Hospitals prioritising sustainability in their food service strive to operate in an environmentally friendly manner while maximising resource efficiency. To ensure people's and the environment's well-being, hospital management practices must fully integrate sustainability principles³⁴. Hospitals can adopt sustainable food practices by sourcing local and organic food options for their food service³⁵. Hospitals must prioritize waste reduction and management, particularly regarding food waste a significant source of waste generated by hospitals. Adopting sustainable practices in their food service operations is imperative for hospitals to benefit financially and socially. Hospitals must ensure recyclable packaging, appropriate equipment and technology, and optimised processes for maximum efficiency to achieve this^{36,37}. The implementation of sustainable hospital food services faces multiple barriers, including a lack of staff knowledge and training, insufficient policies, and inadequate funding. The environmental impact of these services is primarily caused by food waste, which can have severe financial consequences for hospitals if it accumulates in significant amounts³⁸.

The Pearson correlation in this study demonstrates the significant relationship between food waste, hospital services, nutrition, and food quality. Providing patients with safe, healthy, and high-quality food for their recovery and treatment is crucial. Moreover, it is imperative to serve meals on time and ensure a continuous food supply during their hospital stay. A balanced and appropriate diet is of utmost

importance, and we must ensure that patients receive nothing but the best. There is a strong correlation between food waste and hospitals, as food waste is a significant contributor to the impact of environmental sustainability²³. Food waste in hospitals is an important concern as it affects the environment at different stages, including production, distribution, preparation, consumption, and management. A recent study in Saudi Arabia in 2020 revealed that the average hospital patient wastes 0.41 kg of food daily, accumulating to 4,831 tons of food waste in just three weeks. This impacts the environment and has negative economic consequences for the country⁴.

The healthcare industry, including hospitals, significantly negatively impacts the environment, particularly regarding food service. However, hospitals can benefit financially and socially by adopting sustainable food service practices. By doing so, they can position themselves as leaders in the movement toward a sustainable food system and healthcare business³⁹. The success of this transformation depends on the cooperation of those involved with food services, both directly and indirectly. It is essential to consider the environmental impact of hospital food throughout each stage of the food supply chain. Different choices made at each level can significantly influence the overall sustainability of the environment¹⁹. The food supply chain encompasses the procurement, processing, preparation, consumption, and waste management stages. Hospitals can independently source food or participate in collective purchasing groups to secure cost-effective agreements⁴⁰. To guarantee food safety and quality in hospitals, meals must be prepared off-site, stored chilled or frozen, or transported, such as the cook-fresh model. Alternatively, meals can be made on-site using fresh ingredients, like in the cook-chill and cook-freeze models. This is important to ensure the food is safe and of the highest quality possible⁴¹.

Food contamination has a significant impact on food safety, as discovered by the study. To prevent this issue, it is crucial to maintain personal hygiene and ensure that food ingredients and handling areas are kept clean³¹. The amount of food waste in hospitals indicates a sustainable hospital and substantially impacts the food service provided. A good hospital food service can enhance food quality and boost patient satisfaction³⁹. Hence, finding research strategies that reduce food waste and improve food service to provide exemplary patient nutrition is essential. One of the findings in this research is that to reduce food waste, food waste must be recycled so that others can use it. One practical approach to minimising food waste is offering a diverse menu and engaging in a constructive dialogue with the patients to develop a tailored menu that aligns with their nutritional requirements and personal preferences. This approach can help reduce unnecessary food waste while ensuring patients receive the optimal dietary intake. Besides that, hospital food waste is essential to realising sustainable hospital development.

Conclusion

Hospital food waste is an essential issue for sustainable hospital development. Managing hospital food waste, from food production to reducing food thrown away by patients, can reduce negative environmental impacts. To achieve sustainability in hospitals, it is important to manage food waste, as it has been found that hospitals produce the highest amount of food waste when compared to other sectors. The article has two main themes: hospital food service and environmental sustainability. Most of the research on these themes aims to understand the environmental impact of hospital food waste and how it can be managed to achieve sustainability. Recent studies have shown that researchers are experiencing challenges in managing hospital food waste, environmental sustainability,

food service in hospitals, and food waste management. Based on the findings of this study, it is suggested that future research focus on developing hospital sustainability through effective management of food service and food waste in hospitals. In future research, research can be carried out on the relationship between food waste and hospital sustainability using qualitative or quantitative research methods.

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Conflict of interest

There are no potential conflicts of interest to declare.

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