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Hospital Food Waste: Contributing Factors of Waste Generation and Strategy for Waste Minimization

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Abstract

The rapid and concerning increase in global food waste has garnered much attention due to its profound social, economic, and environmental ramifications worldwide. Healthcare facilities significantly influence the food chain because of their considerable resource consumption, waste generation, and procurement capabilities. Furthermore, insufficient waste management procedures can have significant ecological repercussions, predominantly due to the carbon emissions generated while disposing of healthcare waste, which also encompasses food waste. The matter of food waste in hospital food services is a complex and multifaceted problem, influenced by a multitude of factors. Conversely, endeavors to mitigate food waste within hospital settings encountered substantial obstacles. The challenges encountered pertain to every facet of hospital services through the emphasis on sustainability. This literature review aims to examine the literature on hospital food waste and identify the gaps in the existing resources that concentrate on the factors that lead to food waste being produced in healthcare facilities and the possible solutions to this problem. The findings point to the contributing factors of hospital food waste, including food quality and quantity, patient satisfaction, patient characteristics and clinical condition, meal times and food from outside, and the environment surrounding the hospital. It also indicates that implementing strategies such as improving the food delivery system, design of the menu, implementing room service model, improving food quality and the presentation of the meal, recruiting food dietitians, improving the dining environment as well as promoting reuse, recycling, composting, and anaerobic digestion can all help reduce food waste. Since food waste generation is context-specific, study outcomes may vary. Therefore, reduction strategies may vary by circumstance. Future research requires more advanced analytical methodologies and specific study designs, time frames, and locations.

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Keywords

Food waste; Hospital; Food Services; Contributing Factors; Reduction Strategies

1. Introduction

The alarming rate of global food wastage raised significant concerns and has social, financial, and environmental implications on a global scale. Approximately one-third of the food produced yearly is discarded (Carino et al., 2021; Cook et al., 2022a, 2022b; Diana et al., 2022; FAO, 2014; Malefors et al., 2019; Porter & Collins, 2021; Razalli et al., 2021; Schiavone et al., 2019; Skaf et al., 2021) across the diverse stages of the food value chain, spanning from agricultural production to ultimate consumption (Beretta & Hellweg, 2019). Food waste signifies the inefficient

utilization of resources, encompassing land, water, labor, and energy in food production. Approximately more than 60% of the available freshwater resources are utilized for irrigating crops, whereas the annual worldwide production of wasted food consumes approximately 306 km^3 of water (Paiva et al., 2022). Moreover, food waste disposal in landfills produces methane and carbon dioxide, both harmful greenhouse gases contributing to global warming (Cook, Collins, et al., 2022a). It is responsible for almost one-tenth of the overall carbon emissions, exacerbating food shortages, generating society strife, and incurring a yearly expense of approximately one trillion USD to the global economy (Antasouras et al., 2023; Cook, Collins, et al., 2022a, 2022b; Razalli et al., 2021). Therefore, these circumstances emphasize the need for a global effort to reduce food waste.

In 2015, the United Nations established the Sustainable Development Goals (SDGs), intending to attain objectives related to urban sustainability, sustainable production and consumption, and addressing climate change across other areas (Carino et al., 2021; UN, 2015). The objective is to curtail worldwide food wastage at the retail and consumer stages by half per capita by 2030 while mitigating food discards across various stages of the food production and supply networks (Antasouras et al., 2023; Cook, Collins, et al., 2022b; Malefors et al., 2019). Healthcare facilities hold significant influence within the food chain due to their substantial procurement capabilities, consumption of resources, and waste production (Carino et al., 2021). Approximately half of the waste generated in hospitals is attributed to food waste (Antasouras et al., 2023; Eriksson et al., 2020; Razalli et al., 2021). Moreover, inadequate waste handling practices can substantially impact the environment, primarily due to the carbon emissions that arise from the disposal of healthcare waste, including food waste (Cook, Collins, et al., 2022a).

The issue of food waste within hospital food services is multifaceted and intricate, with numerous contributing factors. In contrast, attempts to reduce food waste from hospitals had significant challenges. The obstacles faced cover all aspects of hospital services by prioritizing sustainability. They must achieve environmental objectives, including reducing carbon emissions and minimizing food waste while working within a limited budget, meeting dietary requirements, and ensuring that patients are content with the food provided (Carino et al., 2020; Eriksson et al., 2020). Hospital food waste, concerning clinical matters, has emerged as a significant challenge in implementing waste reduction programs (Norshariza et al., 2019). There is a correlation between high levels of food wastage and decreased consumption of energy and protein, which in turn contributes to malnutrition-related issues within hospital settings (Antasouras et al., 2023; Gomes et al., 2020; Norshariza et al., 2019). The issue of malnutrition in hospitals is widely acknowledged within the clinical community. It has been extensively established to have negative consequences such as higher rates of death, morbidity, prolonged hospital stays, and increased healthcare expenses (Neaves et al., 2022). Furthermore, Inadequate nutritional intake and aggravation of malnutrition are connected to rising hospital expenses due to readmission and resource usage (Trinca et al., 2022). Hence, it is imperative to understand the factors contributing to waste generation and implement measures to enhance the quality of food services inside hospital settings, with the dual objective of mitigating malnutrition and minimizing food wastage.

This paper will examine the existing studies of hospital food waste and identify the gap within the resources available. It will focus on the factors that cause food waste in hospitals and what efforts can be made to reduce this waste generation. Thus, this review will address the following two research questions.

1. What are the primary factors that contribute significantly to food waste generation in hospitals?
2. What are the various strategies for food waste reduction in healthcare settings?

The authors employ an unsystematic narrative review to conduct the study. A narrative overview is a paper synthesizing information and resources from diverse sources, such as peer-reviewed journal articles and government and international reports, to comprehend a particular topic's progression. The identification of published articles and reports was conducted by searching many databases, including Griffith Library, SCOPUS, Web of Science, and PubMed, along with an additional search using Google Scholar. The specified search terms included "food waste" and "hospital", "plate waste" and "hospital", "food waste" and "quantifying", and "food waste", "hospital", and "determine factor". This review did not restrict the study design or timeframe, although it prioritized publications or articles published during the past five years. Following an extensive search in the databases, a comprehensive total of 53 papers and two reports were examined and incorporated into this study.

2. Methodology

The waste quantification is necessary to comprehend the depiction of food waste inside medical settings. Waste measurement has significance in establishing a fundamental reference point for comprehending the present circumstances, simulating the consequences of diverse waste reduction approaches, and overseeing advancements made in this domain (Collins & Porter, 2023). Efforts to mitigate food waste generation align with the intent to enhance patient nutritional intake. Therefore, including data on food waste can offer valuable insights into assessing dietary sufficiency among those receiving medical care.

Hospital food waste comprises preparation, serving/ tray, and plate waste. Preparation waste refers to the food waste made while preparing and cooking meals. Tray waste refers to the uneaten food that has been prepared and provided but remains unserved. Plate waste refers to the food served to patients but returned uneaten (Antasouras et al., 2023). Measuring food waste in healthcare facilities is a complex process requiring precision. Variations in disposal methods impact measurement, as waste may go undetected during audits if disposed of within hospital wards. Additionally, there is a possibility of misinterpreting data when visitors provide food for patients, which may replace their hospital meals (Cook, Collins, et al., 2022a).

The quantification of food waste in various studies has been conducted by weighing food waste, visually estimating the remaining food, photography, and using questionnaires with a list of questions related to food consumption. Recent research efforts have focused on developing novel methodologies that integrate many approaches, individually or collectively with digital technologies, to attain more precise outcomes.

2.1. Food Weighing Method

The weighing approach entails gathering all food remnants and documenting the aggregate quantity of a representative subset (Antasouras et al., 2023). The quantification outcomes were recorded through a manual paper-based method or electronic spreadsheet software (Malefors et al., 2019), commonly filled out by nursing personnel (Heighington-Wansbrough & Gemming, 2022). Particular kitchens employed specialized web applications for food-waste quantification provided by various software companies, while others utilized a dedicated, intelligent scale to document the quantification process (Malefors et al., 2019).

The disadvantage of this method is that it can be resource-intensive and time-consuming, potentially causing disruptions or delays in regular food service operations (Antasouras et al., 2023; Heighington-Wansbrough & Gemming, 2022; Manimaran et al., 2023). In addition, this approach may result in imprecise data input and patient recollection, as well as challenges in determining serving quantities (Ofei et al., 2019), as the establishment of a standardized format for food records is lacking. These records are often created at the discretion of each hospital or ward, resulting in significant divergence in the magnitude of information disseminated (Heighington-Wansbrough & Gemming, 2022).

Despite having certain drawbacks, the employment of the weighing method appears to be a more advisable approach in studies conducted on hospitalized industries, as it has the potential to yield more accurate outcomes (Cook, Collins, et al., 2022a; Paiva et al., 2022). Furthermore, it is worth noting that researchers often seek to determine the energy and protein content of discarded food, a task that necessitates the identification of individual food components (Antasouras et al., 2023). Food weighing technique is widely regarded as the benchmark for evaluating the precision and reliability of alternative measuring techniques (Budiningsari et al., 2016; Heighington-Wansbrough & Gemming, 2022; Ofei et al., 2019).

2.2. Visual Estimation

The visual estimation technique employs a rating scale to assess the approximate proportion of unconsumed food, typically rated as 0%, 25%, 50%, 75%, or 100% (Antasouras et al., 2023; Cook, Collins et al., 2022a). This approach involves the utilization of a guide or tool to aid assessors in evaluating the volume of food or liquid ingested (Heighington-Wansbrough & Gemming, 2022). Besides percentages, the most comprehensive measurements for food consumption are the seven-point scale and the Comstock 6-point scale. Following these scales in terms of comprehensiveness are the five-point scale, a four-point scale, and a three-point scale (Manimaran et al., 2023).

Visual estimate exhibits a notable level of dependability and necessitates reduced labor, time, and spatial requirements (Giboreau et al., 2019). However, in general, it has been observed that the technique tends to either underestimate or overestimate the proportion of leftover food on a plate compared to the weighing method (Antasouras et al., 2023; Heighington-Wansbrough & Gemming, 2022; Ofei et al., 2019). This measurement frequently relies on subjective monitoring of patient food intake, such as estimating food intake through plate diagrams and employing diverse job roles as evaluators (Heighington-Wansbrough & Gemming, 2022; Papathanail et al., 2021; Rinninella et al., 2023). It is also affected by missing data, such as conflicting obligations of nursing personnel that result in hurried record-keeping, unintentional mistakes, and administrative oversights, such as skipped meals and evaluators' failure to grasp the significance of monitoring (Heighington-Wansbrough & Gemming, 2022; Rinninella et al., 2023).

Furthermore, previous research also highlights the importance of providing sufficient training to the nurses, coupled with raising awareness regarding their critical role in the effective implementation of this approach (Amano & Nakamura, 2018; Giboreau et al., 2019; Kawasaki et al., 2019). The latest optimization technique could pertain to digital photography employed for documenting food waste, thereby mitigating issues and facilitating accurate assessments of portion sizes at a later stage. Visual estimation appears to be a more suitable method in situations where the sample population consumes food of identical type and size, such as in school studies (Antasouras et al., 2023; Williams & Walton, 2011), cafeteria environments or other public dining locations (Williamson et al., 2003).

2.3. Digital Imaging Method

This approach employs techniques akin to the direct visual estimating method. However, instead of relying on human observers in the eating set, the process involves capturing the meals and plate waste through a digital video camera (Ofei et al., 2019; Williamson et al., 2003). Trained observers examine pictures on a computer screen. Portion sizes are estimated using photos of items in a controlled laboratory setting without time constraints (Parent et al., 2012; Williamson et al., 2003).

The advantage of this method includes the swift collection of data within the eating context, the ease it provides for both participants and researchers, and the comparatively relaxed assessment of meals evaluated through images, as opposed to in the real-time eating situation (Parent et al., 2012; Williamson et al., 2003). Additionally, the findings indicate that training is unnecessary, as the results demonstrate no statistically significant disparities in food waste estimates between trained or untrained raters (Parent et al., 2012). In the context of future study inquiries, digital photographs can be kept and utilized to validate estimations about food waste (Parent et al., 2012).

One of this method's disadvantages is that determining portion size based on a picture might be laborious and impede the regular monitoring of food consumption within a healthcare environment (Ofei et al., 2019). Scholars and practitioners have recognized the challenges associated with accurately determining portion sizes, which is the primary factor contributing to inaccuracies in assessing nutritional intake (Ofei et al., 2019). Another limitation pertains to the expenses of acquiring high-quality cameras to enhance the clarity of images and differentiate food items (Parent et al., 2012).

2.4. Questionnaire

The questionnaire is another approach employed to compute food waste production. In terms of this, patients were asked to indicate the percentage of their consumed meals. The inquiry pertained to the consumption of the initial plate, subsequent plate, accompanying side dish, and fruit, with responses recorded on a 5-point Likert scale ranging from "nothing/almost nothing" to "all/almost all" (Mahmoud & Mahmoud, 2023; Schiavone et al., 2019). The phrase 'almost nothing' denotes that patients merely sampled the food and subsequently declined it (Schiavone et al., 2019).

This method's latest development is adding the food intake visual scale (FIVS). This comprises visual representations of four distinct plates of food, each depicting varying amounts of consumption: "about all," "half", "a quarter", or "nothing" (Saueressig et al., 2023). Following the completion of their meal, the patients were given instructions to discern the image on the tool that most accurately depicted their food consumption (Saueressig et al., 2023). The strengths of this technique include using a practical, easily implemented, and cost-effective tool (Saueressig et al., 2023). The shortcoming pertains to its exclusive assessment of the quantity ingested without considering the quality

of the meal. Alternative methodologies are necessary to facilitate a more comprehensive assessment to ascertain diminished consumption and evaluate the intake caliber (Saueressig et al., 2023).

2.5. Other Developing Techniques

Additional techniques employed for waste generation estimation involve enhancing pre-existing methodologies through integrating specialized instruments, hence facilitating the acquisition of more precise and reliable data. For example, Budiningsari et al. (2016) devised the Pictorial Dietary Assessment Tool (PDAT) to estimate patient food consumption concerning the food weighing approach. The advantage of this method is its ability to offer a convenient means of estimating energy and protein consumption, reducing the time required to complete the activities and tasks that can be accomplished by the personnel with little training (Budiningsari et al., 2016). A potential drawback of this study was the necessity for additional research to thoroughly investigate the validity of the PDAT across all meal times (Budiningsari et al., 2016).

Another example was developed by Ofei et al. (2019). They established the Dietary Intake Monitoring System (DIMS) that incorporates images, a weighing device, an infrared thermometer, radio-frequency identification technology (RFID), and WIFI connectivity to facilitate real-time data capture. The design was to automatically record both the total weights and photographs of food before and after eating. One benefit of DIMS over previous visual dietary evaluation methods is the ability to determine portion size using an assortment of periodic weighted images (Ofei et al., 2019). A drawback of this method is that it quantifies the overall weight of the meal instead of the individual weights of specific food items. Hence, using visual methodology in conjunction with the DIMS total weight for estimating the portion size of individual food items may yield imprecise estimations of serving sizes while still yielding a projected aggregate weight that matches the DIMS total weight (Ofei et al., 2019).

3. Contributing Factors

Numerous factors have been linked to the elevated levels of plate waste observed in hospital settings (Cook, Collins, et al., 2022b; Norshariza et al., 2019; Williams & Walton, 2011). Hospital food waste can be attributed to both internal and external factors. Internal factors pertain to the performance of food service within hospitals, and external factors related to patients (Cook, Goodwin et al., 2022; Porter & Collins, 2021; Razalli et al., 2021). The primary factors contributing to plate waste in hospitals are the quality of food and service. Various published studies have demonstrated a correlation between patients' satisfaction and the sensory attributes of food, including its visual attractiveness, taste, texture, and temperature (Razalli et al., 2021).

3.1. Quality and Quantity of the Food

Food quality and quantity were also noted as contributors to food waste. Food quality relates to the food's taste, appearance, texture, and temperature, whereas quantity is related to the portion of the food. Multiple studies have demonstrated that the quality and number of meals influence food waste. Sumarto and Saragih (2020) investigated the correlation between the taste and appearance of food as it pertained to food waste at the Jasa Kartini Hospital in Indonesia. According to the results, there are substantial correlations among these variables. Other researchers also found similar correlations. Porter and Collins (2021) reported that several factors negatively impacted the food quality, including the use of the cook-chill model's, "double cooking" method, the unnecessary addition of parsley as a garnish, the use of unripe fruit, and the unappealing preparation of boiled meat and vegetables. They also highlighted that the excessive portion of the patient's meal increased the food waste.

Furthermore, Razalli et al. (2021) found that modifying food texture lowers food waste in Hospitals in Malaysia. Modifying food texture (TMD) facilitates chewing and swallowing the food, enhancing the patient's ability to consume the prescribed diet. (Razalli et al., 2021). Therefore, TMD can be an option for elderly patients or patients with certain health conditions to fulfill nutrition, which in turn can reduce food waste. Food temperatures are also essential to reduce plate waste, as confirmed by Dynesen et al. (2021). Their study mentioned that the ability to select a preferred meal, whether hot or cold, decreases plate waste. The quality and quantity of meals can influence patients' appetite. It is imperative to implement alterations or enhancements in this domain to mitigate food wastage and enhance the nutritional intake of patients.

3.2. Patients' Satisfaction

Assessing patient satisfaction is a valuable metric for evaluating the quality of meal provision within hospital environments (Teka et al., 2022) and is frequently linked to plate waste. Patient satisfaction is complex and encompasses multiple dimensions, making it challenging to quantify due to the diverse range of factors that influence it (Schiavone et al., 2020). The quality of food service and food served is crucial in determining patient satisfaction (Razalli et al., 2021; Schiavone et al., 2020; Teka et al., 2022). Research has demonstrated that patient satisfaction with food service is contingent upon the identity of the individual responsible for its delivery (Hartwell & Edwards, 2003). The meal quality ratings are more significant when dietary employees are responsible for the delivery (Hartwell & Edwards, 2003). In contrast, patients may negatively perceive the food given in hospitals due to inadequate staff behaviors, perhaps reinforcing unfavorable perceptions and leading to decreased food intake and satisfaction (Trinca et al., 2022). In addition, the delivery by nursing staff is associated with higher scores in terms of care and concern (Hartwell & Edwards, 2003).

The adverse effects on patient satisfaction and food intake can arise from meal duration and scheduling deemed unsuitable, the limited capacity to select food close to mealtimes, and disruptions during meals, such as medical staff rounds (Mahmoud & Mahmoud, 2023). Moreover, a study by Rapo et al. (2021) showed that patients who had more extended hospital stays and those who reported consuming less food than normal expressed higher dissatisfaction with the food service. Specifically, these patients were unsatisfied with the food's overall quality and the meals' taste and flavors. Another research finding by Navarro et al. (2019) suggests that patients who were allocated orange napkins demonstrated a noteworthy improvement in their contentment with the hospital's food provision. Jonsson et al. (2021) analyzed the viewpoints of elderly patients regarding dining experiences within hospital settings. The patients expressed their worries over the insufficient support during meal periods, challenging relationships with other patients in the shared dining area, and instances where the food offered failed to meet their satisfaction.

Patient satisfaction measurement usually uses a questionnaire, where one of the consensus tools is the Acute Care Hospital Foodservice Patient Satisfaction Questionnaire (ACHFPSQ). This tool can serve as a foundation for recognizing the necessity for enhancing quality and strategizing and assessing interventions (Capra et al., 2005). The questionnaire comprises socio-demographic information, expectations, food and service attributes, and food waste rates (Schiavone et al., 2020).

3.3. The Patient's Characteristics and Clinical Condition

Patient characteristics such as gender and age correlate with the quantity of hospital food waste. The research conducted by Schiavone et al. (2019) indicated that women tended to waste food more than males while being hospitalized. The findings of this study were consistent with those reported by Norshariza et al. (2019) and Gomes et al. (2020), which showed that female patients exhibited higher levels of food waste production. The investigation of gender-based disparities in food waste is deemed significant due to variations in nutritional needs between males and females. Kong et al. (2020) confirmed that male participants in their research exhibited significantly greater average calorie and protein consumption than their female counterparts.

Regarding patients' age, Norshariza et al. (2019) found that older people exhibited the highest levels of food wastage in comparison to younger individuals. Contrarily, Gomes, et al. (2020) revealed that pediatric wards' food waste was significantly higher than other types of wards. Higher food waste generation in older patients is closely related to health conditions. Problems with eating and swallowing have had a substantial impact on food wastage, resulting from a drop in oral intake (Norshariza et al., 2019).

Furthermore, the dining experience within a hospital environment is frequently marked by the impact of illness (Jonsson et al., 2021; Norshariza et al., 2019). The provision of meals to patients may exhibit variability contingent upon the necessity of a specialized dietary regimen under their medical condition. According to a Malaysian study, cancer patients have a significant prevalence of plate waste (Razalli et al., 2021). In addition, some gastrointestinal diseases such as dysphagia, nausea, vomiting, loss of appetite, lethargic behavior, dental issues, and abdominal distension impact plate waste (Razalli et al., 2021; Williams & Walton, 2011). The inability to eat and digest food due to digestive issues and post-surgical recovery could result in decreased appetite and excessive food waste. As a

result of a decreased appetite and menu weariness, a prolonged duration of stay led to more plate waste (Diana et al., 2022; Williams & Walton, 2011).

The significance of patient interest in food or appetite was emphasized as a crucial element linked to food consumption and, consequently, food wastage while hospitalized (Eriksson et al., 2020). For example, the study's participants in Melbourne, Australia, reported experiencing a feeling of guilt as a result of their initial intentions to order a meal but subsequently lacking the desire to consume it upon its arrival. Nausea and sickness hindered their capacity to ingest the delivered food (Porter & Collins, 2021). Moreover, patients with certain health conditions need feeding assistance to facilitate their nutritional intake. The research found that the elevated proportion of food waste present in the introductory course of the soft diet can be rationalized by the patients' heightened state of debilitation, necessitating assistance with feeding (Gomes et al., 2020). In addition to its association with health-related factors, the patient's appetite may also be subject to various external influences, such as food taste, meal arrangement, meal times, and food items procured by the patient's relatives.

3.4. Meal Time and Outside Food

Plate waste is also associated with meal delivery timetables and external food sources. The study in Italia illustrates that mealtimes held significant value for patients from the southern region (Schiavone et al., 2020), with many of them opting to bring food from their homes to the hospital through their visiting relatives (Diana et al., 2022; Schiavone et al., 2019, 2020). Several studies have yielded varying outcomes concerning the quantity of food waste produced during each meal. Mahmoud and Mahmoud (2023) reported that most patients, namely over one-third, consume their entire breakfast, more than one-quarter take barely half of their lunch, and approximately one-third consume their entire dinner. Additionally, most patients surveyed reported bringing their meals from home or an external catering service and provided reasons for discarding the food (Mahmoud & Mahmoud, 2023). Likewise, it has been observed by Norshariza et al. (2019) that dinner exhibits a higher proportion of food waste in comparison to lunch. The provision of home-cooked meals by guardians outside of working hours and the lack of a well-defined policy regulating the delivery of home or retail food delivery by patient guardians or retailers might lead to increased food waste during dinner time (Norshariza et al., 2019).

Furthermore, numerous studies have indicated a lower occurrence of plate waste during breakfast than other primary meals, although it is essential to note that this observation is not universally consistent (Williams & Walton, 2011). Similarly, research by Razalli et al. (2021) and Anari et al. (2023) revealed that the proportion of plate waste was comparatively more significant during lunch. This phenomenon may be attributed to patients experiencing satiety after consuming a morning meal (Razalli et al., 2021). In contrast, some studies in Indonesia discovered that morning plate waste is somewhat higher than lunch (Diana et al., 2022).

3.5. Hospital Environment

The ambient factors within a hospital setting might influence patients' appetites. Providing clean and comfortable rooms devoid of any unpleasant odors and staff-related disturbances can enhance patients' dining experience. According to a study conducted in the Netherlands, which examined the associations between plate waste and various patient and environmental factors, it was determined that other than appetite, the movement of individuals entering and exiting rooms for patients was the most substantial indicator of heightened plate waste (Trinca et al., 2022; Williams & Walton, 2011). Diana et al. (2022) also mentioned a significant correlation between environmental factors and hospital services, specifically inpatient classes, and the amount of plate waste generated within certain hospitals in Indonesia. Food wastage was higher among patients occupying inpatient rooms classified as class 2 and 3, compared to those in class 1 and VIP rooms.

4. Waste Minimization Strategy

Upon understanding the waste generation and the underlying factors contributing to it, hospital administration can develop a suitable strategy for reducing food waste. The Food Waste Hierarchy can serve as a guiding framework for waste management practices, where preventing food waste from occurring in the first place is the most effective strategy (Collins & Porter, 2023; Lewandowski et al., 2023). Some of the approaches include improvement in the food delivery system, design of the menu, room service model, improvement in food quality and meal presentation,

employment of clinical nutrition, the implementation of recycling, composting, food donation, and improving management or alternative processing methods, such as anaerobic digestion.

4.1. Improving the Food Delivery System

The food delivery system is a significant aspect that impacts patients' dietary intake. A centralized delivery system guarantees that each patient receives a fully assembled order with a predetermined portion size and quality control measures from a central location (Kong et al., 2020). On the other hand, a decentralized delivery service system only dispatches large quantities of hot or cold prepared foods to ward kitchens all over the hospital (Kong et al., 2020). A measure that has been the subject of numerous research is transitioning from a centrally plated meal system to a bulk meal distribution system (Dias-Ferreira et al., 2015). The utilization of bulk service offers the benefit of tailoring the size of portions to meet the specific demands of patients (Williams & Walton, 2011).

Furthermore, research has demonstrated that implementing a bulk food delivery system, wherein a diverse range of food options is transported to patients and served from mobile carts based on individual preferences and appetites, is more efficient in minimizing food waste compared to conventional plated meal delivery systems (Schiavone et al., 2019). In addition, research conducted by Norshariza et al. (2019) confirmed that centralized systems exhibit more significant proportions of food waste than bulk systems. Bulk systems can maintain the temperature of recently prepared foods, ensuring the meals remain warm and stimulating patients' appetites (Norshariza et al., 2019). Some critiques of this system are related to the amount of remaining food in the trolley, which somewhat undermines the benefits of minimizing plate waste (Dias-Ferreira et al., 2015). This is because the distribution of meals is carried out by ward assistants, increasing the likelihood of mistakes (Kong et al., 2020). Therefore, it is imperative to exercise caution when determining the quantity of food to be cooked to prevent waste transmission along the food supply chain (Dias-Ferreira et al., 2015).

4.2. Menu Design

Another measure that appears to be effective in reducing plate waste is enhancing patients' autonomy in selecting their meals by providing selective menus. Implementing a program to enhance patients' meal options by providing tailored menus appears to hold significant potential, particularly in mitigating food wastage (Antasouras et al., 2023; Paiva et al., 2022; Rinninella et al., 2023). The food selection allows patients to exert a certain degree of influence over their healthcare experience, albeit limited, such as having the option to choose their dessert. This may enhance their satisfaction levels and views on food quality (Trinca et al., 2022). A further pilot study was conducted to investigate if a chosen menu might raise food intake and reduce plate waste by hospitalized children with orthopedic conditions. The study revealed that transitioning from nonselective to particular menu styles reduced the amount of vegetable plate waste compared to other food groups. Also, fewer vegetables were returned on specific menus than on selective menus (Antasouras et al., 2023). In addition, a study conducted in Denmark investigated the efficacy of the menu modification strategy. It revealed that implementing the Free Choice Menu enabled patients to select from a diverse range of hot and cold food options throughout the day and facilitated the adoption of improved cooking techniques (Manimaran et al., 2023).

One approach to enhancing the ease of menu choosing involves the development of electronic technologies. Implementing a bedside menu ordering system is an alternative to the conventional meal delivery method (Schiavone et al., 2019). The automated interactive menu selection system is a potential ordering system that could enhance patient satisfaction with food service and yield cost savings for hospitals that rely on printed menus (Ottrey & Porter, 2016). Multiple pieces of research indicate that electronic bedside meal ordering systems yield positive results regarding food intake, plate waste reduction, and overall satisfaction compared to traditional paper menus. Barrington et al. (2018) reported that patients who utilized the Bedside Menu Ordering System (BMOS) method exhibited a higher frequency of meal ordering and consumption in comparison to those who employed the Paper Menu (PM) method. Moreover, MacKenzie-Shalders et al. (2020) revealed the same result regarding using Electronic bedside meal ordering systems (eBMOS) to reduce plate waste.

The electronic system may pose difficulty in terms of management for elderly patients, but it is comparable to a conventional paper menu in terms of facilitating food selection (Rinninella et al., 2023). Collins and Porter (2023)

contested that using paper menus in all three hospitals delays the process, as manual activities such as printing, disseminating, and retrieving menus and manually verifying and summing up orders necessitate scheduling. An electronic system exhibits agility in its ability to promptly adapt to patient admissions, discharges, and dietary requirements changes, potentially reducing missed meals and minimizing excess food waste (Lewandowski et al., 2023; MacKenzie-Shalders et al., 2020). Furthermore, this system enables patients to place their orders more conveniently at their designated mealtimes, enhancing their ability to choose a meal that aligns with their preferences (Dynesen et al., 2021; Lewandowski et al., 2023; MacKenzie-Shalders et al., 2020). Adopting digital technology is crucial for healthcare facilities because it can eliminate laborious manual tasks (Collins & Porter, 2023; Rinninella et al., 2023; Yona et al., 2020).

4.3. Room Service Model

Incorporating the ordering and delivery system appears to positively impact patient contentment, heightened consumption of nutrients, and decreased disposal of uneaten food. This intervention seems to enhance patients' food consumption by promoting satisfaction, potentially by expanding their food options, addressing issues with meal scheduling, and improving the quality of food presentation in terms of temperature and aesthetics (Antasouras et al., 2023). Analogous to the bedside menu ordering system, a room service enables patients to select and request individual food items, receiving their order within 45 minutes (Manimaran et al., 2023; Schiavone et al., 2020). This model entails the provision of meals to patients upon request, following an à la carte menu format (Eriksson et al., 2020).

Multiple research findings indicated that implementing a room service model decreases plate waste. The cross-sectional study conducted in Canada found that the room service implementation resulted in a notable rise in customer satisfaction, decreased food costs during breakfast and lunch, and reduced waste across all meals. Notably, there was a rise in the consumption of energy, protein, carbohydrates, and fats during the lunch period (Rinninella et al., 2023). Additionally, Dynesen et al. (2021) found that participants consumed more of the food provided than the trolley model, particularly during the afternoon meal. The room service implementation resulted in a significant reduction in food waste, decreasing it from 29% to 12% compared to a conventional food service model (Schiavone et al., 2019). In addition, Neaves et al. (2022) reported that consistent with prior research, the implementation of room service resulted in a notable decrease in plate waste, as seen by a substantial reduction in the average plate waste from 40% to 15%.

The provision of room service presents a broader array of menu options and the ability to select high-energy and high-protein meals as desired, resulting in enhanced nutritional consumption (Rinninella et al., 2023). Moreover, this approach effectively handles several concerns by using strategies such as enhancing staff-patient interactions and granting patients autonomy in meal selection, in contrast to the conventional food service approach (Manimaran et al., 2023; McCray et al., 2018). Although implementing bedside ordering and room service models may incur high costs, it is essential to consider the potential cost savings achieved through enhanced intake, reduced food waste, and decreased hospital-associated expenses (Trinca et al., 2022). The decrease in excessive meal orders for patients who could not select their preferred meals or had their dietary needs altered after submitting their initial menu choices significantly reduced waste, consequently leading to cost savings (McCray et al., 2018). It recommended that all hospitals, including those publicly funded, conduct an evaluation within their respective contexts to determine the potential benefits of implementing room service in reducing food waste and enhancing patient and hospital outcomes (Collins & Porter, 2023; Rinninella et al., 2023; Yona et al., 2020).

4.4. Improving Food Quality and Meal Presentation

Food quality includes improving the patient's meals, such as taste, texture, flexible portion size, and temperature. Implementing strategies aimed at reducing food waste in hospitals, such as enhancing food quality and adjusting serving sizes to meet the specific needs of patients, can lead to several positive results (Anari et al., 2023). One method to enhance food flavor is the development of Nutritional Intelligence. The Nutritional Intelligence initiative, grounded in the culinary approach advocated by the NR-FPT, effectively mitigated food waste and enhanced customer pleasure without incurring additional service expenses (Piciocchi et al., 2022). Another approach to improve the palatability of low-sodium food is altering the selection of salt or flavoring agents. A specific variety of salt that has been

formulated is known as monomagnesium di-L-glutamate. The efficacy of this particular salt or flavoring has been demonstrated through successful testing, indicating its potential as a viable long-term strategy for consumption among patients with limited sodium intake (Sumarto & Saragih, 2020). The enhancement of food texture can be achieved by using an adjusted diet to alter its texture. The term "texture-modified diet" (TMD) refers to foods that have been altered to have a softer texture (Razalli et al., 2021). These modifications ensure that the foods are easier to chew and consume for patients given this specific dietary regimen. Food texture can be modified through physical or chemical alterations (Razalli et al., 2021).

Multiple studies have demonstrated that implementing adjustable portion sizes has consistently decreased plate waste (Antasouras et al., 2023; Williams & Walton, 2011). Augmenting the frequency of meals while reducing the portion size could be a feasible approach to alleviate the possibility of excess food being discarded and associated with public health issues in hospital settings. This approach could reduce the likelihood of excessive portion sizes and subsequent food waste (Antasouras et al., 2023). Another potential strategy that could be more feasible is allowing patients to select from two different portion sizes (Dias-Ferreira et al., 2015; Schiavone et al., 2019) that would enable patients to select their preferred quantity of food for a single meal (Schiavone et al., 2019). In addition, prior research conducted in a geriatric rehabilitation facility has indicated that when meal portions are substantial, older adults frequently experience feelings of being overwhelmed or dissatisfied, resulting in a subsequent decrease in their appetite (Dias-Ferreira et al., 2015).

While the implementation of flexible portion sizes seemed to decrease plate waste, it is essential to note that improvements in nutrient intakes were not observed unless this intervention was accompanied by additional measures aimed at enhancing the nutrient density of the food (Williams & Walton, 2011). It may be essential to adequately incorporate small healthy snacks between meals to fulfill patients' energy requirements (Antasouras et al., 2023). Hence, the kitchen staff must implement effective management strategies to ensure the consumption of these snacks. Failure to do so may result in the accumulation of food waste within the healthcare institution (Antasouras et al., 2023).

Enhancing the food processing system is also an option to improve food quality. The cook-freeze technique resembles the cook-chill approach, except the cooked meals are promptly frozen instead of frozen in a blast freezer (Manimaran et al., 2023). Furthermore, to enhance the versatility of the menu, it is possible to freeze food items in large quantities or single portions (Manimaran et al., 2023). Hot meals can be transported to hospital wards via a trolley, allowing patients to choose their preferred meal options on-site (Manimaran et al., 2023). Another approach is the Steamplicity catering system, which uses chilled foods that are either raw, semi-cooked, or fully cooked and plated in a central production unit (Rinninella et al., 2023). The findings from this method's implementation indicated that patients preferred the Steamplicity system in various aspects, including overall satisfaction and specific factors such as food choice, ordering process, delivery, and food quality (Dias-Ferreira et al., 2015). This system offers several benefits: expedited preparation and service durations, a versatile menu selection with adaptable serving schedules, and prompt delivery of freshly cooked food within a limited preparation space (Collins & Porter, 2023; Rinninella et al., 2023). Although these interventions may effectively decrease waste generated during trayline operations, they concurrently increase packaging waste (Collins & Porter, 2023). Hence, it is imperative to establish recycling mechanisms and implement effective plate waste monitoring systems to prevent the substitution of one waste issue with another (Collins & Porter, 2023).

Another strategy to increase the patient's appetite is to improve the method of serving food. Enhancing the presentation of meals impacted the patient's visual perception and sensory experience, significantly decreasing food wastage. Furthermore, research has demonstrated a positive impact on the consumption of nutrients and decreases the likelihood of patients being readmitted to the hospital (Manimaran et al., 2023; Navarro et al., 2019). Training food service officers to present food properly and appetizing patients can also be input for hospital management. Rinninela et al. (2023) investigate the relationship between the ease of opening food packages and the patient's appetite. The findings indicate that elderly patients may encounter challenges when accessing certain pre-packaged items, including cheese portions, biscuit portions, water bottles, fruit cups, and milk bottles, within hospital and community environments. In a prior investigation, researchers collaborated with hospital food service professionals to reorganize

the presentation of meals to enhance visual attractiveness, deviating from the customary plating and serving methods employed for patients (Navarro et al., 2019). Based on the information provided, it can be observed that the Diet Service implemented a strategy to enhance the assortment of fish and gourmet preparations offered during meals, increasing the number from two to seven types. This modification yielded a notable drop in plate waste (Paiva et al., 2022).

4.5. Employment of Food Dietitians

Many healthcare facilities strive to implement a standard measure involving assisting specialist staff to patients in opening food packaging and promoting their food consumption (Antasouras et al., 2023). The quality of meals heavily depends on food accessibility, which is influenced by various factors, including the availability of help due to staffing, competing demands, and food service procedures such as the opening of packaging (Trinca et al., 2022). Multiple studies have indicated that the nursing staff encountered challenges in nourishing no more than two to three patients per meal. Additionally, they encountered significant challenges in enhancing their support in administering patient nutrition, primarily stemming from their limited knowledge and training in this area (Antasouras et al., 2023).

Healthcare practitioners, including dietitians, may play a crucial role in enhancing the palatability of meals and ensuring adherence to patient nutritional intake. Food Service Dietitians fulfill a vital role in the production line by ensuring the delivery of proportionate and sufficient dietary requirements and in meal preparation and distribution (Kong et al., 2020). Moreover, they possess a favorable position to impact environmental modifications throughout the food system, particularly within hospital food services (Collins & Porter, 2023). Rinninela et al. (2023) reported that patients who undergo an effective and personalized nutritional intervention, along with nutritional counseling, exhibit a rise in the consumption of oral nutritional supplements (ONS). Additionally, Yona et al. (2020) found that patients admitted to these medical facilities can anticipate receiving meals customized to their medical condition and nutritional schedule, leading to decreased plate waste. This reduction was achieved by more effectively adjusting portion sizes to meet patients' specific needs and ages, considering factors such as medical conditions and age groups.

4.6. Improving Dining Environment

Another strategy for enhancing a patient's appetite involves altering the immediate surroundings to facilitate a more enjoyable dining experience, such as introducing communal dining areas to accommodate mobile patients (Antasouras et al., 2023). The success of this technique may be attributed to the heightened social engagement at meal times, which could potentially elucidate the significance of offering patient meals in dining room settings, when feasible, as opposed to bedside delivery (Williams & Walton, 2011). Additionally, they are assisted in opening food packages and actively urged to consume them (Williams & Walton, 2011).

It is advisable to adopt the concept of hospitality to address fulfilling patients' requirements and preferences regarding the meals provided (Jonsson et al., 2021). A study examined the impact of specific educational techniques on food intake and food waste. The result depicted a notable reduction in daily food (Rinninella et al., 2023). Furthermore, it emphasizes the importance of effective communication among all stakeholders, including food service providers, dietitians, and medical personnel (Rinninella et al., 2023). Incorporating perspectives and insights from key stakeholders has contributed to advancing knowledge about various facets of hospital meal preparation that impact patients' inclination to consume and partake in food (Manimaran et al., 2023).

An additional cost-effective strategy for enhancing dietary consumption and satisfaction with food service involves implementing music during mealtime. This practice has been linked to higher calorie intake among those residing in extended care facilities. Additionally, this approach increased energy intake during mealtime for those residing in nursing homes and experiencing dementia (Navarro et al., 2019). Moreover, to increase patient dining experience, implementing protected meal hours can help prevent interruptions from ward rounds or patient procedures, potentially mitigating environmental issues associated with food wastage (Antasouras et al., 2023; Williams & Walton, 2011).

4.7. Other Approaches

Aside from avoiding food waste, alternative methods such as recycling, reusing it, food donation, or diverting it from landfills by utilizing it to feed animals are viable approaches that can aid in achieving the objective of reducing food

waste. Reusing food is considered the most promising approach within the food recovery hierarchy when addressing food waste in cases where avoidance is not feasible (Cook, Goodwin, et al., 2022). Food items have the potential to be retained within the hospital setting and repurposed through their redistribution to patients (Cook, Goodwin, et al., 2022; Lewandowski et al., 2023) and managed following established inventory control protocols, such as the first-in, first-out principle (Lewandowski et al., 2023). The second approach entails the provision of food items for personnel utilization that help financial recovery (Cook, Goodwin, et al., 2022; Lewandowski et al., 2023). Food items can also be repurposed through donations to food rescue charities, which redistributes them to individuals needing food assistance. The allocation of packaged foods to food banks, emergency shelters, food pantries, and soup kitchens would be optimal resource utilization (Lewandowski et al., 2023). Regulations and legislation pose significant obstacles that must be addressed to facilitate the feasibility and acceptance of food reuse practices within a medical setting (Cook, Goodwin, et al., 2022). Managing food waste from hospitals presents a distinct and noteworthy problem concerning contamination potential (Carino et al., 2020; Cook, Goodwin et al., 2022; Porter & Collins, 2021).

Composting has been identified as an effective technique for reducing food waste in hospitals. It diverted roughly 5,200 pounds of organic food waste from landfill disposal (Plevris et al., 2022). It also has the potential to stimulate other activities to address food waste, generating economic and educational advantages (Plevris et al., 2022). One implementation of composting includes hospital and community garden composting (Plevris et al., 2022; Porter & Collins, 2021). Plevris et al. (2022) showed a positive outcome in the project where the consistent increase in composting weight seen from the initiation of the intervention until one and a half years later was also implemented and embraced by the food service sector. Applying anaerobic digestion can be the last alternative based on a food hierarchy (Collins & Porter, 2023; Cook, Goodwin, et al., 2022). Utilization of food waste for industrial applications, specifically anaerobic digestion, may pose logistical and financial challenges when implementing this technology (Cook, Goodwin, et al., 2022).

Educating the hospital community also contributes to food waste reduction. One potential strategy for enhancing food waste reduction initiatives in the public sector could involve implementing mandatory measurement and documentation of food waste quantities, accompanied by a standardized methodology for subsequent actions (Eriksson et al., 2020). It is recommended that a periodic assessment of food waste be undertaken in every hospital to identify the particular dishes that are crucial for enhancing meal quality and minimizing plate waste (Paiva et al., 2022). Furthermore, implementing the zero-waste project has resulted in an enhanced level of consciousness among hospital personnel regarding plate waste. In 2013, an initiative was launched in Turkey to diminish bread waste. This effort aimed to enhance public consciousness regarding food waste, mitigate losses across the supply chain, and promote the use of whole wheat bread (Yuksel & Önal, 2021).

5. Conclusion

This paper aims to analyze the existing research on hospital food waste and ascertain the gaps in the available resources, focusing on the determinants contributing to food waste generation in healthcare facilities and the potential measures to mitigate this issue. The outcome of this literature review highlighted food quality and service as the dominant contributing factors to food waste generation. It can include food quality and quantity, patient satisfaction, meal times and food from outside, and the hospital's environment. Other factors are patient characteristics and clinical condition. It also indicates that implementing strategies such as improving the food delivery system, design of the menu, implementing room service model, improving food quality and the presentation of the meal, recruiting food dietitians, improving the dining environment as well as promoting reuse, recycling, composting, and anaerobic digestion can be effective in minimizing food waste.

This literature review highlights constraints that require cautious deliberation when interpreting the results. The analytical technique is restricted to search engines and does not employ in-depth analysis. The lack of detailed differentiation of intervention or sample approach in each study further constrains the small number of articles. Food waste generation is a phenomenon specific to a particular context, and the results of one study may vary from another. Moreover, the main factors contributing to waste generation and the reduction strategy are anticipated to differ in various scenarios. More comprehensive analytical methods with more specific study designs, time frames, and locations are needed for future studies.

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