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Therapeutic diet plate waste and satisfaction among adult patients

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ABSTRACT

Introduction: There are limited studies on plate waste and satisfaction levels among adult patients receiving therapeutic diets in hospitals, particularly in the local context. Therefore, this study aimed to determine the percentage of plate waste and the level of satisfaction among adult patients receiving therapeutic diets, as well as the contributing factors. **Methods**: This cross-sectional study was conducted at a university hospital during lunch and dinner hours on eleven types of therapeutic diets. Food weighing and photography-assisted visual estimation by the Comstock scale were used to measure plate waste. Interviews were conducted with patients using the Acute Care Hospital Foodservice Patient Satisfaction Questionnaire (ACHFPSQ) to collect information about their satisfaction towards food quality and service. **Results:** Mean overall plate waste rate for 96 patients receiving therapeutic diets was 43.6% (40.0% for lunch, 47.3% for dinner), with the highest rate of wastage in a combined diet low in fat and salt. Overall score for patient satisfaction was 3.7 out of 5. Patients had higher satisfaction levels with staff and food service (4.0) compared to food quality (3.4). Food quality negatively contributed to the rate of plate waste in terms of taste (r=-0.107, p=0.035), presentation (r=-0.078, p=0.043), and texture (r=-0.052, p=0.020). **Conclusion:** Therapeutic diet plate waste among adult patients in this study was high and primarily attributable to food quality. Efforts to minimise therapeutic diet plate waste should be made by improving food quality for the best possible outcomes for patients.

Keywords: food service, hospital, plate waste, satisfaction level, therapeutic diet

INTRODUCTION

Food waste can be defined as the amount of food that is served, cannot be consumed by the consumer, and thus thrown away. According to the Food and Agriculture Organization of the United Nations, as much as 17.0% of the world's food, which is equivalent to approximately 1.3 billion tons, is wasted every year (FAO, 2019). As much as 22.0% of the 1.3 billion tons of food is wasted at the end of the food supply chain, which includes settings such as households, the food service industry, and the retail sector (Cook *et al.*, 2023). Although waste still occurs everywhere,

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food waste in hospitals can reach up to 50.0% of the total waste generated from the wards (Alam *et al.*, 2008).

According to Williams & Walton (2011), food waste generated by hospitals is the most challenging for the implementation of food waste reduction strategies. There are three types of food waste produced in the hospital setting: food preparation waste, tray waste (food left unserved), and plate waste (Williams & Walton, 2011). Among these, plate waste contributes the most to the rate of food waste in hospital institutions (Goonan, Mirosa & Spence, 2014). Leftover plate in hospitals is defined as the amount of food that has been served and can be eaten, but not eaten by patients. Plate waste of more than 30.0% in a hospital setting is generally agreed upon as high (Edwards & Nash, 1997). Out of 17 observational studies that have been conducted in Indonesia, the median plate waste in hospital institutions was reportedly 27.6% (ranging from 14.8 % - 88.7%), which was caused by several factors such as patients' clinical conditions, food taste, and hospital food service environment (Diana *et al.*, 2022). In addition, a study showed that the rate of hospital food waste in Malaysia ranged from 17.0% to 67.0%, with the highest rate of food waste at dinner time (Zakiah, Saimy & Ah, 2005). A high percentage of plate waste can potentially be a major factor related to nutritional malpractice in hospitals and incurring hospital management with higher financial and environmental costs (Williams & Walton, 2011).

There are various factors that contribute to high plate waste in hospitals. Most of the factors that contribute to the generation of plate waste in hospitals are related to elements such as the appearance and characteristics of the foods served to patients, patient's medical condition, medication, hospital environment, and also food service management. A study showed that the quality of food service greatly affects the level of patient satisfaction in hospitals (Amany *et al.*, 2012). Another study by Aminuddin, Vijayakumaran & Abdul Razak (2018) in East Malaysia's government hospitals discovered that the average plate waste was 36.0% in 2017. Recently, Razalli *et al.* (2021 found that hospitalised patients who were on a textured modified diet had a significantly higher plate waste of 47.5%. The study identified blended diet as the most wasted (65.0%), followed by minced diet (56.0%), and mixed porridge (35.0%). Additionally, a local study conducted by Jamhuri *et al.* (2017) revealed that food wastage among cancer patients was considerable, with rates of 59.3% using the observational method and 41.9% using the weighing method, respectively.

In addition, the level of patient satisfaction is also one of the factors that greatly influences food intake among patients. Research findings suggested factors such as meal taste, menu variety, and staff responsiveness as contributors to patients' satisfaction with food service in hospital settings. A study done by Sahin *et al.* (2006) found that 48.7% of hospital patients were mainly dissatisfied with the taste and appearance of foods served by hospital food service. A more recent study by Nakamura (2021) suggested that the characteristics and appearance of food play a very important role in the level of acceptance and satisfaction of patients towards the food that has been served to them.

Despite extensive studies on hospital plate waste globally, research on plate waste in therapeutic diets and its link to patient satisfaction is limited. Therapeutic diets, prescribed by doctors and planned by dietitians, control specific nutrients and foods based on patients' medical conditions.

These diets modify macronutrients (carbohydrates, protein, fats) and micronutrients (vitamins, minerals) to suit patients' needs, including allergens and texture. In Malaysia, the common types of therapeutic diets include calorie modification diet/diabetic diet, protein modification diet, low-fat diet, low/high-fibre diet, micronutrient modification diet, and other diets (Ministry of Health Malaysia, 2016). A study by Norshariza *et al.* (2019) among patients in Malaysian public hospitals revealed that 47.4% of therapeutic diets were wasted. However, the study did not investigate patient satisfaction levels. Furthermore, Rattray, Desbrow & Roberts (2017) found that the energy and protein intakes of acute care patients on therapeutic diets were poor, with only 18.0% meeting their estimated needs. This issue is linked to factors such as low nutrient availability, high patient nutritional needs, and reduced intake. They suggest several strategies to improve nutritional intake and prevent or treat malnutrition in these patients.

MATERIALS AND METHODS

Study design

A cross-sectional study was conducted among 96 patients aged 18 years old and above who received therapeutic diets in the wards at Universiti Kebangsaan Malaysia (UKM) Medical Centre. Ethical approval was obtained from the Research Ethics Committee, Universiti Kebangsaan Malaysia (UKMPPI/111/8/JEPUKM_JEP-2023-286). Information sheets of the study were distributed and written consent was obtained from all subjects prior to data collection.

Sampling and subjects

Subjects were selected from the Department of Dietetics and Food Services using the Caring Hospital Enterprise System (C-HETS) via convenience sampling. The inclusion criteria were adult patients aged 18 years old and above who received at least one full day of nutrient modification therapeutic diet meals (breakfast, lunch, and dinner), able to give feedback on the level of satisfaction of food service, and fully capable of undergoing height and weight measurement procedures. Exclusion criteria included patients receiving a therapeutic diet of texture modification, i.e. mixed porridge diet or a minced diet, patients from psychiatric wards, intensive, semi-intensive, and those infected with COVID-19. A total of 11 types of therapeutic diets were assessed in this study, which consisted of three single nutrient modification diets (diabetic diet; low-sodium diet; low-purine diet) and eight multiple nutrient modification combination diets (diabetic, low-sodium diet; diabetic, low-fat diet; diabetic, low-sodium, low-fat diet; diabetic, low-sodium, low-potassium diet; diabetic, low-sodium, low-potassium, low-phosphate diet; low-sodium, low-fat diet; low-potassium, low-phosphate diet; low-sodium, low-phosphate diet).

Data collection

Kish's (1965) formula determined a minimum sample size of 96 patients for this study with 95% confidence. Data were collected through a questionnaire, which subjects completed after explanation from researchers. The structured questionnaire had five sections: sociodemographic information, anthropometry, food intake, clinical information, and food service quality.

Data collection on sociodemographic information was done by collecting name, age, race, education level, type of ward admission, and others. Some were collected through interviews or medical records. Nutritional status was assessed using anthropometric measurements, including height and weight. The subjects were classified according to

body mass index (BMI) categories based on the World Health Organization (2007) classifications. For the clinical part, information on signs and symptoms of disease, appetite, consumption of oral nutrition supplements (ONS), and whether subjects were taking outside food were collected from patients.

Two methods were employed to assess the amount of plate waste – weighing and photography-assisted visual estimation, which were conducted by two trained undergraduate researchers. However, each patient's tray was only evaluated by a single researcher. For the weighing method, a Tanita KD 160WH digital food weighing scale (Itabashi-ku, Tokyo, Japan) with a weight capacity of 2 kg and weight graduation of 1 gram was used. A standard weight of the therapeutic diet on the tray was first measured and recorded. The remaining weight of the therapeutic diet was measured again and compared with the standard weight to obtain percentage plate waste. This method involved collecting all food waste from each patient and separating it into four different food components: starch, protein, vegetables, and fruits/dessert before weighing them accordingly. The following formula was used to determine the rate of plate waste:

Rate of plate waste (%) = Amount of plate waste(g)/Standard food weight(g) x 100%

Visual estimation of waste expressed on a 6-point scale developed by Comstock *et al.* (1981) was used to measure approximately what proportion of food was left. Food waste was separated into four different food components, then observed and recorded in different values from 0%, 25%, 50%, 75%, 90%, 100% (all consumed to none consumed). Digital photography was also used to assist in the recording of plate waste, which can minimise errors and allow unhurried estimates of portion sizes at a later time. Both of these methods were carried out within one day with two main dishes, which were lunch and dinner, with a clear classification of food according to food groups.

Information on patient satisfaction level was measured using the Acute Care Hospital Foodservice Patient Satisfaction Questionnaire (ACHFPSQ) (Capra *et al.*, 2005). The Malay version of the questionnaire (Aminuddin *et al.*, 2018) was approved for use in this study and modified according to the needs of this study. The questionnaire consisted of 5 parts: (A) respondent information; (B) evaluation of food quality; (C) evaluation of food service quality; (D) evaluation of staff and service issues; and (E) evaluation of the physical environment. Scoring was done on a 5-point scale: 1-strongly disagree, 2-disagree, 3-neutral, 4-agree, 5-strongly agree. Satisfaction scores were then analysed in two main domains: (i) food quality and (ii) staff and food service. A higher mean score correlated with better results and indicated greater satisfaction.

Statistical analysis

Data were analysed using IBM SPSS Statistics for Windows Version 27.0 (IBM, Armonk, New York, USA). The statistical significance level used was 0.05. Descriptive analyses were employed to assess sociodemographic and anthropometric profiles, plate waste percentages for therapeutic diets at lunch and dinner using weighing and visual methods, and satisfaction scores across various domains. Means and standard deviations were calculated for therapeutic diets and satisfaction scores. Additionally, the non-parametric Spearman's correlation test was conducted to examine the relationship between percentage of total plate waste and its influencing factors due to non-normal distribution. This test

also assessed the link between plate waste and patient satisfaction levels. Multiple linear regression analysed the association between percentage plate waste and significant satisfaction factors.

RESULTS

A total of 96 patients receiving therapeutic diets were included in this study and their sociodemographic profile is presented in Table 1. The average age of the patients was 65.3 years old, with a higher number of males (*n*=52, 54.2%) compared to females (*n*=44, 45.8%). In terms of length of stay, more than half of the patients (*n*=60, 62.5%) had stayed in the hospital for more than two days. For anthropometric data, the average BMI of the patients was 23.9 kg/m^2, which fell within the normal category.

Table 1. Socio-demographic and anthropometric profiles of subjects [represented as mean±*SD* or *n* (%)]

Parameters	*Total (n=96)*
Age	65.3±13.7
Gender	
Male	52 (54.2)
Female	44 (45.8)
Race	
Malay	61 (63.5)
Chinese	19 (19.8)
Indian	16 (16.7)
Education level	
Lower secondary	20 (20.8)
Upper secondary	47 (49.0)
Diploma	11 (11.5)
Degree	18 (18.8)
Length of stay	
>2 days	60 (62.5)
>7 days	23 (24.0)
>2 weeks	8 (8.3)
>1 month	5 (5.2)
Anthropometry	
Height (cm)	163.0±7.6
Weight (kg)	63.4±10.7
Body mass index (kgm^{-2})	23.9±3.7

Table 2 shows the percentage of plate waste for therapeutic diets using the weighing method and the Comstock visual estimation method according to each meal time. During lunch time, the weighing method revealed high plate waste percentages for diabetic diet (33.7%), low-sodium diet (43.0%), and low-purine diet (46.3%). Meanwhile, plate waste for combinations of diets were also high at more than 30% for diabetic, low-sodium diet (40.9%); diabetic, low-fat diet (51.5%); diabetic, low-sodium, low-fat diet (41.0%); diabetic, low-sodium, low-potassium diet (42.6%); low-sodium, low-fat diet (51.8%); low-potassium, low-phosphate diet (72.7%); and low-sodium, low-phosphate diet (39.1%). Diabetic, low-sodium, low-potassium, low-phosphate diet had a slightly lower percentage of plate waste at 24.4% compared to other therapeutic diet combinations.

As for dinner time, high plate waste percentages were also recorded for diabetic diet (42.4%), low-sodium diet (32.0%), and low-purine diet (70.0%). Diet combinations also had a high percentage of plate waste: diabetic, low-sodium diet (58.1%); diabetic, low-fat diet (42.1%); diabetic, low-sodium, low-fat diet (44.1%); diabetic, low-sodium, low-potassium diet (31.9%); diabetic, low-sodium, low-potassium, low-phosphate diet (42.2%); low-sodium, low-fat diet (72.5%); and low-potassium, low-phosphate diet (28.3%); except for low-sodium, low-phosphate diet (4.7%).

In detail, using the Comstock visual estimation method, the percentages of plate waste during lunch time were recorded high for diabetic diet (34.7%), low-sodium diet (43.3%), and low-purine diet (43.8%). Plate waste percentages were also high, exceeding 30% for most combinations of diet such as diabetic, low-sodium diet (40.4%); diabetic, low-fat diet (54.0%); diabetic, low-sodium, low-fat diet (41.1%); diabetic, low-sodium,

Table 2. Percentage of plate waste for therapeutic diet during lunch and dinner by using weighing method and visual estimation method (mean±*SD*)

Types of therapeutic diet	*Weighing method*		*Visual estimation method*	
	Lunch (n=96)	*Dinner (n=96)*	*Lunch (n=96)*	*Dinner (n=96)*
Diabetic diet (*n*=39, 40.6%)	33.7±25.3	42.4±31.5	34.7±26.3	42.7±32.0
Low sodium diet (*n*=5, 5.2%)	43.0±22.0	32.0±22.1	43.3±21.8	31.3±20.7
Low purine diet (*n*=2, 2.1%)	46.3±10.0	70.0±3.3	43.8±8.8	72.1±3.0
Diabetic, low sodium diet (*n*=20, 20.8%)	40.9±34.0	58.1±33.2	40.4±33.9	58.4±32.9
Diabetic, low fat diet (*n*=5, 5.2%)	51.5±34.7	42.1±33.2	54.0±34.0	43.8±34.0
Diabetic, low sodium, low fat diet (*n*=8, 8.3%)	41.0±27.7	44.1±27.9	41.1±30.0	45.4±25.3
Diabetic, low sodium, low potassium diet (*n*=2, 2.1%)	42.6±8.4	31.9±12.2	39.4±2.7	30.0±15.9
Diabetic, low sodium, low potassium, low phosphate diet (*n*=4, 4.2%)	24.4±41.7	44.2±40.5	22.8±37.8	44.1±37.9
Low sodium, low fat diet (*n*=7, 7.3%)	51.8±24.6	72.5±35.8	50.5±27.2	73.1±34.9
Low potassium, low phosphate diet (*n*=3, 3.1%)	72.7±20.3	28.3±35.9	70.4±21.3	29.6±36.2
Low sodium, low phosphate diet (*n*=1, 1.1%)	39.1±0.0	4.7±0.0	37.5±0.0	6.3±0.0
Total (*n*=96, 100%)	39.9±28.3	47.1±32.3	40.0±28.5	47.5±32.2
Overall	43.6±15.7		43.8±13.0	

low potassium diet (39.4%); diabetic, low-sodium, low-fat diet (50.5%); low-potassium, low-phosphate diet (70.4%); and low-sodium, low-phosphate diet (37.5%); except for low-potassium, low-phosphate diet (22.8%).

Meanwhile, for dinner time, the percentages of plate waste using the Comstock visual estimation method were recorded as similarly high for diabetic diet (42.7%), low-sodium diet (31.3%), and low-purine diet (74.1%). Most combination diets also had percentages of plate waste at almost 30.0% or more during dinner time: diabetic, low-sodium diet (58.4%); diabetic, low-fat diet (43.8%); diabetic, low-sodium, low-fat diet (45.4%); diabetic, low-sodium, low-potassium diet (30.0%); diabetic, low-sodium, low-potassium, low-phosphate diet (44.1%); low-sodium, low-fat diet (73.1%); and low-potassium, low-phosphate diet (29.6%); except for low-sodium, low-phosphate diet (6.3%).

Overall, the mean plate waste for therapeutic diets in this study using the weighing method was 43.6%, where the wastage of food occurred mostly during dinner time compared to lunch time (47.0% for dinner time vs. 39.9% for lunch time). On the other hand, mean plate waste of therapeutic diets measured using the Comstock visual estimation method was 43.8%, mostly contributed by dinner time (47.5%) and the remaining produced during lunch time at 40.0%.

An additional statistical analysis was conducted to determine if there was any significant difference between the results obtained from the weighing method and the Comstock visual estimation method for both lunch and dinner times. Data from the Comstock visual estimation was compared with data from the weighing method since weighing food waste from individual plates using a scale is considered the gold standard

method (Allison, 1995). From the paired sample *t*-test that was conducted, the difference between the average plate waste obtained from the weighing method and the Comstock visual method for lunch was not significantly different (p=0.820). Similarly, there was no significant difference between both methods for dinner time (p=0.312). As a result, the overall mean percentages of plate waste for therapeutic diets using both the weighing method (43.6%) and the Comstock visual estimation method (43.8%) were almost the same, showing only a slight difference of 0.2%, which was not statistically significant.

Table 3. Satisfaction scores according to different criteria of satisfaction domains (mean±*SD*)

Criteria	*Mean score*
Satisfaction level to food quality	3.4±0.6
Taste	2.3±0.7
Vegetables	3.3±1.0
Variety of choices	2.8±0.8
Texture	3.6±1.0
Appearance	3.7±1.1
Portion	3.5±1.0
Temperature	4.3±0.7
Satisfaction level to staff and food service	4.0±1.0
Cleanliness	3.5±1.8
Attire	4.2±0.6
Manners	4.0±0.7
Ward surrounding smell	4.4±1.1
Food service quality	3.8±1.0
Overall satisfaction level	3.7±0.8

Patients who were receiving therapeutic diets in the hospital were assessed for their satisfaction levels in two main domains: food quality and staff and food service (Table 3). Under the domain of food quality, there were seven items, including taste, vegetables, variety of choices, texture, appearance, portion, and temperature. In comparison, the domain of staff and food service consisted of five main items: cleanliness, attire, manner, smell, and overall satisfaction level. The findings revealed that patients had higher satisfaction levels with staff and food service (mean=4.0, standard deviation, *SD*=1.0) compared to food quality (mean=3.4, *SD*=0.6). Among the specific aspects of food quality, temperature received the highest mean satisfaction score (mean=4.3, *SD*=0.7). On the other hand, surrounding smell received the highest mean satisfaction score under the domain of staff and food service (mean=4.4, *SD*=1.1). Overall, the mean satisfaction score from both domains (food quality and staff and food service) was 3.7±0.8 out of 5.

The study employed the Spearman's correlation test to assess the relationship between factors influencing plate waste and percentage of total plate waste (Table 4). The results revealed that there was no significant correlation for the overall factor. However, within the domain of food quality, three specific aspects – taste (r=-0.107, p=0.035), appearance (r=-0.078, p=0.043), and texture (r=-0.052, p=0.020) – exhibited significant and negative correlations with percentage of total plate waste. This suggested that as the quality of taste, appearance, and texture improved, there was a decrease in the amount of plate waste. On the other hand, the overall satisfaction level had a weak and negative association with percentage of total plate waste, but this association was not statistically significant (r=-0.152, p=0.139). This implied that overall satisfaction did not have a significant impact on the amount of plate waste.

Next, the study utilised multiple linear regression to examine the relationship between percentage of total plate waste and seven different factors related to food quality. The results, as presented in Table 5, indicated that only

the appearance of food was significantly associated with the total amount of plate waste.

DISCUSSION

The overall mean plate waste among patients who took therapeutic diets at the UKM Medical Centre was 43.6%, which was considerably high given that plate waste of more than 30.0% in a hospital setting is generally considered high (Edwards & Nash, 1997). The result obtained was almost identical to a study carried out by Zakiah *et al.* (2005), where plate waste was 43.3%. The mean percentage of plate waste produced during lunch time was approximately 40.0%, whereas the average percentage of plate waste produced during dinner time was 47.3%. This showed that plate waste contributed during dinner time was relatively higher compared to plate waste produced during lunch time. The above study findings are almost identical to those of another study done by McCray *et al.* (2018), in which hospital plate waste fell within the range of 21.0% to 65.0%, with a median of 34.0%. However, the overall mean plate waste obtained in this study was slightly low compared to the findings of Norshariza

Table 4. Correlations between percentage of total plate waste with contributing factors and satisfaction level (n=96)

Factors	*Percentage of total plate waste (%)*	
	r	*p-value*
Gender	0.152	0.139
Race	0.094	0.364
Education level	0.092	0.372
Length of stay	-0.088	0.391
Type of therapeutic diet	0.102	0.323
Appetite	0.081	0.549
Ward discipline	-0.062	0.597
Signs/Symptoms	-0.055	0.342
Age group	0.102	0.453
Body mass index (BMI)	-0.098	0.546
Oral nutrition supplement consumption	-0.051	0.654
Outside food consumption	-0.011	0.780
Satisfaction level to food quality		
Taste	-0.107*	0.035
Appearance	-0.078*	0.043
Texture	-0.052*	0.020
Vegetables	-0.116	0.259
Temperature	-0.080	0.440
Variety of choices	-0.003	0.979
Portion size	-0.069	0.503
Satisfaction level to staff and food service		
Cleanliness	0.005	0.962
Attire	-0.067	0.517
Manners	-0.170	0.098
Surrounding smell	-0.145	0.158
Overall satisfaction level	-0.152	0.139

*Statistically significant at p<0.05, analysed using Spearman's correlation test

Table 5. Multiple linear regression analysis of total plate waste as dependent variable and satisfaction factors as independent variables

Variables	*Percentage of total plate waste (%)*		
	Regression coefficients	*t-value*	*p-value*
Taste	-0.115	0.169	0.447
Appearance	0.230	-0.078*	0.032
Texture	0.032	0.219	0.828
Vegetables	-0.165	-0.130	0.262
Temperature	-0.050	-0.434	0.658
Variety of choices	0.053	0.434	0.658
Portion size	-0.001	-0.100	0.992

*Statistically significant at $p<0.05$
Statistical model $R^2=0.260$

et al. (2019), which was 47.4%. In that study, various factors were found to have contributed to plate waste of therapeutic diets among patients in Malaysian public hospitals, including patients sleeping or were not present in the ward, lacked appetite during the times when meals were served to them, and their physical condition, which contradicted their ability to consume their meals in comfort.

The percentage of plate waste did not show a significant correlation with the contributing factors identified in the study. This finding contradicts the results of Razalli *et al.* (2022), who found a negative association between contributing factors related to appetite and mean percentage of plate waste. Our questionnaire results revealed that approximately 52.1% of patients on a therapeutic diet had a moderate level of appetite, which could explain the difference in findings. Additionally, satisfaction level with food quality and food service was found to be an important factor contributing to plate waste. Taste, appearance, and texture were negatively associated with plate waste, aligning with the findings of Chik *et al.* (2018), who identified taste as a significant contributor to plate waste.

This study observed that the combination of a low-sodium and low-fat diet yielded the highest percentage of plate waste. Several factors may contribute to elevated plate waste levels among patients receiving low-fat, low-salt meals in hospital settings. These factors encompass dissatisfaction with taste and texture, limited menu variety, and the challenge patients encounter in adapting their palate to alterations in fat content, which affects mouthfeel, and sodium level, which influences taste perception. Acknowledging the temporal nature of patients' adjustment to these changes underscores the significance of incorporating food preferences into meal planning to mitigate plate waste and bolster patient satisfaction. While published evidence is limited regarding patients receiving low-fat diets, a study in Indonesia reported a significant, negative relationship between plate waste and food taste, as well as plate waste and food appearance among patients receiving low-sodium diets (Saragih, 2020). Specifically, some respondents in this study commented that the food was tasteless, which can be attributed to the fact that most respondents were on a diabetic and low-salt diet, resulting in higher amounts of plate waste due to unmet taste expectations.

Furthermore, the low-sodium, low-fat diet combination (during dinner time) together with the combinations of low-

potassium, low-phosphate diet (during lunch time) and low-purine diet (during dinner time) were found to be highly wasted at 70% or more. Low-potassium, low-phosphate diet is normally prescribed for patients with renal disease (Ministry of Health Malaysia, 2016). In a study conducted at an American hospital, significantly lower intake and higher plate waste were reported for patients receiving renal diet compared to regular non-therapeutic diet (Sargent, 2010). Potassium restriction typically involves abstaining from high-potassium vegetables, particularly green leafy varieties (Ministry of Health Malaysia, 2016) and replacing them with harder textured vegetables. This substitution may potentially lead to increased plate waste, particularly among elderly patients or those experiencing dental issues. Low-purine diet is characterised by a diet low in purine prescribed for patients with gout and hyperuricemia (Ministry of Health Malaysia, 2016). No previous studies have reported a high percentage of plate waste among patients receiving this kind of diet. However, it might be possible that the limitation of protein sources, such as fish, chicken, meat, and seafood, might affect patients' acceptance.

Among all, low-sodium, low-phosphate diet (during dinner time) had the lowest percentage of plate waste (4.7% by weighing, 6.3% by visual estimation). This is in contrast with the data of this study, where any diet combination with sodium restriction was normally highly wasted. However, generalisations cannot be made since this low-sodium, low-phosphate diet was only consumed by one patient.

Results of the multiple linear regression analysis revealed a significant relationship between the appearance of food and plate waste. This finding is consistent with the findings of Zaid *et al.* (2019), who also found that the appearance of the food served was associated with higher plate waste. Previous studies have emphasised the importance of meal appearance in generating and maintaining appetite (Navarro *et al.*, 2014. The presentation of food plays a crucial role in stimulating patients' eagerness to try food, which in turn affects their food intake and nutritional benefits. When less appealing foods are presented, patients are more likely to ignore them or look up for more appealing options such as fruits, leading to increased plate wastage in hospitals. In order to determine the optimal food service system for hospitals, it is important to comprehensively measure all key outcomes related to the food service system, as highlighted by the study conducted by McCray *et al.* (2018). Additionally, Sonnino & McWilliam (2011) stated that improving communication between patients and hospital staffs is essential for better understanding the reasons behind food wastage and its consequences.

To address the issue of excessive plate waste, it is crucial to implement a systematic and effective intervention strategy through a sequence of trials. This approach will provide opportunities for quality improvement in food services and reduction of plate waste. However, it is important to recognise that tackling this complex problem requires collaboration from all individuals involved. Everyone, including hospital staffs, patients, and food service providers, must work together to find sustainable solutions. It is important to acknowledge that this issue cannot be fully resolved overnight and will require ongoing efforts and continuous improvement.

There were several limitations present in this study. One of those limitations was that this study only recorded and interpreted plate waste produced during lunch and dinner times due to logistic challenges for the undergraduate

researchers. Plate wastage contributed by patients during breakfast and teatime was not recorded, thus making it less accurate to represent the actual plate waste among patients who consumed therapeutic diets. Another limitation that affected the findings of this study was the fact that certain patients' food might have also been consumed by their family or caretaker; therefore, the percentage of plate waste could actually be higher than recorded. Furthermore, plate waste assessment for each patient's tray was performed by a single rater, potentially introducing rater's bias during visual observation. Nonetheless, both undergraduate researchers who conducted the assessments had received prior training and the Comstock visual estimation data did not exhibit any statistical variance when compared to data from the weighing method, which served as the gold standard for plate waste measurement (Allison, 1995). Other than that, this study was a single-centre study, thus making it less suitable to generalise the total plate waste to those produced by patients in Malaysia. On that account, for more precise findings regarding plate waste, it is suggested that a study be carried out to identify the differences in plate waste produced during every menu rotation that is set up by the hospital food service.

CONCLUSION

The overall mean plate waste among adult patients who received a therapeutic diet at UKM Medical Centre was high. Furthermore, there was a significant, negative relationship between food quality and percentage of therapeutic diet plate waste. Urgent measures must be taken to address the high plate waste rates among patients on therapeutic diets. Prioritising patient satisfaction with food quality and service is crucial for reducing waste in hospital settings. This involves regular plate waste audits to pinpoint menu underperformance, menu revisions, and providing kitchen staffs with training to enhance meal quality in terms of taste, texture, and presentation.

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Authors' contributions

Moorthy JM & Ruzalee RS, conducted the study, data analysis and interpretation, prepared the draft of the manuscript; Hafizon DMP, assisted in data collection, advised on data analysis and interpretation, and reviewed the manuscript; Razalli NH, principal investigator, conceptualised and designed the study, edited the draft of the manuscript, and reviewed the manuscript.

Conflict of interest

This study has no conflict of interest.

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