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Acute postoperative dietary intake in older adult hip fracture patients: an exploratory three-day weighed food diary observational study.

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Statements and declarations

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Availability of data and materials

The study was registered with ClinicalTrials.gov (NCT06451679) and supplementary files are included.

Author contributions

HL designed the study, collected the primary data and conducted the data analysis. JF contributed to the design of the study and the data analysis. SA, NB and CJ contributed to the design of the study and the clinical trial protocol. VZ contributed to the design of the study and the clinical trial protocol. CJ contributed the analysis of food data. VW contributed to the data analysis. HL was responsible for drafting the manuscript and led the writing and revision process. All authors contributed to the development of the manuscript through critical review and feedback and approved the final version for submission.

Conflicts of interest

The authors declare that there is no conflict of interest.

Consent to participate

Consent to participate was written and for those lacking capacity a Consultee process was used which was approved by the Health Research Authority (REC reference: 24/NE/0034).

Consent for publication

N/A

Ethical approval

This study was approved by Teesside University School of Health and Life Sciences Ethics sub-committee and approved by NHS Ethics - approval was granted by the Health Research Authority (REC reference: 24/NE/0034).

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Abstract

Background

Older adults recovering from hip fracture surgery are at risk from poor outcomes that can impede dietary intake, delay recovery and exacerbate comorbidities. Adequate nutrition is critical to recovery in this group, yet acute postoperative intake is poorly understood. Measuring resting energy expenditure (REE) can inform optimal nutritional strategies.

Aims

The primary aim of this observational study was to explore whether acute dietary intake of older adult hip fracture patients met individual REE needs and secondary aims were to explore patterns between REE and hospital length of stay, comorbidity and postoperative complications.

Methods

A weighed food diary was used from postoperative day zero to three inclusive. All meals served were weighed before and after service. Snacks and oral nutritional supplementation were recorded. The study was registered with ClinicalTrials.gov (NCT06451679).

Summary

Twenty-one participants were recruited; complete data were available for fourteen. Only one participant (male) met REE requirements. Lower intake on postoperative day one was observed alongside a longer length of stay. Oral nutritional supplement compliance was 11.9%. Additionally, 62.0% of participants would not meet REE based on standard hospital meal provision. This study provides preliminary insights regarding the energy intake of older adult hip fracture patients during acute postoperative recovery. The patterns observed suggest frequent underachievement of energy needs and highlight potential focuses for targeted education to support early postoperative nutrition. Given the small sample size, these patterns should be interpreted with caution.

Keywords

Hip fracture; nutrition; food diary; acute; postoperative; older adult

Introduction

Older adult hip fracture patients are at an increased risk of presenting with malnutrition or developing malnutrition whilst undergoing surgical treatment (Avenell et al, 2016). In the UK, guidance to support the nutritional intake of hip fracture patients is non-specific and underpinned by low-quality evidence (NICE, 2019). However, nutritional recommendations for this population vary between countries, reflecting differences in healthcare systems, clinical practice, and the strength of the available evidence. With an optimum standard of prompt surgery, the effects of preoperative fasting and anaesthesia can further prolong a malnourished state, which in consideration of frailty and morbidity, a reduced dietary intake can lead to postoperative complications (Williams et al, 2021).

Previous research has demonstrated that nutritional status is correlated with mortality up to 12 months after surgery (Zanetti et al, 2018) and reduced functional outcomes (Wong et al, 2021). But in relation to specific dietary intake, research is limited, focussing either on plate waste or intake from a later stage of recovery (Sahota et al, 2023; Nematy et al, 2006). The visual estimation method (VEM) is a standard unit of measure that is commonly used in hospital wards to quantify dietary intake, however this relies on subjective estimation expressed as a half/quarter or a percentage (Heighington-Wansbrough and Gemming, 2022). Weighing food is regarded as the 'gold standard' of measurement due to the level of precision in comparison, but in the balance of daily clinical duties this can be unattainable (Budiningsari et al, 2016).

Dietary intake in the acute postoperative phase is fundamental to recovery, that with optimum energy levels a hip fracture patient is able to mobilise, thus reducing the risk of postoperative complications such as infections and pressure ulcer formation (Moran et al, 2025; Oberstar et al, 2023). Furthermore, the combined effects of preoperative fasting, the invasive method of surgery and metabolic stress associated with trauma or pre-existing inflammation can increase energy requirements, leading to early muscle catabolism which

may conflict with early mobilisation strategies and prolong length of stay (Hirsch, Wolfe and Ferrando, 2021). However, with a lack of evidence regarding the actual dietary intake of older adult hip fracture patients in the acute postoperative phase, research is necessary to identify where targeted interventions may be required, particularly with respect to carbohydrate intake to address fasting or malnutrition-related hypermetabolic catabolism and protein intake to counter early muscle atrophy (Hirsch, Wolfe and Ferrando, 2021). To our knowledge, this is the first study to use a weighed food diary to explore the dietary intake of older adult hip fracture patients from postoperative day (POD) zero to day three inclusive. Given the challenges associated with accessing and collecting detailed dietary intake in this acute and vulnerable patient population, this study was undertaken to provide an initial exploration of postoperative nutritional intake.

Aims

The primary aim was to observe if the postoperative dietary energy intake (kcal/kJ) of older adult hip fracture patients met their daily resting energy expenditure (REE) needs.

The secondary aims of the study were to explore patterns between postoperative dietary intake and hospital length of stay (LOS); to explore patterns between comorbidity (where reported) and postoperative dietary intake; and to explore postoperative complications (including, delirium, infection, pressure ulcers (PU) and venous thromboembolism (VTE)) alongside dietary intake.

Methods

Ethics

The study was conducted in accordance with the principles of the Health Research Authority (HRA) Good Clinical Practice (HRA, 2020). The study was registered at ClinicalTrials.gov (NCT06451679).

Study design

The design was a cross-sectional observational study using a convenience sampling method, according to the previously published protocol that outlines the methods in detail (Lloyd et al, 2025). To ensure transparency, the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement was used to ensure good reporting of the study (Von Elm et al, 2007) (Supplementary Items Figure 1). The study was conducted in one continuous phase of four weeks from May 2024 to June 2024, of which a member of the research team attended the hospital ward three times daily for said period according to each meal service:

- Breakfast 8:00am – 9:00am
- Lunch: 12noon – 13:00pm
- Dinner: 17:30pm – 18:00pm

The weighed food diary commenced on the participants day of surgery – POD 0 and concluded at POD 3 inclusive. An electronic digital kitchen scale with a weight graduation of 1g (AccuWeight 201, maximum weight 5kg) was used to weigh all items served to the participant before and after each meal service, per day of the food diary. Prepackaged food was documented according to the weight stated on the packaging.

Inclusion Criteria

The inclusion criteria for the study were adults aged 60 years and above that had sustained a hip fracture from a fall at standing height or less, that would be classed as a 'fragility fracture'. There was no upper age limit, and no exclusions were based on gender or ethnicity. Following ethical approval, permission was granted to include older adult hip fracture patients with any form of cognitive decline.

Exclusion Criteria

The exclusion criteria for the study were 1) pathological hip fractures, 2) traumatic hip fractures, for example sustained in a road traffic collision, 3) those that could not speak English language due to obtaining informed consent, and 4) those who were undergoing current oncologic treatment.

Recruitment

All eligible patients according to the inclusion and exclusion criteria were invited via a gatekeeper for the study (a registered healthcare professional) as they were admitted to the hospital orthopaedic trauma ward. The standard diagnosis at the study site for a hip fracture was an X-ray on admission to the accident and emergency department, following which, the participant's care adhered to a specific 'neck of femur (NOF) fracture pathway' which was already in place at the study site. Written informed consent was obtained from participants that were assessed as having capacity by medical staff on admission to the ward.

Those who presented with cognitive decline were approached for inclusion in the study via a discussion between medical staff (the 'Consultee') in consultation with a family member/friend. Following an introduction of the study, the opinion of family/carers was sought as to whether they believed their family member or friend that had sustained a hip fracture would be likely to consent to taking part in the study if they had capacity. A separate 'Consultee Form' was used to document the process, which was not used as a consent form but recorded the discussion, which was also approved by the Health Research Authority (HRA) Research Ethics Committee. A flow chart of the Consultee process can be found in Supplementary Items Figure 2.

All participants were informed that they could withdraw from the study at any time with no reason required. Should a participant have lacked capacity initially and subsequently regained capacity later in the study, they would be informed immediately of the study and given the option to remain in the study, withdraw from the study and withdraw their data, or

withdraw from the study and allow the research team to keep their data up until that point. There was no follow-up period.

Sample size

A pragmatic sample size approach was adopted, informed by feasibility and expected recruitment at the study site, rather than a formal power calculation. A target sample of 30 participants was considered achievable in the study timeframe, based on average monthly admissions at the study site reported in the National Hip Fracture Database (2022). Given the exploratory nature of the study, the planned sample size was not intended to support formal inferential statistical testing, and analyses were planned to focus on descriptive patterns and observational insights rather than formal hypothesis testing or inferential conclusions (Nayak, 2010).

Food diary protocol

All hospital food served to participants per meal service was weighed and the data recorded by a member of the research team in order to reduce the burden of recall on patients or ward staff. Food items served to participants were weighed before being served to the participant per plate, with plates placed on the digital weighing scale and recorded by the researcher. After the food tray was retrieved from the participant, the researcher weighed the plate if it was a complete meal (for example lasagne), or, if it was a multiple item meal (for example meat, potatoes, and vegetables), the researcher weighed the leftover food groups individually to ensure the validity of the weighed food method and to achieve the highest degree of accuracy possible. At each meal service, baseline weights of plates and bowls were taken, as it was observed that the plates were often different sizes, and for individual food group weighing after each meal, a paper plate was used to separate items. After each meal service, each participant was asked by the researcher if they had consumed any snacks in between breakfast and lunch, lunch and dinner or overnight, and for

participants enrolled under the Consultee process, ward staff and/or family members were asked about snacks, additional foods during mealtimes and whether any spillages occurred.

In addition to dietary intake, the NOF pathway already in place at the study site included the provision of two oral nutritional supplements (ONS) (Nutricia Fortisip Compact or Fortisip Compact Protein) per participant per day which were tracked and recorded by the researcher on the ward daily.

Adverse Events

Should a participant have experienced an adverse event during the study, such as a stroke, myocardial infarction, or a major haemorrhage requiring a blood transfusion, the participant would be removed from the study, which was agreed after consultation with the study site research department. Any data collected up until that point would be kept in the study and anonymised. The participants end point in the study was when LOS and discharge destination data was obtained.

Outcome measures

a. Baseline characteristics

A range of data including sociodemographic (age, sex, height, weight), American Society of Anaesthesiologists (ASA) grading, nutritional screening (MUST) and medical history data was collected (Table 1) in addition to comorbidity and past medical history (PMH) (Supplementary Items Table 1) to provide a descriptive overview of the study sample.

b. Dietary Intake

Dietary intake was analysed to explore whether participants were sufficiently meeting their estimated REE requirements and to explore potential patterns between early postoperative dietary intake, LOS and postoperative complications. Current guidance was used to

calculate and subsequently estimate REE and nutritional requirements (Todorovic and Mafrici, 2018a).

c. Covariates

Baseline characteristics data such as sex and age along with LOS data (measured in days) was obtained from participants' medical records to provide contextual description within the dataset, and the occurrence of postoperative complications was checked daily. Given the exploratory nature of the study and limited sample size, these variables were included for descriptive contextualisation only and were not intended for adjustment or inferential interpretation.

Calculation of REE and nutritional requirements

Using the participant's weight (kg), this was multiplied by a factor of 23kcal/kg actual body weight per day for 'surgical fixation of a hip fracture'. Total energy expenditure (TEE) was calculated by multiplying REE with a combined factor for physical activity and diet-induced thermogenesis (PAL), using the range stated of 1.00 – 1.10 for 'in bed and immobile, post-surgery' to account for the related decrease in physical activity according to an acute trauma state (Todorovic and Mafrici, 2018b). If a participant's body mass index (BMI) was at opposing ends of the scale (e.g. $<18.5\text{kg/m}^2$ or $>30\text{kg/m}^2$), the REE calculation was adjusted according to guidance (Todorovic and Mafrici, 2018c). Where BMI was at the higher end of the scale, protein requirements were additionally adjusted according to 75% of the value as specified (Todorovic and Mafrici, 2018d).

Macronutrient data

Macronutrient data for all meals served by the catering service at the study site were provided to allow for calculation of dietary intake according to energy (kcal/kJ), protein, carbohydrates, fats, and fibre. For any snacks consumed or foods not listed by the hospital, Nutritics v5.09 software (2019) was used for macronutrient data. There were some

discrepancies observed in the macronutrient data provided by the study site in relation to carbohydrate side items (chips, roast potatoes, creamed potatoes, potato wedges) in that some macronutrient elements stated zero and therefore following consultation with a registered dietitian, McCance and Widdowson's composition of food data (2021) was substituted into the dataset.

Statistical analysis

Descriptive data was analysed in Microsoft Excel, with food diary tables created for each meal service per participant from POD 0 to 3 including calculations for total kcal, kJ, and macronutrients consumed per participant according to guidance calculations (Todorovic and Mafrić, 2018a). REE attainment was summarised as REE met per day, percentage of REE met, meals refused, total and average kcal consumption using JASP version 0.19 software (JASP, 2025).

Exploratory analyses were undertaken to describe patterns in the dataset. Variation in the percentage of REE met across postoperative days was summarised descriptively, with results presented by day and sex to illustrate patterns in dietary intake. Given the exploratory nature of the study and small sample size, findings are presented descriptively, a deviation from the original protocol. Daily dietary intake values were analysed separately without aggregation. For secondary aims, regression analysis was used to explore patterns in REE and LOS. Postoperative complications and capacity status were included for descriptive contextualisation only and were not used for adjustment or inference.

Differences in REE attainment between males and females were described using frequency counts. Where REE was met or exceeded, individual food diaries were reviewed to identify possible contributing dietary factors (e.g. energy-dense food items). Where REE was not met, food diaries were examined alongside reported postoperative complications to explore

contextual influences. All analyses were exploratory in nature and are presented to identify patterns for hypothesis generation. Given the limited sample size, findings should be interpreted cautiously and are not intended to support inferential conclusions.

Results

A total of 21 participants were recruited (male=6, female=15), with a mean age of 80.5 ± 8.9 years (range 60-100 years) of which five participants were assessed as lacking capacity. A further five potential participants were identified but were not recruitable due to reasons including admission to a different ward, end of life care, family uncontactable and surgery not viable. No participants withdrew and all participants approached for the study elected to take part. No adverse events were reported during the food diary data collection phase, however one participant died on POD 7, after completion of the data collection phase, and was included in the dataset. Of the total participants, 14 food diaries were completed (males=4, females=10). Findings from the completed diaries are reported descriptively to characterise postoperative dietary intake within the study cohort. Total energy intake accumulated over the three-day food diary period was 4532 ± 1894 kcal (18,962 kJ) for males and 3459 ± 1513 kcal (14,473 kJ) for females, a 31% lower intake in females compared with males. When expressed as mean daily intake, this corresponds to approximately 1510 kcal/day for males and 1150 kcal/day for females. Mean length of stay was 7.9 ± 3.7 days. Seven participants were transferred out of the trauma ward during the study ranging between POD 1, POD 2 and POD 3. Two were transferred to a surgical ward due to the need for trauma beds, one was transferred to a rehabilitation ward at a different hospital, and four were transferred to the orthopaedic ward as a preventative measure on account of having a total hip replacement (THR) to reduce the risk of postoperative infection. The baseline characteristics of the participants in the study are outlined in Table 1. PMH data demonstrated the average number of comorbidities/PMH instances for the total participants was 4.4, with the most common hypertension (n=13) (Supplementary Items Table 1).

a) Primary Aim

Only one participant (male) met their REE needs on each day of the food diary (excluding POD 0 due to fasting for surgery) and additionally exceeded their recommended TEE intake. Of the 14 completed food diaries, excluding POD 0 (day of surgery), REE was achieved on 12 days out of a possible total of 42. The food diary data and percentage of REE achieved is detailed in Table 2. Variation in the percentage of REE met across postoperative days was summarised descriptively, with results presented by day and sex to illustrate patterns in dietary intake. These findings should be interpreted cautiously given the small sample size and are presented to support exploratory interpretation rather than formal comparison.

b) Secondary aims

Patterns were explored between the percentage of REE met across POD 0-3 and LOS to describe potential relationships within the dataset with sex (male/female) and capacity (yes/no) to provide contextual description of the sample. A pattern was observed between the percentage of REE achieved on POD 1 and LOS (95% CI, -0.11 to -0.02), with lower intake observed alongside a longer LOS. Given the small sample size and exploratory nature of the study, this pattern should be interpreted cautiously and considered hypothesis-generating. A similar pattern was observed for POD 0 (95% CI, 0.0049 to 0.15), although interpretation is limited due to variable fasting durations on the day of surgery.

Comorbidity and dietary intake were explored in relation to the American Society of Anaesthesiologists (ASA). Due to small numbers per comorbidity category, individual-level comparisons were not undertaken. A descriptive pattern was observed in the completed food diary data (n=14), in that as the ASA grade increased, total dietary intake decreased, with lower variability in intake amongst participants with higher ASA grades (Figure 1). In relation to capacity, total calorie intake across the completed food diaries was lower in

participants that lacked capacity (3025 ± 1927.31 kcal, 12,656.6 kJ versus with capacity 3913 ± 1448.48 kcal, 16,372 kJ) (Supplementary Items Figure 3).

A total of 24 postoperative complications were observed across all participants recruited, with a loss of appetite the most frequently reported postoperative complication ($n=13$), which was secondary to another complication (nausea) in ten participants. The number of refused meals was recorded with the highest number observed on POD 1 which aligned with reduced dietary intake on POD 1 and longer LOS (Table 2). A refusal was defined as food items, not fluids; for example starter options for lunch and dinner comprised of fruit juice or soup, therefore if fruit juice was refused this was not classed as a meal. No reported complications in relation to infection, VTE or PU were reported. Further exploratory review of complications and dietary intake did not identify any associations.

c) Further observations

Participants were more likely to eat more than 50% of a meal that could be eaten with a spoon or hands compared to those requiring a knife and fork. Average energy intake for spoon/hand meals was 170.9 ± 65.8 kcal and for knife and fork meals 190.5 ± 140.1 kcal (Supplementary Items Table 3). It is possible that higher intake of spoon/hand foods reflected not only ease of eating but also differences in meal characteristics (e.g., temperature, aroma/colour, palatability, and energy density); however, this exploratory study did not control for specific meal type or nutritional density. Whilst males consumed more food than females at breakfast, lunch, and dinner, both male and female participants showed a reduction in average intake between lunch and dinner (Supplementary Items Figure 4). Protein intake was low across the cohort, with females consuming 29-41g per day and males 42-55g per day (Supplementary Items Table 4) compared with recommended intakes of 1.0g-1.5g per kg of body weight per day (Todorovic and Mafrici, 2018e).

d) Key finding

An additional exploration of meals fully consumed by participants was undertaken to describe whether baseline hospital meal provision aligned with estimated REE requirements. Completed breakfast, lunch and dinner meals were identified and average energy content calculated across the meals (Supplementary Items, Table 5). For example, of the 21 participants recruited, only 15 participants ate all of their breakfast, and the frequency of completed breakfasts consumed for the 15 participants was 27 breakfast meals across the food diary out of a possible 45 (15x3 food diary days). The total calories for the 27 breakfast meals were calculated as an average, which showed that the average breakfast serving was 204kcal. The average total calories served per day for breakfast, lunch and dinner was 1368.4kcal (5,725.39kJ), while the average REE for participants in the study was 1519.4±326.5kcal (6,357.17kJ). Based on the REE needs of the participants in this study, only eight participants (38%; 1 male, 7 female) would therefore meet their REE if consuming three standard hospital meals, excluding snacks and oral nutritional supplements. These observations suggest that within this cohort, standard hospital meal provision alone would not meet the estimated REE needs of 62% of participants, potentially reflecting differences in portion size, energy density, or a combination of both.

e) Snacks and oral nutritional supplements

Ten participants reported eating snacks between meals that ranged between biscuits, toast, chocolate, fresh fruit, and crisps, with biscuits and fresh fruit the most popular items, and the majority of snacks were brought by family or friends. Whilst two ONS per day were a standard prescribed element of the NOF pathway at the study site, a total of ten ONS bottles were observed (11.9%) out of a possible 84 prescribed for participants that completed the food diary.

Discussion

To our knowledge, this is the first study to explore postoperative dietary intake in older adult hip fracture patients from POD 0 using a weighed food diary, including participants lacking

capacity. A total of 21 participants were recruited, comprising 7 males and 14 females, with complete food diary data available for 14 participants (4 male, 10 female), with no elective dropouts nor adverse events to warrant removal from the study. The study findings revealed that only one participant (male) met and exceeded their REE intake for POD 1-3. Descriptive variation in the percentage of REE achieved suggests substantial variability across participants, likely influenced by the small sample size. These observations should be interpreted cautiously and are intended to inform patterns for hypothesis generation in future studies rather than to support inferential conclusions.

There is limited research reporting dietary intake in the acute postoperative period after hip fracture surgery in older adults, therefore comparison is limited. A previous study (Goisser et al, 2015) examining postoperative dietary intake in hip fracture patients used a VEM expressed as percentage. Although the sample size was relatively larger ($n=88$), the study did not account for specific food groups, snacks or oral nutritional supplements. Additionally, calorie intake was not calculated. Nonetheless, consistent with our findings, the authors reported that 72% of participants consumed less than 50% of meals served. This correlates with the findings of a study that assessed potential eating difficulties of 520 older adults (mean age 81.0 years) in a rehabilitation hospital setting, which found 'manipulating food on the plate' ($p<0.0005$) and 'transport of food to the mouth' ($p<0.0005$) were significant barriers to eating and that patients with low energy require more support at meal times (Westergren et al, 2002). Regarding ONS compliance, there is a plethora of research that has explored postoperative ONS effectiveness in this patient group (Avenell et al, 2016; Chen et al, 2023). While ONS can aid recovery, their effectiveness depends on the overall dietary intake they are meant to support. Based on our findings, supplements alone are insufficient when dietary intake is as low as observed.

A descriptive pattern in this study suggested that lower dietary intake on POD 1, expressed as the percentage of REE achieved on POD 1 was observed alongside an increased LOS.

Given the small sample and variability in intake, this pattern should be interpreted cautiously and viewed as hypothesis-generating rather than confirmatory. Nevertheless, it highlights the potential importance of early nutritional support in the first 24 hours when metabolic demand is increased owing to the surgical stress response (Cusack et al, 2020).

Furthermore, based on the findings that baseline hospital meal provision would not meet the REE needs of 62% of the participants in this study emphasises that a renewed focus on nutritional strategies is imperative in the care of older adult hip fracture patients. Whilst there are currently no directly comparable studies, a retrospective study of over 160,000 hip fracture patients in the USA found that early postoperative nutritional support in addition to standard dietary intake was associated with a shorter LOS (5.8 ± 6.6 days) in 680 patients, compared with no early support (7.6 ± 5.8 days, -1.1 days, 95% CI, -1.7 to -0.4 days)³. However, the design of the study relied on coded entries and did not explore dietary intake, but rather an ONS recorded as given.

Limitations

There are several limitations that must be acknowledged. The small sample size ($n=21$), with 14 participants completing the food diary, limits the generalisability of the findings and precludes inferential conclusions. Completion of the food diary was affected by patient transfers between wards as part of routine clinical care, reducing the number of completed datasets. Consequently, the findings should be interpreted within the context of the study design and sample size. The imbalance between male and female participants within the completed diaries (male=4, female=10) further limits interpretation of sex-based observations beyond descriptive dietary factors. The pragmatic sample size was influenced by feasibility constraints, including the available study timeframe and resources, which limited recruitment to a single site and contributed to the small final sample. The single-phase design of the study without follow-up restricts the ability to evaluate the long-term effects of dietary intake on recovery outcomes. Bodyweight measurements were obtained postoperatively, as preoperative weights were estimated, therefore this may have been

influenced by perioperative shifts, potentially affecting the precision of estimated energy requirements. The study population was ethnically homogenous, which limits applicability to more diverse populations. Additionally, due to the small sample size, the influence of potential confounding factors such as comorbidities, medications, and functional status could not be fully explored, reinforcing the descriptive nature of these findings.

Conclusion

This study provides preliminary, descriptive insights into early postoperative nutrition in the recovery of older adults following surgical repair of a hip fracture. Given the small sample size, the findings offer early insight into the barriers to adequate dietary intake in this vulnerable population but should be interpreted with caution. Challenges such as nausea and a loss of appetite significantly limited intake, and the study further demonstrates that oral nutritional supplements are insufficient when compliance is low and baseline dietary intake is inadequate. These observations underscore the potential value of patient-centred nutritional strategies that go beyond a reliance on supplementation. Future research should explore sustained interventions, including preoperative preparation, optimised fasting protocols and the routine provision of fortified meals. The patterns observed in this study can inform future research and guide future work aimed at refining nutritional guidelines and hospital policies to support recovery in this high-risk group.

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