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Weekend days are not required to accurately measure oral intake in hospitalised patients

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LSC was responsible for study design, recruitment, data collection, data entry, data analysis, statistical analysis, interpretation of the data and drafting the manuscript. She is guarantor of this work, and as such, had full access to all the data in the study and takes responsibility for the accuracy of the data analysis.

MJC, AMD, and LTW contributed to the study design, interpretation of the data, and critical revision of the manuscript for important intellectual content.

KL was responsible for analysis and interpretation of the data, contributed to the study design, and critical revision of the manuscript for important intellectual content.

AK contributed to data collection, data entry, interpretation of the data, and critical revision of the manuscript for important intellectual content.

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Weekend days are not required to accurately measure oral intake in hospitalised patients

Abstract

Background

Nutrition studies in patients admitted to hospital frequently disregard oral intake because measurement is time-intensive and logistically challenging. In free-living populations, weighed food records (WFR) are the gold-standard and are conducted on weekend and weekdays to capture variations in intake; yet this may not translate during hospitalisation. The study objective was to determine whether oral intake differs between weekends and weekdays in hospitalised patients.

Methods

For adult patients initially admitted to ITU with a moderate-severe head injury over a 12-month period, WFR were conducted each week on Tuesday, Thursday and Saturday throughout hospitalisation. Meal components were weighed before and after consumption, and energy and protein intakes calculated with specialised software. Data are mean (SD). Differences were assessed using paired t-tests and agreement using Bland-Altman.

Results

Thirty-two patients had WFR collected on 220 days, 68% (n=149) on weekdays and 32% (n=71) on weekends. Overall, daily intakes were 1367 (877) kcal and 62 (40) g protein. There were no differences in intake across all days ($p=0.937$ energy, $p=0.797$ protein) or between weekdays and weekends in weeks one to three of oral intake (all $p>0.1$). Limits of agreement between mean intakes across days were wide for energy (range: -2680 to 2283 kcal) and protein (range: -125 to 110 g).

Conclusions

Grouped energy and protein intakes from WFR in hospitalised patients are similar on weekdays and weekends but large intra-patient variations occur. Future quantification of oral intake during hospitalisation should include as many days as feasible, but not necessarily weekend days, to reflect true intake.

Keywords:
Nutrition; oral intake; dietary intake methodology; weighed food record; head injured patients

Introduction:

Studies of nutrition practices in a hospitalised setting frequently disregard oral intake due to the time-intensive nature and logistic challenges associated with obtaining accurate intake measures. This may explain the absence of recommendations on oral intake in critical illness[1, 2]. Excluding orally ingested nutrient may lead to considerable underestimation of energy and protein intakes over the entire hospitalisation. Of note inferences from nutrition interventions conducted within the intensive therapy unit (ITU) have not measured oral intake either in ITU or after ITU discharge[3, 4-7]. The lack of detailed information regarding oral intake means that much of the nutritional intake throughout hospitalisation remains an unmeasured confounder, which could lead to incorrect inferences for both observational and interventional studies[8]. Accordingly, a precise but efficient and feasible method to measure oral intake in hospitalised patients is required.

Hitherto, hospital-based nutrition studies have used a range of methods to assess oral intake including recall, measures of waste, and estimates of intake[9-11]. These methods contain inherent inaccuracies, which may limit their use in high-quality research[12]. Methods that rely on patient memory are prone to recall bias and exclude patients with acute delirium and following certain presentations, such as head injury, reducing the generalisability of results. Similarly, methods that provide an indirect measure of intake lack precision[12].

Weighed food records (WFR) are considered the gold-standard technique for precise measurement of nutrient intakes in free-living populations[13]. It is recommended these be conducted at least three days per week, comprising two week days and one weekend day, to account for social variations and provide a reliable representation of actual intake[14]. The extent to which this is true in an institutionalised setting, such as a hospital, where variations in intake may differ from free-living individuals, has never been evaluated. If, similar to free-living individuals, intake varies between week days and weekends WFR will need to be conducted on both to accurately quantify intake in

hospitalised patients. Such a requirement has considerable cost and feasibility implications for studies of nutritional therapies in critically ill and hospitalised patients, whereas if variations in intake do not occur across different days of the week, the need to conduct WFR on a range of days, or outside of usual work days, may be unnecessary. Finally, a rigorous evaluation of oral intake over time as patients recover from ITU has not been done.

It was therefore hypothesised that, because of fewer fasting periods for procedures and greater periods when family were present to assist with feeding, head-injured patients recovering from critical illness would consume more energy and protein on weekends. The primary aim of this study was to compare energy and protein intakes derived from investigator-led WFR conducted on weekdays and weekends in patients with a head injury. The secondary aim was to determine if energy and protein intakes increased over time as patients recovered from their primary illness.

Materials and Methods:

Adult patients consecutively admitted to ITU with a moderate-severe head injury (Glasgow Coma Scale score 3-12) to the major neuro-trauma referral centre in the state of South Australia over a 12-month period were screened for eligibility. Data on energy and protein consumed orally throughout the hospital stay were collected prospectively and censored at 90 days.

To precisely quantify oral intake WFR were conducted once tube feeding was ceased and on three pre-determined days per week, including two weekdays (Tuesday and Thursday) and one weekend (Saturday), by trained research dietitians. Patients received hospital meals as per usual practices, based on individual meal selection or standard menu choices. Individual meal components (e.g. meat portion, mashed potato, gravy) provided from breakfast to one hour post-dinner were weighed prior to delivery to the patient. Meal components were weighed separately as they were plated on the plating line using Salter Brecknell Model 405 digital scales (Australia) to the nearest 0.1 gram. After consumption individual components of waste were weighed and deducted from the pre-weights to calculate the total proportion consumed in grams. Items provided outside of observation times were estimated using collection of wrappers, nursing notes, and communication with patient, family, and nursing staff.

Recorded weights were entered into FoodWorks 8 Xyris dietary analysis software (Brisbane, Australia) using pre-entered hospital recipes to calculate energy and protein intakes. WFR were excluded if they were partial days (due to hospital discharge or day leave) or if patients also

received artificial nutrition simultaneous (e.g. overnight enteral tube feeding). Energy and protein requirements prescribed by the hospital dietitians as part of standard care were recorded.

Ethical Approval

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human patients were approved by the Royal Adelaide Hospital Human Research Ethics committee (HREC/14/RAH/100). Written informed consent was obtained from all patients or their legal authorised guardian where appropriate.

Statistical Analysis

Data are presented as mean (SD). For weekend versus weekday analyses, mean intake data from the two weekdays per week were combined to be representative of a single weekday and this was compared to the corresponding weekend day for that week. Differences between energy and protein intakes on week versus weekend days were assessed using linear mixed models with a fixed effect for day of week and random effects to account for clustering of multiple days within subjects. Agreement between energy and protein intakes assessed on week versus weekend days were determined using Bland-Altman plots with the bias (mean difference) and limits of agreement calculated at two standard deviations from the derived mean and difference variables. Based on these results, all analyses were repeated for individual days. Poor agreement was defined a.priori to be approximately 25% of the patient's requirements[15] (>500 kcal/day and >25 g protein/day) given prior research suggests that weight loss occurs when less than 75% of daily requirements are delivered and therefore this is considered inadequate[10].

Results:

Consent to participate was obtained in 32 patients admitted to ITU following a moderate-severe head injury and who were subsequently ingesting food orally while hospitalised. Baseline patient characteristics are shown in **Table 1**.

A total of 220 days of WFR were included, 68% (n=149) on a weekday and 32% (n=71) on a weekend. Patients contributed data from a mean of 6.9 (range 1-26) days; 5.0 (range 1-21) weekdays and 2.3 (range 1-7) weekends.

Overall, mean daily oral intake was 1367 (877) kcal/d and 62 (40) g protein/d, with similar amounts consumed on week and weekend days (1368 (894) vs 1364 (845) kcal/d, 61 (41) vs 63 (39) g protein/d). Total mean prescribed energy and protein requirements were 2249 (412) kcal and 105 (20) g protein, respectively. Days with interruptions were similar between groups (49.4% for weekdays and 50.6% for weekends).

There were no differences in energy or protein intakes received on any individual day (p=0.937 energy, p=0.797 protein) or between combined week versus weekend days (p=0.913 energy, p=0.567 protein). There were no differences in energy or protein intakes consumed across days in the first (p=0.665 energy, p=0.433 protein; n=83 WFR), second (p=0.529 energy, p=0.907 protein; n=56 WFR), or third (p=0.426 energy, p=0.110 protein; n=30 WFR) week of oral intake. In patients that remained in hospital for at least two full weeks, mean oral energy and protein intakes increased over time **(Table 2)**.

Bland Altman plots of mean difference in energy and protein intake across individual days are shown in **Figure 1**. There were wide limits of agreement for both energy and protein, but these were consistent across days. There were consistently wide limits of agreement across days and between combined weekdays and weekend days in both week one and week two (**Table 3**).

Discussion:

This is the first study to explore variations in oral intake in hospitalised patients measured on weekdays compared to weekends using the gold standard technique, investigator-led WFR. At the population level (e.g. mean intake for all patients) there were no differences in mean energy or protein intakes between weekday and weekends, or individual days per week. Hence, these results negate the hypothesis of this study, that head-injured patients recovering from critical illness would consume more energy and protein on weekends. This observation is important for future population-based research, such as observations of intake in specific patient groups, as representative intake could be collected on any day of the week.

Only one other study has previously attempted to quantify oral intake in a critically ill population. Peterson and colleagues reported that energy and protein intakes from oral intake were less than 50% of estimated requirements each day, however data were limited to the week following weaning from ventilatory support[9]. Given the lack of data the need to collect precise dietary intake

information post-ITU has been identified by several authorities as an important objective [16,17]. Given the scarcity of research that includes the measurement of nutrition consumed orally in both critically ill and head-injured patients the finding that representative intake does not require measurement on weekend days provides an achievable, sufficiently accurate methodology to quantify energy and protein intakes, with positive inferences for funding.

However, on an individual patient-level, there was considerable day-to-day variation in energy and protein intakes, irrespective of the measurement day, and large intra-patient variation across days. Given this, in studies exploring the influence of oral intake in individual hospitalised patients (e.g. interventional or observational studies exploring associations between variables)[18,19], a single day is an imprecise measure of mean intake for that patient. Accordingly, WFR should be collected on as many days as possible to precisely reflect actual intake. This finding also has implications for clinical practice where estimates of oral intake made on a single day will need to be repeated as frequently as possible to improve accuracy. While in free-living populations a small selection of both week and weekend days are required to provide a true reflection of intake, in this patient group large intra-patient variation occurred across all days demonstrating the need to include measurements on as many days as possible. That there was no difference in oral intake between week and weekend days also has implications for staffing a clinical service as this information does not require measurement on the weekend.

In this study there was also an increase in mean energy and protein intakes over time. This requires consideration, both for research and clinical practice. Based on these results a longer duration of measurement is required when evaluating for nuanced relationships between oral intake and recovery[15,20].

While this study was conducted in a specific population, the measurement of energy and protein consumed via the oral route has been described in other patient groups. These studies have all used single day snapshots of oral intake, with data from self-reported intakes[21], visual reports of categorised food waste (e.g. nothing, <1/2, >1/2, all),[22,23] or measures of plate waste but not the portion provided[24]. While these studies have not been able to show changes in intake longitudinally, taken together they are consistent with the concept that patients consuming nutrients orally receive suboptimal nutrition[21,22,24,25], which is associated with adverse outcomes such as increased infection rates and mortality [21-23]. Therefore, assessment of ingested nutritional intake is important, and greater emphasis on accurate measurement of nutrients consumed via this route should take place both in clinical practice and nutrition research.

This study has a number of strengths. It is the first to investigate the variance and agreement between energy and protein intakes quantified using WFR on weekdays versus weekends in an institutional setting. Compared to WFR in free-living populations where the individual completes the measurements, these WFR were conducted by two independent study investigators not open to respondent bias. The main limitation was that two weekdays and one weekend were considered representative of weekly intake, as is common practice in dietary methodology. Additionally, any items consumed overnight were not included in the observation period. However, the latter was consistent for all days. Finally, these data were obtained from a small, defined group of patients admitted to a single-centre and so results may not be generalisable to all healthcare settings and patient groups.

Conclusion

In hospitalised head-injured patients recovering from critical illness, mean energy and protein intakes were observed to be similar across days but with large intra-patient variations. This suggests that future quantification of oral intake in hospitalised populations, but not individuals, could be performed using investigator-led WFR on any day of the week. This has significant implications for resourcing nutrition research. Studies of individual treatment effects should include as many days as feasible, but not necessarily weekends, to adequately reflect true intake.

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Figure Legend:

Figure 1: Bland Altman plots of difference versus mean of energy and protein intake measured across days

------- Mean intake

— — – Clinical agreement (defined as 500kcal and 25g protein from the mean)

——— Two standard deviations from the mean (Bland Altman limits of agreement)

Table 1: Patient demographics, n=32

	Total
Age (y), mean (SD)	44 (16)
Sex (male) n, (%)	28 (88)
Initial GCS: GCS 3-8, n (%) GCS 9-12, n (%)	 20 (63) 12 (37)
APACHE II score, median [IQR]	18 [13 - 21]
SOFA score, mean (SD)	6 (3)
Body Mass Index (kg/m^2), mean (SD)	26 (6)
ITU LOS (d), median [IQR]	12 [6 - 17]
Hospital LOS (d), median [IQR]	30 [19 - 50]
Days to commence oral intake, median [IQR]	13 [5 - 25]
Days received oral intake, median [IQR]	15 [9 - 23]

APACHE II: Acute Physiology and Chronic Health Evaluation, GCS: Glasgow Outcome Scale, IQR: Interquartile Range, LOS: Length Of Stay, SOFA: Sequential Organ Failure Assessment

Table 2: Mean (SD) energy and protein intakes per day for week one and week two for patients with complete data, n=15

	Energy (kcal), mean (SD)			Protein (g), mean (SD)		
	Week 1	**Week 2**	**p-value**	**Week 1**	**Week 2**	**p-value**
Saturday	1073 (858)	1313 (729)	0.31	52 (44)	64 (36)	0.29
Thursday	935 (907)	1440 (914)	**0.035**	39 (35)	69 (45)	**0.005**
Tuesday	1140 (772)	1600 (945)	0.91	55 (41)	68 (44)	0.39
Mean for all days	1050 (833)	1451 (856)	**0.004**	49 (40)	67 (41)	**0.009**

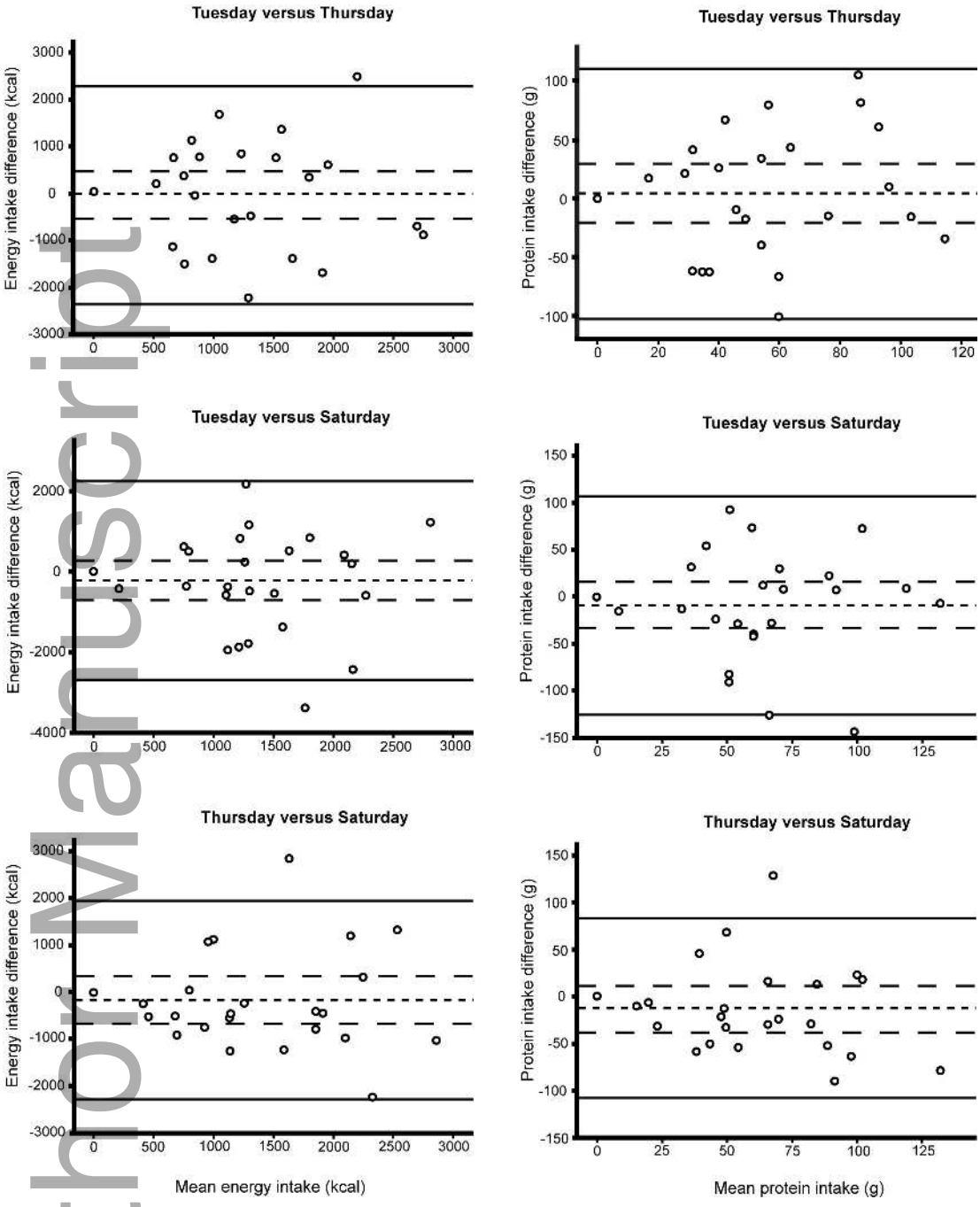
SD= Standard deviation

Paired-samples t-test for means comparison

Table 3: Mean energy and protein intakes and limits of agreement across days from Bland Altman plots

	Energy (kcal)		Protein (g)	
	Mean difference intake	**Limits of agreement (Mean+/-2SD)**	**Mean difference intake**	**Limits of agreement (Mean+/-2SD)**
Week one (n=25)				
Tues vs Thurs	-36	-2355, 2283	4	-103, 110
Thurs vs Sat	-175	-2281, 1931	-13	-108, 83
Tues vs Sat	-211	-2680, 2258	-9	-125, 107
Weekend vs weekday	-153	-2135, 1828	-11	-90, 67
Week two (n=15)				
Tues vs Thurs	161	-958, 1279	-2	-56, 53
Thurs vs Sat	126	-1779, 2031	5	-88, 98
Tues vs Sat	287	-1055, 1629	3	-59, 66
Weekend vs weekday	155	-1398, 1708	-2	-97, 94

SD= Standard deviation



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