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Original article

Validation of a plate diagram sheet for estimation of energy and protein intake in hospitalized patients

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SUMMARY

Background & aims: Validation of simple methods for estimating energy and protein intakes in hospital wards are rarely reported in the literature. The aim was to validate a plate diagram sheet for estimation of energy and protein intakes of patients by comparison with weighed food records.
Methods: Subjects were inpatients at the Cardio Thoracic ward, Landspitali National University Hospital, Reykjavik, Iceland ($N = 73$). The ward personnel used a plate diagram sheet to record the proportion (0%, 25%, 50%, 100%) of meals consumed by each subjects, for three days. Weighed food records where used as a reference method.
Results: On average the plate diagram sheet overestimated energy intake by 45 kcal/day (1119 ± 353 kcal/day versus 1074 ± 360 kcal/day, $p = 0.008$). Estimation of protein intake was not significantly different between the two methods (50.2 ± 16.4 g/day versus 48.7 ± 17.7 g/day, $p = 0.123$). By analysing only the meals where ≤50% of the served meals were consumed, according to the plate diagram recording, a slight underestimation was observed.
Conclusion: A plate diagram sheet can be used to estimate energy and protein intakes with fair accuracy in hospitalized patients, especially at the group level. Importantly, the plate diagram sheet did not overestimate intakes in patients with a low food intake.

1. Introduction

Malnutrition is a known health care problem among hospitalized patients.[1–6] Usually, a large part of patients is already undernourished when admitted to hospitals and malnutrition often progresses during their hospital stay.[7–9] Malnutrition is associated with higher risk of developing complications.[1,4,5] Furthermore, malnourished patients stay longer in hospitals than patients who are not malnourished, which increases hospital costs.[10,11]

The European Society for Clinical Nutrition and Metabolism (ESPEN) has provided guidelines for nutrition risk screening. Hospitals should also have appropriate nutritional care plans and their effectiveness should be monitored by defined measurements and observations, such as recording of dietary intake.[12] Precise measurements of dietary intake (e.g., food records) are time consuming and expensive and thus discouraging for the hospital employees. An acceptable monitoring method has to be simple, reasonably accurate and easy to use by hospital employees with minimal training. The lack of an acceptable and simple monitoring tool to record dietary intake is a limiting factor for improvement.[12]

Limited amount of reports describing results of studies assessing the validity of simple monitoring tools can be found in the literature, and results are conflicting. Some studies suggest that simple estimates can be useful to quantify patients' intake in a clinical setting[13–15] but with some limitations, like only being valid in situations of reduced intake in malnourished patients,[14] or useful mainly on a group level.[13] Results of one of these studies are presented in German, thus limiting its recognition to others than German speaking individuals.[15] Other studies indicate that simple estimates might be inaccurate with a tendency to overestimate food intake, which can lead to that inadequate food intake among patients remains unrecognized by caregivers and therefore the

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Table 1
Characteristics of the subjects ($n = 73$, 53 males and 20 females). Data is presented as mean ± standard deviation (SD) or percentages.

Age (year)	63 ± 17
Height (cm)	173.2 ± 9.3
Weight (kg)	82.0 ± 18.9
Underweight *n* (%)[a]	1 (1.3)
Overweight *n* (%)[a]	30 (42.2)
Obese *n* (%)[a]	17 (23.9)
Cardiovascular surgery patients *n* (%)	50 (68.5)
Thoracic surgery patients *n* (%)	14 (19.2)
Other patients *n* (%)	9 (12.3)

[a] Body mass index (kg/m^2) was used to define underweight (<18.5 kg/m^2), overweight (25.0–29.9 kg/m^2) and obese (≥30 kg/m^2).

patients are not followed up for further nutritional assessment.[16–18] One possible explanation for conflicting results could be different methods used in the previous studies along with differences in the level of training to those responsible for recording the intake.

One potentially useful method for estimating patients' meal consumption is a simple plate diagram sheet.[15] Thus, the aim of the present study was to evaluate a plate diagram in order to estimate energy and protein intake in hospitalized patients. Prior to the study the hospital employees were trained in how to use the plate diagram sheet correctly.

2. Materials and methods

2.1. Subjects

Patients (age 19–94 years) admitted to the Department of Cardio Thoracic Surgery, at the National University Hospital in Reykjavik, Iceland, in the period June 20th to December 14th 2011 were invited to participate in the present study. The inclusion criteria was a planned hospital stay of at least five days. Eighty one subjects gave their written consent. The study was approved by the Local Ethical committee at the National University Hospital, Reykjavik. The following descriptive information was obtained from each subject's medical record: age, gender, height, body weight and reason for hospitalization.

2.2. Nutrient composition of the hospital diet

Five main meals with known nutritional composition are served daily at the National University Hospital, i.e., breakfast, lunch, afternoon snack, evening meal and evening snack. The nutrient composition of the diets is in line with the recommendations on diet and nutrients from the Public Health Institute of Iceland[19] and the Swedish Recommendations for Hospital Patients.[20] Based on the patient's appetite and condition, assessed by a clinical dietitian or by a nurse in the ward, the meal portion size is chosen for each patient individually. In the present study subjects where served with meals that provided either 7 MJ/day (1672 kcal/day) or 8 MJ/day (1911 kcal/day). Average protein content of the 7 MJ menu was 77.6 g/day and the 8 MJ menu provided 89.6 g protein/day.

2.3. The plate diagram sheet recording

Training in how to fill in the plate diagram sheet took place at the Department of Cardio Thoracic Surgery prior to the study period. The head nurse and assistant head nurse at the ward were involved in the training process. Meetings were held with the hospital employees, starting with discussions about the importance of nutrition in the hospital setting. The plate diagram sheet was introduced and examples provided on how to record. Research staff was available at the ward during the first few weeks of registration, in order to give second opinion regarding the registration. This support was mainly used by those who felt unsure about the recording and those who had for some reasons not attended the meetings. After each meal, the trained hospital staff estimated and recorded the proportion of the meal consumed by the subjects (0%, 25%, 50% or 100%). The recording was made for three days. Energy and protein intakes were estimated using the known energy and protein content of the meals.

2.4. The reference method

All leftover food was weighed by a trained research person on a digital scale (Philips Essence HR 2393). The leftovers (grams of each individual food item left on the plate) were then subtracted from the standard portion provided to each subject. In order to get information about the total energy and protein intake of the subjects, food and drinks consumed in between the five main meals were also recorded by the study personnel. Energy and protein intake was analysed using Kostplan for Windows, version 1.0 (AIVO AB, Stockholm, 1996), supported by the Icelandic nutrient composition database (ISGEM).

2.5. Statistical analysis

Statistical analyses were performed using the program SPSS for Windows (Version 20, 2011, Inc, Chicago, IL). Distribution of baseline data are described as mean ± standard deviation (SD). The mean energy- and protein intakes over the three day period estimated by the plate diagram sheet were compared with the results from the weighed records by paired *t*-test. We made a separate analysis, only including meals where the hospital staff estimated the consumption to be either 25% or 50% of the served meals in order to estimate the agreement between the two methods at low food intake. Pearson correlations were used to assess associations between the different methods. The overall agreement for energy- and protein intakes between the two methods was assessed by

Table 2
Energy (kcal/day) and protein (g/day) intake estimated by the plate diagram sheet (estimated) compared to weighed food intake (weighed).

	Energy			Protein		
	Estimated ($n = 73$)	Weighed ($n = 73$)	*p*-value	Estimated ($n = 73$)	Weighed ($n = 73$)	*p*-value
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Breakfast	220 ± 80	216 ± 95	0.593	9.5 ± 3.5	9.2 ± 4.2	0.326
Lunch	319 ± 133	320 ± 127	0.951	18.1 ± 7.7	17.7 ± 7.8	0.460
Afternoon snack	170 ± 77	166 ± 81	0.283	2.5 ± 1.1	2.7 ± 1.3	0.114
Evening meal	327 ± 131	288 ± 122	<0.001	17.1 ± 6.9	16.4 ± 7.3	0.185
Evening snack	83 ± 49	85 ± 55	0.694	2.9 ± 1.7	2.8 ± 2.0	0.432
All five meals[a]	1119 ± 353	1074 ± 360	0.008	50.2 ± 16.4	48.7 ± 17.7	0.123

[a] In between meals provided on average additional 286 ± 207 kcal/day and 13.3 ± 10.4 g proteins/day to the energy and proteins provided by the five main meals.