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Original article

# Energy and protein intake in 330 geriatric orthopaedic patients: Are the current nutrition guidelines applicable?

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SUMMARY

*Background and aims:* Elderly orthopaedic patients are potentially at a high nutritional risk. The reasons for this are numerous as i.e. reduced appetite, sensation of satiety after eating small amounts of food, multi-medication or immobility. This is in contrast to the increased energy and protein recommendations for geriatric orthopaedic patients.

*Methods:* Oral intake during hospitalization of more than 1000 geriatric orthopaedic patients aged over 80, with or without fracture, was recorded, calculated and then compared to energy and protein requirements by clinical dietitians according to international guidelines.

*Results:* 330 patients were included in the sample of which 76.7% were female (n = 253) and 23.3% male (n = 77). The mean age was 87.4 (+/−4.7) years. Most patients (204 = 61.8%) had lived at home prior to hospital admission. 72 patients (21.8%) lived in a retirement home, 54 (16.4%) lived in a nursing home. 98.5% of the included patients were unable to cover their energy needs and 99% were unable to achieve their protein needs. Only five patients (1.5%) were able to achieve their energy needs and one single patient (0.3%) achieved his recommended protein intake.

*Conclusion:* Orthogeriatric patients are at high risk of malnutrition. Very few of these patients were able to cover their estimated energy and protein needs through dietary intake. This suggests that there is a high need of dietetic interventions in this multimorbid elderly patient group. The aim of the nutritional therapy and its interventions should be its continuity, especially after hospital discharge so that long-term optimization of the nutritional status can occur. Future research should further investigate if current recommendations are applicable and the best way to achieve a better nutritional status in this population risk group.



## 1. Introduction

A suboptimal nutritional status is often observed in hospitalized patients. Geriatric patients in particular frequently suffer from malnutrition [1]. Depending on the specialty and structure of the hospital department, the screening and assessment tools for measurement of the prevalence of malnutrition or risk of malnutrition the results are diverse. In geriatric orthopaedic patients the prevalence of malnutrition ranges from 22 to 56%, representing a wide range [2–5].

Malnutrition can be defined as a condition that results from a deficit of nutrition intake leading to a change in body composition followed by a decreased physical and mental function and impaired clinical outcome [6]. It is known that a poor nutritional status in hospitalised patients can increase the risk of infections and delay wound-healing which leads to an increase of hospital costs and often length of stay [1].

At an older age, several mechanisms are involved in the process of malnutrition: comorbidity, polypharmacy and age-related physiological changes of the gastrointestinal tract are all contributing to a reduction of nutritional intake [5]. According to the current guideline from the European Society for Clinical Nutrition and Metabolism (ESPEN), sarcopenia is defined as a syndrome of progressive loss of skeletal muscle mass, strength and function that leads to a series of adverse outcomes [7]. Primary sarcopenia is a natural phenomenon of ageing [6]. It is known that from the age of 50–60 years, muscle mass decreases by approximately 1.5%

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annually, which enhances the risk of falls and fractures at an older age [3,8].

The current European and American guidelines recommend at least 1 g protein per kilogram bodyweight per day and around 30 calories per kilogram bodyweight of energy depending on physical activity for the majority of sick elderly patients to maintain nutritional status, independence and quality of life [7,9–11]. These requirements are increased compared to their healthy counterparts, but often they do not even achieve an energy intake of 20 calories per kilogram bodyweight corresponding to the resting energy expenditure (REE) nor a protein intake of 0.8 g per kilogram bodyweight [10,12].

The discrepancy observed between the actual protein and energy intake and the established recommendations for the elderly motivated us to evaluate food consumption of geriatric orthopaedic patients in a single municipal hospital in Switzerland and to compare these results with the current guidelines. We also investigated whether age, gender and housing arrangements (living at home, retirement home or care unit) before hospitalization had an effect on nutritional status at hospital admission.

## 2. Material and methods

### 2.1. Population and setting

The data analysis occurred over a period of 12 months (between September 2015 and September 2016) at the department of geriatric orthopaedics at the Hospital Waid (Zürich, Switzerland). Patients with a fall at home, at the retirement home or at the nursing home who were admitted to the geriatric orthopaedic ward, were included. During the data collection period, oral intake of all geriatric orthopaedic patients aged 80 and over, with or without fracture, were recorded by clinical dietitians.

Clinical dietitians recorded type of fracture, age, sex, date of admission and discharge of more than 1000 patients during the study period.

To improve the validity of the study we only included patients who had at least 5 days of complete 24 h dietary recalls (24 HR). Patients with tube feeding or parenteral nutrition were excluded but patient receiving oral nutritional supplements (ONS) were included in the study. Because most patients did not have a complete 5 day 24 HR, we had to exclude about two thirds of the screened patients from the study. We also excluded those days when only two meals were taken or documented due to examinations or treatments. Therefore, our final survey population was composed of 330 geriatric orthopaedic patients with different fractures and/or contusions. Patients with multiple fractures were excluded as we wanted to investigate if type/location of fracture had an impact on dietary intake (Table 1).

**Table 1**
Description of the study population (gender, age, housing and admission causes) (n = 330 patients).

| Variable | *n* | % |
|---|---|---|
| **Gender** | | |
| Male | 77 | (23.3) |
| Female | 253 | (76.7) |
| **Age** | | |
| 80–89.9 | 108 | (33) |
| >90 | 222 | (67) |
| **Housing** | | |
| Living at home | 204 | (61.8) |
| Retirement home | 72 | (21.8) |
| Nursing home | 54 | (16.4) |
| **Admission Causes** | | |
| Femur fracture | 145 | (43.9) |
| Humerus fracture | 67 | (20.3) |
| Fracture upper limb (e.g. rip, clavicula fracture) | 31 | (9.4) |
| Fracture lower limb (e.g. pelvic ring) | 32 | (9.4) |
| Contusion (no fracture, e.g. contusion capitis) | 55 | (16.7) |

### 2.2. Measurements

The Nutrition Risk Screening 2002 (NRS-2002) was used to assess nutritional status of participants. The NRS takes into account Body Mass Index (BMI), age, dietary intake for the last week and severity of disease. For the later, a score of 1 was used for all patients corresponding to mild disease such as patients with chronic disease, admitted to hospital due to complications and/or hip fracture [13].

Height was measured with a regular measuring tape. Weight was measured using a calibrated digital weight chair with a variability range of maximum ±0.1 kg. For these measurements, patients were dressed in light hospital clothing and asked to take off shoes. In cases where it was not possible to measure weight or height, patients were asked to estimate it. When patients were unable do this due to delirium or mental illness, nurses were asked to estimate the patients weight.

Body weight and height were measured by ward nurses who filed the data into a medical information system (NEXUS.Medfolio®). Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Due to a lack of evidence-based practice guidelines about the optimal body weight range for older adults, we used a BMI between 24 and 31 kg/m2 as recommended by dietitians at the Nutrition Education Materials Online (Queensland Health). This BMI range has been shown to be associated with a lower risk of all-cause mortality [14].

### 2.3. Energy and protein requirement

Energy requirements were calculated by dietitians using the Harris Benedict (HB) formula, which determined the basic energy rate using body weight, height, age and sex [15]. A Physical Activity Level (PAL) value of 1.2 was used for bed rest. This value is established for frail patients. A stress factor of 1.0 was used for both fractures and contusions. The HB formula was chosen because the calculation of basic metabolic rate correlates reasonably with indirect calorimetry [16].

As comparison, energy requirement was calculated using 30 calories per kilogram body weight, as recommended in the geriatric guidelines of the German Society for Nutritional Medicine (DGEM) and ESPEN [10]. For all calculations the actual weight was used.

For establishing protein requirements, DGEM guidelines [10] who recommend a minimum of 1 g protein per kilogram body weight per day were used.

### 2.4. Dietary recall

Menu items served to patients were standardised in portion size. The percentage of every food item eaten was estimated by patients and controlled by ward nurses who wrote their estimation on the food card provided. These food cards were collected and used by dietitians to calculate energy and protein intake. Excluded were days when only two meals were documented or patients were fasting for interventions.

### 2.5. Statistical analysis

For the descriptive analysis, mean and standard deviation were calculated for continuous variables. Number and percentage were used for categorical variables. All analyses were conducted with R 3.4.2 for Windows® (R Core Team, 2017). Additional tables were produced using the report tools package in R. (Rufibach, 2009). Significance was set to 0.05.

## 3. Results

### 3.1. Demographic data

330 patients were included in the sample (Table 1), of which 76.7% were female (n = 253) and 23.3% male (n = 77). The mean age was 87.4 (+/−4.7) years.

Most patients (204 = 61.8%) lived at home prior to hospital admission. 72 patients (21.8%) lived in a retirement home, 54 (16.4%) lived in a nursing home prior to admission.

### 3.2. Cause of hospital admission

The most common cause of admission was femur fracture 44% (n = 145), followed by humerus fracture 20% (n = 67), fracture of another lower limb (e.g. tibia fracture) 10% (n = 32). From our total sample only 9% (n = 31) had a fracture of the upper body (e.g. rip fracture) and 17% (n = 55) fell without any fracture but suffered from a contusion (Table 1).

### 3.3. Nutritional status

Based on the Nutrition Risk Score 2002 (NRS-2002), all patients had an increased risk of malnutrition (NRS≥ 3) and 14.2% (n = 47) were even found to have a high risk of malnutrition (NRS = 5) (Table 2). Mean BMI was 24.4 kg/m2 (+/− 4.5), 24.3 kg/m2 (+/−4.7) and 24.5 kg/m2 (+/− 3.7) for all patients, female patients and male patients respectively. Approx. 41% (n = 135) had the recommended BMI of 24–31 kg/m2 (dashed region in Fig. 1). 50.5% (n = 167) of participants were below the recommended BMI range (BMI < 23 kg/m2) (Fig. 1).

### 3.4. Energy and protein intake

Analysis of estimated food intake revealed that 98.5% of included patients were unable to cover their individually calculated daily energy needs and 99% were unable to achieve their recommended protein needs. Only five patients (1.5%) were able to achieve their calculated energy needs. These five patients lived at home prior to hospitalisation (Fig. 2). The dashed region represents patients who achieved their recommended energy needs and the dashed line at 20 kcal per kg body weight per day represents resting energy expenditure.

**Table 2**
Information about body mass index and nutrition risk score (n = 330).

| Variable | *n* | % |
|---|---|---|
| **Body Mass Index** | | |
| BMI less than 24 | 167 | (50.5) |
| BMI 24 to less than 31 | 135 | (40.9) |
| BMI 31 or greater | 28 | (8.6) |
| **Nutrition Risk Score** | | |
| NRS 3 | 161 | (48.7) |
| NRS 4 | 122 | (37) |
| NRS 5 | 47 | (14.3) |

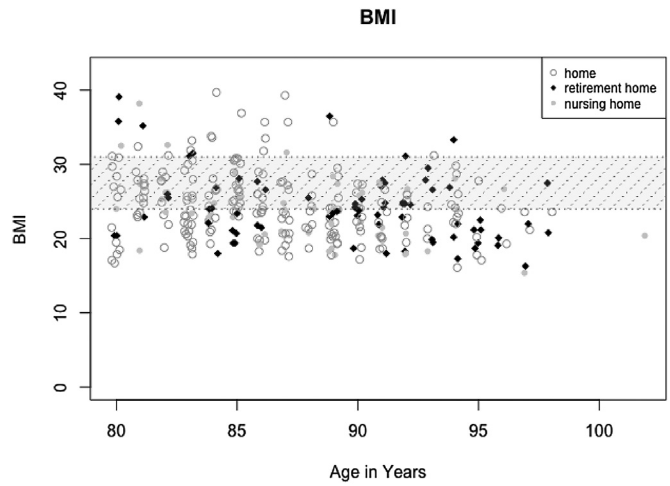


**Fig. 1.** Body mass index (BMI) and age, by previous inhabitation.

Resting energy expenditure (REE) is estimated at 20 calories per kg body weight per day and was only achieved by 21.2% (n = 70) of the patients enrolled in our study. One single patient (0.3%) achieved his recommended protein intake and only 31 patients (10.6%) ate more than 0.8 g protein per kilogram body weight per day.

Fig. 3 illustrates the relation between body weight and energy intake, and body weight and protein intake, respectively. Patients with a lower weight were closer in achieving their recommended energy and protein intake.

### 3.5. Associated factors

We investigated the effect of three factors (housing prior to hospital admission, gender and fracture) on nutritional status in geriatric patients (Table 3).

A One-way ANOVA was conducted to compare the effect of housing arrangements prior to hospital admission on energy and protein intake during hospitalization. An analysis of variance showed that the effect of housing on energy and protein intake was significant. The post-hoc Tukey analysis showed that there was a significant difference in energy (p = 0.0002) and protein (p = 0.0005) intake between patients who lived at home compared to patients who lived in a nursing home prior to admission.

All other tests were not significant. There was not enough evidence to drop the null-hypothesis that there are no differences in the distributions.

## 4. Discussion

### 4.1. Nutritional status

All patients enrolled in our study had a Nutrition Risk Score ≥3, representing an increased risk of malnutrition. Of all these, 47 patients (14.2%) had a Nutrition Risk Score of 5, a severe risk for malnutrition. Patients who lived in a nursing home were found to be more likely to have a NRS of 5 (28.8%) than patients who lived at home (10%). This may be explained by the fact that older people who live at home are often more independent and in better health, and therefore possibly have a better nutritional status compared to patients living in a nursing home.

Overall, more patients were at risk for malnutrition in our group than documented in other published studies involving trauma and orthopaedic patients [3–5]. The reason for this discrepancy may be explained by a difference in malnutrition assessment tools used

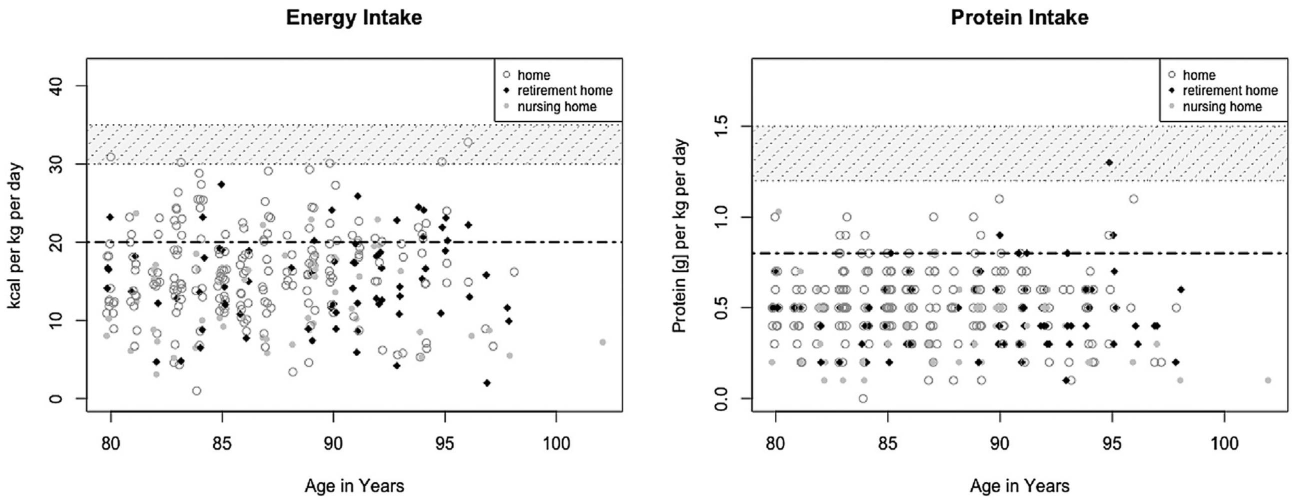


**Fig. 2.** Energy and protein intake, by the previous inhabitation.

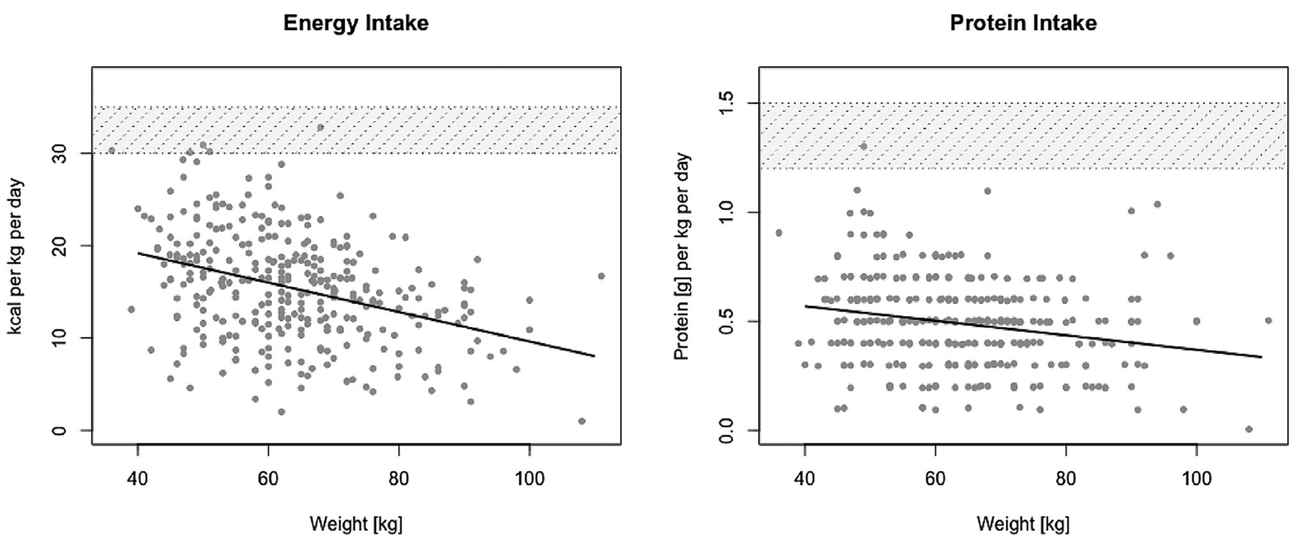


**Fig. 3.** Energy and protein intake plotted versus weight.

**Table 3**
Factors interacting with energy and protein intake (n = 330).

| Factors | p-value |
|---|---|
| Protein intake: home vs nursing home | 0.0002 |
| Energy intake: home vs nursing home | 0.0005 |
| NRS – previous inhabitation | 0.0161 |
| Energy intake – gender | 0.3623 |
| Protein intake – gender | 0.8474 |

and the fact that we did not exclude patients with dementia and/or delirium [1]. Earlier studies have reported that individuals with dementia suffer more often from malnutrition due to various nutritional issues and recommend their inclusion in research [17].

For the nutritional assessment, we used two of three possible risk indicators of the NRS tool: BMI and oral intake for the last week. We added at least 1 point (impairment) for all the patients, since the factor weight loss was not considered seeing that it could often not be assessed, this for diverse reasons such as lack of information, cognitive disorders, etc.

Only 40.8% (135 patients) had the recommended BMI of 24–31 kg/m2 [14]. The majority (50.7% or 167 patients) of participants were below the recommended BMI range (BMI < 24 kg/m2) which has been associated with an increased risk of mortality [14].

Although Body Mass Index is used worldwide to estimate body composition, its relevance in older adults is questioned in recent studies [18,19]. Significant changes in body composition in older adults, especially older women, with a decrease in bone density and muscle mass and an increase and redistribution in fat mass can lead to sarcopenic obesity which may be masked by a normal BMI [20].

### *4.2. Energy and protein intake*

In our study population, the average daily energy intake was approximately 900 kcal and the average protein intake was approximately 30 g per day. A recently published study also described food provision and food consumption of geriatric orthopedic rehabilitation patients [21]. In this study, a mean energy intake of 990–1349 kcal and an average protein intake of 31–51 g per day was observed. The higher intakes described in this study might be explained by a less acute study setting involving less surgical procedures than in our study.

Participants with a lower body weight were closer in achieving their recommended energy and protein needs. This may be explained by the fact that the calculation used to estimate energy and protein needs involved current body weight. In patients who are overweight or suffer from edema, this may overestimate their needs, whilst it may underestimate needs in people who are underweight.

### *4.3. Recommendations*

The evidence about macro- and micronutrient requirements for elderly and particularly for very old patients (≥85yr) is limited. One explanation is the challenge of a satisfactory dietary assessment, which reflects itself on the lacking data regarding dietary intake in this age group [22].

Our results revealed that most hospitalized orthopaedic patients do not achieve the current recommended energy and protein requirements for people over 65 years of 30 kcal/kg/d and 1 g/kg/d, respectively [10]. This brought us to rethink about dietary interventions but also to critically question whether the equation used to estimate energy requirements are applicable in this population group.

Ideally, indirect calorimetry should be used to measure individual energy requirements [16]. In clinical practice however, we favour the use of bedside formulas (30–35 kcal/kg/d) for its convenience or the use of calculations such as Harris Benedict, which has up to this point been shown to estimate BMR better than other equations [15,23,24].

As energy expenditure is influenced by age, sex and body composition it is impossible for one bedside formula to be accurate for the whole elderly population [16,22]. Today, requirements of a 65-year-old is considered to be the same as for a 90-year-old even though physiological processes in different age ranges may vary significantly. Furthermore, there is a lack of evidence about the optimal weight range to be used for clinical decisions.

Therefore, it would be more useful to use a formula or a method that incorporates factors more relevant for the studied population group such as changes in physiological and respiratory processes that may influence the BMR due to progressing age. Valentini et al. [16] recommend the BASA-ROT formula, a measurement very close to the most accurate method, indirect calorimetry. The BASA-ROT formula is based on different rule of thumbs (ROT) for sex, age, BMI which then are correlated with stress/activity factors. They suggest that the BASA-ROT formula is more suitable for women and obese individuals compared to Harris Benedict.

Published data showed [11] that elderly people need a higher protein intake compared to younger adults to maintain their muscle mass und functionality due to age-related metabolism changes such as a reduced anabolic response to ingested protein and catabolic conditions associated with disease and frailty. The PROT-AGE study group [11] recommends at least 1–1.2 g protein per kilogram body weight per day to maintain and regain lean body mass and function after the age of 65. This value needs to be adjusted for people with acute or chronic diseases (higher requirements) or severe kidney disease without dialysis (smaller requirements) [11]. The evidence regarding quality, timing of ingestion and intake of other nutritional supplements is relevant, but further studies are needed to answer these questions.

Certain factors associated with hospitalisation such as inflammation, surgery, trauma, changes in food choices and textures of meals, drugs or exams in combination with bed rest may result in a more significant muscle loss and function in older adults during hospitalization compared to younger adults [25].

Specifically, when defining the protein recommendations, it is necessary to evaluate the proportion of macronutrients (i.e. protein, carbohydrate and fat). For example, if the energy requirements are adapted according to the BMI, the percentage of fat and carbohydrates is also affected and may have an impact on the intake of micronutrients and its absorption when total caloric intake remains constant [26]. Much is known about the importance of adequate protein intake, especially for the prevention of sarcopenia [27]. Nevertheless, the impact of caloric restriction on protein metabolism is often not considered. Other macronutrients may also play an important role in optimizing nutritional status of the elderly. Furthermore, optimal micronutrient intake should also be considered in this population group but was not within the scope of this study. A practical example is thiamin, also known as vitamin B1, which plays an essential role in energy metabolism [28]. Other studies have shown that micronutrients such as calcium and vitamin D play an important role for bone health, muscle mass and quality of life [26].

## 5. Conclusion

Orthogeriatric patients are at a high risk of malnutrition. Very few of these patients were able to cover their estimated energy and protein needs through dietary intake in our study. This suggests that there is a high need of dietetic interventions in this patient group. As these patients are often complex, multimorbid individuals that through multiple reasons naturally eat less (polypharmacy, surgeries, changes in taste, reduced consumption of meat and other protein sources, dysphagia, progressing age etc.), the aim of nutritional interventions should be long term nutritional optimization followed up by community dietitians after hospital discharge. Future research should investigate if current recommendations are applicable to the very old by assessing the impact of dietary intake on quality of life. Further research should also explore ways to achieve a better nutritional status in this population group.

## Conflict of interest

None declared.

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