Original article

Taylor & Francis healthsciences

Body composition, dietary intake and estimated energy expenditure in female patients on geriatric rehabilitation wards

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Abstract

Background: An adequate nutritional status is a prerequisite for successful rehabilitation.
Objective: To examine body composition, to investigate nutritional intake, to calculate energy expenditure in elderly females at a geriatric rehabilitation clinic, to classify whether they were considered as undernourished or at risk of becoming undernourished, and to investigate the subjects' opinions on diet-related issues.
Design: 20 patients aged 82 ± 6 (mean $\pm$ SD) years participated. Percentage body fat was calculated from skinfold thickness measurements, bioelectrical impedance analysis (BIA) and a combination of the two in a multicompartment model. Dietary intake was assessed through a 7 day food record. Energy expenditure was calculated with three established formulae and physical activity level (PAL) factors of 1.2 and 1.4. Questions were asked on diet-related issues.
Results: Average BMI was 23.7 ± 4.5 kg m^{-2} and four subjects had BMI < 20. Relative body fat mass as assessed by skinfold was $29.8 \pm 6.9\%$, by BIA $38.9 \pm 7.7\%$ and by a multicompartment model $35.5 \pm 7.1\%$. Mean energy intake was 1340 ± 170 kcal (5.6 ± 0.7 MJ), around 79% of the recommended daily intake. In 18 of 19 subjects the observed dietary energy intake was lower than estimated energy expenditure when using two of the formulae and a PAL factor of 1.4. All subjects considered that they received a sufficient amount of food.
Conclusions: Only one of the subjects had a satisfactory energy intake relative to calculated energy expenditure, although all believed that they received sufficient food. Four subjects were considered as undernourished (BMI < 20) and all others as at risk of undernutrition.

Keywords: *Bioelectrical impedance*; *energy intake*; *nutritional status*; *skinfold*; *undernutrition*

Received: 5 June 2003; Revised: 9 Aug. 2003; Accepted: 21 Aug. 2003

Introduction

An adequate nutritional status and nutritional intake are important to the wellbeing of the elderly, and are a prerequisite for the successful rehabilitation of elderly patients. However, earlier studies have shown that more than one-third of hospitalized elderly patients suffer from undernutrition (1–3). The causes of undernutrition are multifactorial, and are common among elderly people with severe and chronic diseases.

Undernutrition can cause patients to be subject to infections, leg ulcers and pressure ulcers, among other problems, which can lead to prolonged hospitalization and increased mortality (4–7). The Swedish National Board of Health and Welfare points out that food constitutes a part of the medical treatment for this group of elderly people (8).

Low values of albumin and prealbumin in serum, and a decrease in fat deposits during hospitalization, are associated with increased mortality (2). In undernutrition, both body fat and the fat-free body mass decrease. Loss of fat-free mass is associated with impaired immune function and increased mortality (9, 10). Inadequate dietary intake has been associated with decreased body strength and a decrease in the quality of life (11).

Previous studies have shown that older patients in hospitals often suffer from undernutrition (1–3); a study at the authors' clinic found that 20% of the staff underestimated the energy requirement of patients, and some staff believed that the patients had too much to eat (12).

The aims of this study were to examine body composition by different methods, to investigate

 ISSN 1102-6480

DOI: 10.1080/11026480310018014

nutritional intake, to calculate energy expenditure in elderly female patients in a geriatric rehabilitation clinic, and to classify whether they were undernourished or at risk of becoming undernourished. A further aim was to investigate the subjects' opinions on diet-related issues.

Methods

Subjects

The participants in this study were female patients from two geriatric rehabilitation wards (stroke and orthopaedic) who were picked at random from a list of admitted patients at the hospital and who all had an ordinary hospital diet. The subjects were given oral and written information about the study. Twenty-six patients were asked and 20 agreed to participate, while the rest were either too tired or too weak or not interested in participating in the study. The mean age of the participants was 82 ± 6 years. All subjects gave their informed consent, and the study was approved by the ethics committee of the Medical Faculty of Uppsala University (No. 372/95). The diagnoses of the subjects varied within the group. The main diagnoses for the subjects were five with hip fracture, three with varicose ulcer, two with osteoporosis, two with stroke, two with diabetes, one with colostomy and ileostomy, one with sepsis, one with lung emboli, one with acute confusion, one with urinary infection and one with arthritis. In general, each subject received eight different medicines (range 4–21) daily, including supplements such as calcium, folacin, and vitamin B complex with an alcohol content of 15.7%. When supplements are excluded, the subjects had a mean daily intake of seven different medicines (range 3–18). The types of medicine used were diuretics in 65% of the subjects, laxatives in 60%, heart medicines in 45%, antidepressants in 55%, supplements in 75%, painkillers in 75%, sleeping tablets in 50% and other medicines in 95%.

Design

Dietary intake and body composition were examined during a 1 week period. All measurements related to body composition were performed by one investigator (EO). For practical reasons, the subjects were divided into three groups, which were examined during three different weeks.

Body composition

Height was measured to an accuracy of 1 cm, with the subject in an upright position if possible. If the subject was unable to stand, height was measured with the subject supine on the hospital bed. Body weight was measured in a sitting position by means of a balance with an accuracy of 0.1 kg. One subject, who had undergone leg amputation, was weighed by means of a bed balance. All subjects were fasting, without shoes and with light clothing and without artificial limbs. Body mass index (BMI) was calculated as body weight (kg) divided by the squared height (m).

Anthropometric measurements

Skinfold thickness was measured at four different locations (biceps, triceps, subscapula and suprailiac) with a Harpenden calliper (John Bull; British Indicators, St Albans, UK). The measurements were made on the right side of the body, with the subjects standing. If the subjects were unable to stand, they were measured sitting. Three measurement were performed at each location, and the mean value was used to calculate body density according to Durnin and Womersley's equation, body density $= c - (m \times \log$ sum of skinfolds), using the age- and sex-specific constants c and m (13). Percentage body fat was thereafter calculated on the basis of Siri's equation: percentage body fat $= ((4.95/\text{body density}) - 4.5) \times 100$ (14).

Upper-arm circumference was measured with a plastic measuring tape to an accuracy of 0.5 cm.

Body fat

Percentage body fat was calculated by three different methods: skinfold thickness measurements, bioelectrical impedance analysis (BIA) and a combination of the two in a multicompartment model.

Bioelectrical impedance analysis

BIA was used to measure body water and calculate body fat. In brief, a homogeneous electrical field is passed between electrodes placed on the wrist and ankle on the right side. Fat-free mass conducts the current, whereas fat functions as an insulator. From these properties, the amount of body water can be estimated by measuring body resistance (15). The total volume of body water was calculated by Kushner and Schoeller's equation (15, 16): Total body water $= (\text{height})^2/\text{resistance}$.

The amounts of fat-free mass and body fat can then be calculated from the assumption that fat-free mass contains 73.2% water (16, 17). The BIA measurements were performed with a BIA apparatus (Xitron Technologies B4000; Xitron Technologies, San Diego, CA, USA) in the morning between 07.00 and 08.00 h on fasting subjects in their hospital bed. All beds were aired to standardize the bed temperature. Four electrodes were used (two on the wrist and two on the ankle of the right side), and measurements were performed at least twice at two different frequency levels (50 frequencies from 5 kHz to 1 MHz; and 25 frequencies from 5 kHz to 500 kHz).

Multicompartment model

Percentage body fat was calculated by a three-compartment model based on the results of skinfold thickness measurements (body density) and BIA measurements (body water) as described by Forslund et al. (17).

Biochemical analyses

Albumin, prealbumin, insulin-like growth factor-1 (IGF-1) and triiodothyronine (T_3) in serum were analysed. Blood samples were collected fasting in the morning, and were analysed at the Clinical Chemistry Laboratory, Uppsala University Hospital.

Energy and nutrient intake

Dietary intake was assessed from a 7 day food record, based on observed intake, and was carried out by three dieticians and one nutrition nurse. The observers were trained in assessing portion sizes. The subject, or staff on the ward, placed the food on the plate; the observers assessed portion size as well as the amount of side dishes, such as salad, spread, beverages and desserts. Duplicate portions were then weighed and recorded for each meal. Food served separately, such as bread, ham and cheese, was recorded on individual weight lists, and the subjects were asked whether they had consumed any food and fluid between the main meals. All leftover food was weighed and subtracted from the records. The dietary food records were analysed using the program Kost & Näringsdata-dietist, PC-Kost, and the nutrition database PC-Kost from the Swedish National Food Administration. The results were evaluated against the Nordic Nutrition Recommendations (NNR) for women over 75 years of age (18).

Estimated energy expenditure

The basal metabolic rate (BMR) was calculated and multiplied by a factor for the physical activity level (PAL), to estimate the energy expenditure of the group. BMR was calculated by means of three different equations:

1. Harris and Benedict's (HB) equation (19):
   BMR kcal 24 $h^{-1} = 655 + (9.6 \times \text{weight}) + (1.8 \times \text{height}) - (4.7 \times \text{age})$
2. Schofield, Schofield and James' (SSJ) equation for women (20):
   BMR kcal 24 $h^{-1} = (10.5 \times \text{weight}) + 596$
3. Equation from NNR (modified NNR equation) (18) for women > 75 years old based on WHO/FAO/UNU (21), Schofield et al. (20) and modified data (22):
   BMR MJ 24 $h^{-1} = 0.0410 \times \text{weight} + 2.61$

A few subjects were restricted to wheelchairs, but most were able to walk and participated in rehabilitation programmes involving occupational therapists and physiotherapists. Each subject's intake was compared with energy expenditure calculated by the equations described above, and was multiplied by two different PAL factors of 1.2 and 1.4 (23). These PAL factors are reference values according to NNR; 1.2 is used for people using a wheelchair or who are bedbound. The PAL value of 1.4 is used for inactive people. The estimated energy expenditure was compared with the results of the recorded energy intake from the 7 day food records. To evaluate the energy intake, it was divided by the calculated BMR. If this ratio is below 1.2, the energy intake is probably not sufficient (18). The recorded energy intake was also divided by body weight to examine the mean energy intake per kilogram body weight of the group.

In this study undernutrition was defined as a BMI < 20 and patients at risk for undernutrition were also studied. At risk for undernutrition was defined as one or more of the following factors: inadequate dietary intake compared with calculated energy expenditure, BMI < 24, loss of appetite, decrease in body weight and the use of three or more medications.

Interview on diet-related issues

Questions regarding appetite, food supply, eating disabilities, stomach problems and weight changes during the stay on the ward were asked in individual interviews.

Statistics

Data are presented as means ± standard deviations, with range in some cases. Differences between the body composition measurements, caliper, BIA and multicompartment model were analysed ($n = 17$) by an analysis of variance model. The Bonferroni test of differences between means of the treatments was used. The distribution of the variables was skewed; data were therefore logarithmically transformed before analysis.

Results

Eighteen of the subjects were referred from other clinics, while the remaining two came directly to the geriatric rehabilitation clinic. The mean duration of the hospital stay was 94 ± 86 days (range 18–278 days) and the average length of hospitalization before entering the study was 26 ± 24 days (range 1–78 days). Four of the patients were hospitalized for longer than 200 days.

Body composition

The mean body weight of the subjects was 60.2 ± 14 kg (range 34.5–83.0 kg) and BMI was 23.7 ± 4.5 kg m^{-2} (range 15.3–32.0 kg m^{-2}). Four (21%) of the subjects had a BMI < 20 and nine (47%) had a BMI < 24. Anthropometric measurements resulted in an upper-arm circumference of 268 ± 45 mm, a triceps skinfold thickness of 13 ± 6 mm and sum of skinfolds (biceps + triceps + subscapula + suprailiac) was 43 ± 20 mm. Table 1 summarizes the mean body density, total body water and percentage body fat of the group. One subject with an amputated leg was excluded from calculations of body composition. Two subjects were excluded from BIA, one owing to the presence of a pacemaker and one because of missing data. Percentage body fat, as calculated from the skinfold measurements, gave a significantly lower value than those obtained from BIA measurements ($p < 0.001$) and the multicompartment model ($p < 0.001$). Percentage body fat calculated from BIA gave a significantly higher value than the multicompartment model ($p < 0.001$).

Table 1. Body composition: mean body density, total body water and percentage body fat in elderly female patients

Body composition	No. of subjects	Mean ± SD
Body density (g cm^{-3}): skinfold thickness	19	1.03 ± 0.02
Total body water (l): BIA	17	25.6 ± 4.5
Body fat (%): skinfold thickness	19	29.8 ± 6.9[a]
Body fat (%): BIA	17	38.9 ± 7.7[b]
Body fat (%): multicompartment model	17	35.5 ± 7.1

BIA: bioelectrical impedance analysis.

[a] Significant difference compared with BIA and multicompartment model ($p < 0.001$).

[b] Significant difference compared with skinfold thickness and multicompartment model ($p < 0.001$) (Bonferroni test of differences between means of the treatments).

Biochemical variables

Table 2 shows the results of the biochemical analyses. One subject, who was unwilling to give blood, was excluded from the biochemical analyses. Sixty-three per cent of the subjects had three or more of the biochemical variables below laboratory reference values. All subjects had S-albumin below the reference value of 37 g l^{-1}. S-prealbumin was below 0.26 g l^{-1} in 84% of the subjects, S-IGF-1 was below 96 g l^{-1} in 32% of the subjects and 37% of the subjects had S-triiodothyronine below 1.2 nmol l^{-1}.

Energy and nutrient intake

The mean energy intake was 1340 ± 170 kcal (5.6 ± 0.7 MJ) (range 910–1690 kcal) (3.8–7.1 MJ), corresponding to about 79% of the suggested energy requirement for this group according to NNR (19). Table 3 summarizes the energy and nutrient intake from the 7 day food records. One day of a 7 day record is missing, since the patient left the hospital. None of the subjects had a satisfactory energy intake compared with the NNR. The intake of vitamin D was about half that recommended for the elderly, and the mean intakes of calcium and iron were slightly below the NNR recommendations.

Table 2. Biochemical variables in elderly female patients

Biochemical variable	Mean ± SD	Range	Reference interval[a]
S-Albumin (g l^{-1})	32 ± 3	25–36	37–48
S-Prealbumin (g l^{-1})	0.21 ± 0.05	0.20–0.29	0.26–0.45
S-IGF-1 (μg l^{-1})	145 ± 83	58–404	96–243
S-Triiodothyronine (nmol l^{-1})	1.4 ± 0.4	0.8–2.2	1.2–2.8

Number of subjects = 19.

[a] Reference interval according to the Clinical Chemistry Laboratory at Uppsala University Hospital, Sweden.

IGF-1: insulin-like growth factor-1.

Table 3. Energy and selected nutrient intake assessed from 7 day food records in elderly female patients

Energy and nutrient intake	Mean ± SD[a]	Recommendation NNR women > 75 years[b]
Energy intake (kcal)	1340 ± 170	1700
Energy intake (MJ)	5.6 ± 0.7	7.1
Protein (g)	52 ± 9	
Protein (*E*%)	16	10–15
Carbohydrates (g)	162 ± 24	
Carbohydrates (*E*%)	49	55–60
Fat (g)	53 ± 8	
Fat (*E*%)	35	< 30
Fatty acids (*E*%)		
SAFA	16	10
MUFA	12	10–15
PUFA	4	5–10
Dietary fibre (g)	12 ± 3 (2.1 g MJ^{-1})	3 g MJ^{-1} for adults
Vitamin D (μg)	5.4 ± 2.2	10
Thiamine (mg)	0.9 ± 0.2	1.0
Riboflavin (mg)	1.2 ± 0.4	1.2
Niacin equivalents (NE)	19 ± 3	13
Vitamin B_6 (mg)	1.3 ± 0.3	1.1
Vitamin B_{12} (μg)	4.0 ± 2.0	2.0
Folate (μg)	173 ± 50	300
Retinol equivalents (RE)	870 ± 227	800
Ascorbic acid (mg)	71 ± 26	60
Calcium (mg)	760 ± 240	800
Iron (mg)	8 ± 2	10

Number of subjects = 20.
[a] Daily mean intake ± SD.
[b] Nordic Nutrition Recommendations for women over 75 years of age (15).
SAFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids; *E*%: percentage of total energy intake.

The total energy intake was divided as follows: breakfast 26%, lunch 32%, dinner 24% and all snacks together 18%.

Estimated energy expenditure

The estimated energy expenditure, based on three established formulae and two different PAL factors, is shown in Table 4. One subject with a leg amputation was excluded from calculations of estimated energy requirement.

The mean energy intake from the dietary food record divided by the body weight was 24 ± 8 kcal kg^{-1} body weight. Recorded energy intake divided by estimated BMR gave values of 1.1, 1.2 and 1.1 with the SSJ equation, HB equation and the modified equation in NNR, respectively.

Table 4. Estimated energy expenditure using two assumptions on physical activity level (PAL) and calculated by three equations,[a] and numbers of subjects with an energy intake that was inadequate to meet the energy expenditure

Estimated energy expenditure	Mean ± SD	Energy intake:energy expenditure < 1 *n* (%)
PAL 1.2 and HB	1370 ± 180 kcal 5.7 ± 0.8 MJ	11 (58)
PAL 1.2 and SSJ	1475 ± 180 kcal 6.2 ± 0.7 MJ	12 (63)
PAL 1.2 and modified NNR	1460 ± 170 kcal 6.1 ± 0.7 MJ	12 (63)
PAL 1.4 and HB	1600 ± 210 kcal 6.7 ± 0.9 MJ	15 (79)
PAL 1.4 and SSJ	1720 ± 210 kcal 7.2 ± 0.9 MJ	18 (95)
PAL 1.4 and modified NNR	1700 ± 200 kcal 7.1 ± 0.8 MJ	18 (95)

Number of subjects = 19.
[a] Estimated energy requirement was calculated for two PAL levels (1.2 and 1.4) and with three equations (HB, SSJ and modified NRR).
HB: Harris and Benedict's equation; SSJ: Schofield, Schofield & James's equation; NNR: modified Nordic Nutrition Recommendations equation.

Interview on diet-related issues

Table 5 shows the results of the interview with questions focusing on appetite, food supply, eating disabilities, stomach problems and weight changes during the stay on the ward. All subjects considered that they received a sufficient amount of food. One subject was confused and had difficulty in communicating, and was therefore excluded from the interview part of the study.

Discussion

This study was conducted to investigate body composition, dietary intake and estimate energy expenditure in older women in a geriatric rehabilitation clinic. The sample of patients investigated represent geriatric female patients treated on the two wards who had an ordinary hospital diet. They had different diagnoses and the length of hospital stay varied within the sample. Body composition varies greatly in the elderly population (24). To evaluate body composition, it is necessary to consider different variables, since there is no single measurement considered as the "gold standard".

Usually, a BMI < 18.5 or < 20.0 and a weight loss of 5% or more during the past few months are considered as risk factors for undernutrition. However, Beck and Ovesen suggest that cut-off points of 24 for people over 65 years of age or any degree of

Table 5. Results of the interview with questions on appetite, food supply, eating disabilities, stomach problems and weight changes during the stay on the ward for elderly female patients

Question in brief	Answer Yes	No	Other
Change of appetite?	Better 1 Loss 9	9	–
Change in body weight past year?	Increase 2/19 Decrease 10/19 Both increase and decrease 2/19	3/19	Do not know 2/19
Attitude towards actual weight	–	–	OK 10 Want to increase 4 Want to decrease 5
Sufficient food supply?	19	0	–
Difficulties in chewing food?	3	16	–
Problems with constipation/stools?	Constipation 9 Stools 1 Constipation + stools 2	7	–
Hunger during day/night?	7	12	

Number of subjects = 19.

weight loss are risk factors for undernutrition (25). A BMI value between 24 and 29 has also been suggested as a normal value for people older than 65 years (25, 26). The mean value in the present study was 23.7 and nine subjects out of 19 had a BMI value below 24, which indicates that there are subjects who are at possible risk of undernutrition or who are already undernourished. Nine subjects in the study had lost weight unintentionally during the past year, and one subject had lost weight intentionally.

Every patient had a mean daily intake of seven different medications, supplements not included. Jensen et al. (4) suggest that old age, loss of appetite, depression and a daily intake of more than three medications are strong risk factors for malnutrition. Nine patients reported loss of appetite during the past year, and 10 patients reported that they had lost weight. When the definition suggested by Jensen et al. was used, four patients were classified as undernourished, since they had a BMI value < 20 and a daily intake of more than three medications. Five subjects were classified as being at risk for undernutrition, since they had a BMI value < 24 and a daily intake of more than three medications.

There is no exact method of measuring height in elderly subjects who have osteoporosis and kyphosis. Height was difficult to measure in this group, since some subjects were not able to stand in an upright position and some had hunched backs. The height of seven subjects was therefore measured in bed. In most cases, skinfold thickness was measured with the subjects in an upright position. When it was impossible for the subjects to stand up, skinfold thickness was measured in a sitting position, which is not optimal. To make it possible to measure subscapula and suprailiac skinfold thickness, the subjects had to bend over and the skin was then tightened slightly, which may affect the results by giving lower skinfold values in the present study. It is also difficult to measure skinfold thickness in the elderly, since the elasticity and compression of the skinfold change with age (2, 13).

The measurements in Durnin and Womersley's equation on body density are based on measurements on men and women aged 17–72 years (13). In the present study, the mean age was 82 years, somewhat older than the oldest in Durnin and Womersley's study. This may have affected the results, but Lean et al. point out that the equation of Durnin and Womersley still gives good values of body composition, but underestimates percentage body fat in older people (27). When percentage body fat values from skinfolds and BIA were compared, percentage body fat estimated from skinfolds was lower than the results from BIA and in the present study. Possible explanations are that that the subjects were dehydrated and that the equation has not been adjusted for elderly women. When percentage body fat is calculated from anthropometric variables and BIA, it is assumed that the amount of body water is constant, but if the amount of water differs from the assumption, the results may be affected. The multicompartment model therefore gives a more exact value of percentage body fat, since the amount of body water is taken into account (17). Persson et al. (28) found that BIA overestimated percentage body fat compared with the doubly labelled water method. The present results from BIA were 38.9% body fat, and from the multicompartment model 35.5%. The results from the multicompartment model are more in line with the results from Persson's doubly labelled water study (35.4% fat) on elderly women living in nursing homes, although there was a difference in body weight between the two studies. The body weight in Persson's study was 55.8 ± 9.1 kg (range 45.0–74.8 kg). Dey et al. recently presented reference values on percentage body fat for elderly Swedish people. They found that females aged 75 years had a percentage body fat of 34.1 ± 6.1 measured by BIA (29). The result from BIA in the present study was higher than the suggested reference value.

The methods for measuring body composition were not designed for elderly hospitalized women when they were developed and therefore the results should be interpreted with caution. Reilly et al. showed the percentage body fat from age-specific equations based on BMI and BIA overestimated percentage body fat relative to other methods (30). However, later research found that the three-compartment model calculated from density and total body water offers an acceptable alternative to dual X-ray absorptiometry, doubly labelled water and underwater weighing for measuring percentage body fat (31). In a recent study the percentage body fat and fat-free mass from BIA correlated well with a four-compartment model (29). The multicompartment model used in the present study seems to be acceptable for estimating percentage body fat since both skinfold and BIA have been used, but further studies are needed in this group of elderly hospitalized women.

Four biochemical variables were measured. In 63% of the subjects, three or four of these variables were below the reference values. S-albumin below 35.0 g l^{-1} may be an indicator of undernutrition (4), since a low level of S-albumin may indicate a low intake of protein (32). However, a low level indicates an ongoing catabolic process, and one must always take into account whether the subject has heart insufficiency, pulmonary disease, liver failure, or an infection or inflammation: S-albumin decreases in these conditions (6). In the present study, two subjects had an ongoing inflammation or infection: one had sepsis and the other had a urinary infection. Loss of appetite is common during inflammation, and low levels of S-albumin are therefore an indirect predictor for being at risk of undernutrition (6). All of the subjects had low S-albumin values, and about half of them had decreased appetite. About one-third of the subjects had low levels of S-IGF-1 and S-triiodothyronine. S-IGF-1 probably mirrors undernutrition better than S-triiodothyronine. S-IGF-1 decreases with age, and age must therefore be taken into consideration when analysing S-IGF-1 (33). The results from the biochemical variables indicate that subjects in the present study are at risk of undernutrition.

All subjects had a lower intake than the energy recommendation by NNR. The energy intake was low compared with other studies (28). There was no difference between energy intake and estimated energy expenditure, calculated with a PAL value of 1.2, when the mean values for the group were compared. When each subject's energy intake was separately compared with calculated energy expenditure, more than half of the subjects had a lower energy intake than energy expenditure, as calculated with a PAL factor of 1.2, regardless of which equation was used. When a subject's energy intake was compared with her calculated energy expenditure with a PAL factor of 1.4, and with all of the different equations for BMR, more than 79% of the subjects had an energy intake below the calculated expenditure. A PAL value of 1.2 is only a PAL for very inactive or bedbound people. Persson et al. also found a mean PAL value of 1.2 in geriatric nursing-home patients (28). The subjects in the present study were on a rehabilitation ward, and training at different levels was included. Most of the patients were not bedbound; they were up and walking. A PAL of 1.4 would probably be a better factor to use for this group. It is possible that some of the subjects may have had a PAL level > 1.4, in which case the energy deficit would have been even greater. The ratio between energy intake and calculated BMR indicates that the subjects had a lower intake than their actual energy expenditure.

The calculated energy expenditure according to the HB equation was lower than the values calculated from the SSJ equation and from the modified

NNR equation. Height, weight and age are included in the HB equation, whereas only weight is included in the SSJ equation. Persson et al. (28) criticize this equation, and suggest that it is better to use an equation by Westerterp et al. (34). However, Taaffe et al. state that the HB equation can still be used for older women (35). Persson et al. validated different equations for BMR by use of the doubly labelled water method (28) and found that the modified NNR equation predicts total energy expenditure within a range of $\pm 10\%$. The choice of PAL value appears to be more important than the different equations for estimating energy expenditure. Under-reporting is common when using food records but, since the subjects in the present study did not record their own dietary intake, the possibility of under-reporting is minimal. The subjects in the study probably did not alter their choice of food intake, which is common when using a food record technique, since the hospital diet was set and snacks were the same for all patients on the ward. However, the results may have been influenced by the observers' presence when food was consumed.

In comparison with NNR, the percentage of energy obtained from carbohydrates was lower and the percentage of energy obtained from fat was higher. Saturated fat was above, and unsaturated fat was below the recommendations. The fibre intake was lower than the recommendation (18). The intake of vitamin D, iron and calcium was lower than the recommendations. When the vitamin and mineral intake was compared with NNR's minimum requirement for people 15–50 years old (although no minimum requirements are given for elderly people) the intake was higher than the minimum requirement. The vitamin D intake was about half the recommendations. It is very difficult to attain a dietary intake of 10 μg with ordinary food. It has been suggested that vitamin D and calcium supplements should be given to elderly people at risk of osteoporosis, and to prevent osteoporosis (36).

One interesting result in the present study was that the subjects themselves thought that they had a sufficient food intake while staying on the ward, but the observed energy and nutrient intake was below the calculated energy expenditure and nutrient recommendations in half of the subjects. The results from an earlier study, in which the staff's attitudes were investigated, showed that some considered the portion sizes too large. The present study showed that the subjects' energy intake was not adequate.

In conclusion, only one of the subjects had a satisfactory energy intake compared with calculated energy expenditure, although all subjects thought that they had a sufficient food intake. In the present study, four subjects had a BMI value < 20.0, nine had a value < 24.0 and nine reported loss of appetite. Four subjects were undernourished according to their BMI of < 20, and the remainder were at risk of undernutrition, since their energy intake was not adequate.

Epilogue

The results from this study have been used as a basis for understanding the nutritional situation at this clinic, and as a tool for achieving a better understanding among the staff. This study also resulted in a continuous nutritional education programme for the hospital staff, including better screening routines for undernutrition, in combination with a nutrition plan. The hospital food was also changed and is now more energy and nutrient dense.

Acknowledgements

The study was supported by grants from the Uppsala County Council and Edith and Primus Wahlmark's Foundation.

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