ENERGY AND NUTRIENT CONTENT OF FOOD SERVED AND CONSUMED BY NURSING HOME RESIDENTS

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Abstract: *Objective:* The aim of this study was to compare energy and protein content of the served food with the actual intake from the food consumed by nursing home residents. This study also aimed to compare food intake and dietary allowances. *Design:* This is a cross sectional study. *Setting:* This study was performed in nursing homes. *Participants:* Residents of these 2 nursing homes were eligible for the study if they agreed to participate and if they meet the selection criteria (to be older than 65 years and have a regular texture diet). *Measurement:* Nutrient content of the served food and real food consumption was calculated for all meals during a 5-day period by precise weighting method. Difference between consumed and served dietary content was evaluated by the Chi^2 test. *Results:* Seventy-four Belgian nursing home residents (75% of women, 85.8 ± 7.04 years on average) were included in this study. These subjects had a mean body mass index of 24.9 ± 4.83 kg/m². The mean energy content of the served food was 1783.3 ± 125.7 kcal per day. However, residents did not eat the whole of the meals and the actual energy content of the consumed food was significantly less (1552.4 ± 342.1 kcal per day; p<.001). The average protein content of the food served was equal to 0.96 ± 0.20 g/kg/day and the average consumption of protein by the residents was 0.88 ± 0.25 g/kg/day. The difference between protein served and consumed was also significant (p=.04). Moreover, people considered as well nourished, eating significantly more energy than the others (p=.04). *Conclusion:* Meals served in nursing homes are not entirely consumed by their residents. As expected, the energy consumed are lower in subjects considered as malnourished or at risk of malnutrition.

Key words: Weighing food, food intake, food consumption, nursing homes.

Introduction

Food consumption studies in elderly people have become more and more popular because of the aging of the population and because nutrition is an important life-style factor contributing to health and functional disability (1). Measuring food intake of elderly individuals in geriatric institutions is therefore important, for clinical or research purposes, to assess the effect of diet on health (2). Because total energy intake is a determinant of both the nutrient content of the diet and individual requirements, it is crucial to obtain accurate estimates of intake (2).

Several methods exist to assess food intake. One of the most commonly used method is the "24-hour Dietary Recall", where patients are asked to remember all the foods and beverages consumed during the past 24 hours (3). This is not an appropriate method to use in the elderly who may suffer from cognitive impairments such as memory loss (1, 4). In addition, this is a declarative method and therefore, subjects may be tempted to under- or- over- estimate their food intake due to social norms and personal beliefs (5). Moreover, the estimation of the portion size, in this method, is also challenging (3). Finally, the "24-Hour Dietary Recall" cannot accurately reflect the usual diet of an individual, because day-to-day variability in diet is high (6).

Another possibility to evaluate food intake is the "Food record". Respondents have to record in writing the foods and beverages, with their amounts, consumed over one or more days. This method requires a high level of motivation. Reactivity (i.e. change diet) due to social desirability and reporting biases are the major problems (3, 7).

Food intakes are sometimes measured by the Food Frequency Questionnaire (FFQ). This method measures usual intake over a middle- or long-term period and monitors usual dietary behaviors (3, 8). The FFQ is usually self-administered and avoids recall bias because it is based on usual diet (3). The FFQ can be problematic if diet is not stable (i.e. diet, pregnancy, illness…) and if the subject is not able to remember what he ate (i.e. cognitive decline).

Direct visual estimation is another way to measure food intakes. This method consists of quantifying the food intake of subjects during mealtimes. The estimation is done by care staff, dieticians or experimenters (9-11), but is not always accurate and food intake seems to be often overestimated (11).

Another method consists in photographing plates or trays before and after meals and then, on the basis of these photos to estimate the food intake (12). This technique does not require the presence of a large number of experimenters on site. Moreover, the photographic method avoids the bias introduced

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by the presence of experimenters during mealtimes.

Nutritional biomarkers can also be mentioned as reflecting food intake and can be used to assess different aspects of nutritional status. However, there is seldom a direct relationship between intake and biomarker value. Furthermore, nutrient concentrations vary by individual characteristics (i.e.: genetic and environmental). Biomarkers are also specific to particular nutrients and thus, cannot reflect the multiple dimensions of dietary intake. Finally, nutritional biomarkers require the collection of blood or urine and their analysis is expensive (3, 13)

All these methods have several advantages and disadvantages but generally, they are imprecise. So, the gold standard to measure food intake, in a real life setting, is the weighing food method (14). In this method, calories and nutrients intakes are calculated on the basis of the difference between the weight of the food served and that not consumed by the subjects (15). Weighing food is a very accurate method; however, it involves complex operations in real life-setting (i.e. nursing home) as it requires to reconcile the management of food distribution and data collection. Furthermore, this method is time-consuming and is therefore rarely used in scientific studies.

In the field of geriatrics, few data exist on the precise actual dietary intake of the elderly, and specifically in nursing homes setting. This gap in the literature could be partly filled by this study aimed to evaluate, by means of the weighing food method, the actual energy and nutrient intake in an elderly population. Evaluation and management of undernutrition is a priority of public health policy.

Methods

Study design

This is a cross-sectional study conducted in 2 nursing homes in the area of Liège, Belgium between January and March 2015. The protocol was approved by the Ethics Committee of the University Teaching Hospital of Liège, under the number 2013/178.

Population

Residents of these 2 nursing homes were eligible for the study if they agreed to participate. Informed consent was obtained from each subject (or from the patient's family when the patient was disoriented) prior to their participation in the study. To be included in this study, patients had to be older than 65 years and have a regular texture diet. Participants were excluded if, during the study period, they contracted a disease or encountered a particular psychological problem affecting their usual diet.

Data collection

Food served and consumed

Food served and food actually consumed by residents was evaluated by the precise food weighing method, over a 5-day period. Indeed, all foods were weighed prior to being served and, at the end of the meal, all the leftover foods on the plate were also weighed. Thus, the amount of each food actually consumed was estimated. Weighing was performed using a scale with accuracy to one gram. Then, nutrients content of food eaten was calculated by a dietician, by means of a food composition table (Paul Lambin, 2014) and food labels.

Other data

Other variables were also collected. These variables included socio-demographic data such as age or gender, anthropometric measurements such as weight at the nearest 0.1kg, height at the nearest 0.1cm, from which body mass index (BMI) was calculated, abdominal circumferences at the nearest 0.1 cm and the number of drugs consumed, collected from the medical records. Clinical measurements were also collected:

- Nutritional status was assessed using the Mini Nutritional Assessment (MNA). This test comprises two parts: a screening part followed by an assessment part. If the score obtained for the screening part is of 12 points or more out of a total of 14 points, the subject is classified as well-nourished and does not need to complete the assessment part. When a subject presents a screening score of 11 points or less, the assessment part has to be completed. The full evaluation is scored on 30 points. A score of 24 points or more indicates that the subject is well-nourished, a score between 17 and 23.5 points indicates a risk of malnutrition and a score lower than 17 points indicates malnutrition (16)
- Cognitive status was assessed using the Mini Mental State Examination (MMSE), which consists of a brief 30-point questionnaire. A maximum score of 30 is attainable by a person without any neuropsychological impairment. Any score greater than or equal to 27 points indicates a normal cognition. Below this, scores can indicate severe (≤9 points), moderate (10–18 points) or mild (19–24 points) cognitive impairment (17). In this study, subjects with a score below 24 points were considered disoriented.
- Participant's leisure time activity was evaluated using the short version of the Minnesota Leisure Time Physical Activity Questionnaire. This questionnaire asks participants about types, frequency and duration of their leisure time activity (average hour/day in the following four categories: walking, doing gymnastics or workouts, engaging in sports, and doing household activities). The number of calories burned per day was calculated using the activity metabolic index, which allows the calories burned to be measured using the metabolic equivalent of tasks (18, 19).
- Basal metabolism rate was calculated for each subject using the Harris Benedict's formula. This formula takes into account sex, height, weight and age (20, 21).

Statistical analysis

Quantitative variables that were normally distributed were expressed as mean ± standard deviation (SD), and quantitative

Table 1
Baseline characteristics of the population (n=74)

Characteristics		Mean ± SD	Number (%)
Sex	Women		55 (74.3)
Age (years)		85.8 ± 7.04	
BMI (kg/m²)		24.9 ± 4.83	
Abdominal circumference (cm)		98.0 ± 12.1	
Nutritional status (MNA)	Normal		36 (64.3)
	Risk of malnutrition		18 (32.1)
	Malnutrition		2 (3.6)
MMSE (/30)		20.6 ± 5.82	
Basal metabolism (kcal)		1116.5 ± 208.9	
Energy expenditure estimated with the Minnesota questionnaire (kcal)		1229.2 ± 769.9	
Number of drugs		9.5 ± 3.2	

variables that were not normally distributed were reported as median and interquartile range (percentile 25, percentile 75). A Shapiro–Wilk test verified the normal distribution for all parameters. Qualitative variables were reported as number and frequency (%). The difference between energy and nutrients content of the served food and that actually consumed was calculated by means of the student t test. Student t test was also used to compare results between the 2 nursing homes enrolled in this study, and to compare results between oriented and disoriented subjects. All analyses were performed with Statistica 10 software and SAS Statistical package (version 9.3 for windows). Results were considered statistically significant when 2-tailed p values were less than 0.05.

Results

Population

A total of 74 older adults were included in this study. The characteristics of the total population are shown in table 1 below. Residents were aged 85.8 ± 7.04 years on average and about 75% of them were women.

Energy and macronutrient served and actually consumed

As shown in table 2, meals served in the two nursing homes provided, on average, 1783.3 ± 125.7 kcal and 0.96 ± 0.20 g/kg of protein per day. However, residents did not eat the whole of all the meals. They actually consumed on average 1552.4 ± 342.1 kcal (p<.001) and 0.88 ± 0.25 g/kg of protein (p=.04). Residents did not eat either the totality of other macro-nutrients (i.e. lipids (p <.001) and carbohydrates (p=.002))

Our nursing home residents ate respectively 87%, 93.9%, 83.0%, 90.3% of the energy, proteins, lipids and carbohydrates served. Moreover, nutrient distribution of the meals served in the 2 nursing homes was as follow: 13.1 % of protein, 39.3% of lipid and 47.3% of carbohydrates.

Table 2
comparison between energy and nutrients served and actually consumed in the 2 nursing homes

Nutrient	Served	Consumed	p-value
Energy (kcal)	1783.3 ± 125.7	1552.4 ± 342.1	<.001
Protein (g)	58.3 ± 6.5	54.8 ± 10.7	.02
Protein (g/kg/d)	0.96 ± 0.20	0.88 ± 0.25	.04
Lipid (g)	77.9 ± 5.67	64.1 ± 25.5	<.001
Carbohydrates (g)	210.8 ± 22.3	189.9 ± 51.0	.002

Comparison according to the sex of the subjects

As expected, men have higher energy intake significantly higher than women (table 3).

Table 3
Energy and nutrients actually consumed according to the sex of the subjects

Nutrient	Consumed (Men) n=19	Consumed (Women) n=55	p-value
Energy (kcal)	1801 ± 400.1	1465 ± 273.2	<.001
Protein (g)	57.3 ± 6.84	53.9 ± 11.7	.23
Protein (g/kg/d)	0.82 ± 0.17	0.90 ± 0.26	.20
Lipid (g)	218.8 ± 61.5	61.8 ± 27.8	.003
Carbohydrates (g)	168.3 ± 83.9	179.8 ± 43.0	.11

Comparison according to the BMI of the subjects

Then, as shown in table 4, macronutrient consumption was not different according to the BMI of the subjects.

Table 4

Energy and nutrients actually consumed according to the BMI of the subjects

Nutrient	Consumed (BMI<20) n=13	Consumed (BMI ≥ 20) n=61	p-value
Energy (kcal)	1410 ± 518.9	1580 ± 293.7	.12
Protein (g)	50.4 ± 11.4	55.6 ± 10.4	.13
Protein (g/kg/d)	0.96 ± 0.40	0.86 ± 0.20	.21
Lipid (g)	70.5 ± 57.9	62.9 ± 12.5	.35
Carbohydrates (g)	168.3 ± 83.9	194.3 ±41.4	.11

Comparison according to the MNA of the subjects

When comparing food consumption according to the nutritional status (i.e. MNA), we observe that people considered as well nourished, eating significantly more energy than the others (table 5).

Table 5

Energy and nutrients actually consumed according to the nutritional status of the subjects

Nutrient	Well nourished n=36	Risk of malnutrition n=18	Malnutrition n=2	p-value
Energy (kcal)	1631 ± 261.8*	1456 ± 388.4	1427.8 ± 179.4	.04
Protein (g)	56.6 ± 7.3	53.6 ± 6.65	58.3 ± 4.54	.18
Protein (g/kg/d)	0.85 ± 0.17	1.00 ± 0.17	0.66 ± 0.09	.08
Lipid (g)	71.4 ± 31.6	58.2 ± 13.9	37.3 ± 16.8	.07
Carbohydrates (g)	192.2 ± 43.1	179.1 ± 57.6	231.8 ± 55.2	.46

Comparison between oreinted and disoriented subjects

Among the 47 residents from the second nursing home, 18 were disoriented. Nevertheless, in the same nursing home, subjects with normal cognitive status and disoriented subjects seemed to have similar dietary intakes in terms of energy (p=0.17) and protein per kilogram (p=0.09). However, oriented subjects eat more carbohydrates (p<0.001) than disoriented subjects (table 6).

Table 6

Comparison of energy and nutrient intake between subjects with normal cognitive status and disoriented subjects, within the same nursing home

Nutrient	Oriented (n=29)	Disoriented (n=18)	p-value
Energy (kcal)	1660.1 ± 369.5	1497.3 ± 369.5	.17
Protein (g)	60.4 ± 3.09	50.4 ± 6.67	<.001
Protein (g/kg/d)	0.95 ± 0.18	0.84 ± 0.26	.09
Lipid (g)	63.5 ± 16.4	69.8 ± 36.5	.41
Carbohydrates (g)	204.2 ± 50.1	171.2 ± 40.1	<.001

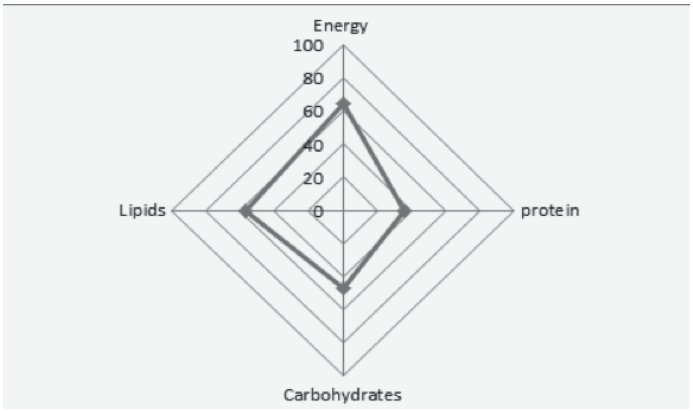
Comparison between energy and nutrient intakes and recommendations

According to Belgian recommendations for the normal population, the recommended dietary allowances are 2000 kcal per day for men and 1800kcal per day for women. Subjects should also consume 1g/kg/day of protein. Carbohydrates and fats should represent, respectively, 50-55% and <35% of the total energy intake (22). Even if these recommendations are not developed to be used at an individual level, it is interesting to note that, in our study, one third of the subjects (31.6% of men and 36.4% of women) have an actual caloric intake below Belgian recommended dietary allowances. More than 60% of the subjects (64.5%) also have a lower protein intake than that recommended.

The figure 1 below represents the percentage of subjects who achieve the recommendations for each nutrient.

Figure 1

Percentage of subjects who achieve the nutritional recommandations



Discussion

These finding showed that the energy content and the nutritional value of the food served to nursing home residents

was below national recommended dietary allowances for a normal population, and that residents ate considerably less than what was served. Indeed, meals served in the 2 nursing homes provided slightly less than 1800 kcal per day and a little less than 1 g/kg/day of protein, whilst the reference value for energy requirement is 2000 kcal per day for men and 1800kcal per day for women and reference value for protein is at least 1g/kg/day. This is in line with a recent review which advocates that the energy requirements correspond 19.4 kcal/kg body weight per day in healthy elderly people and 20.4 kcal/kg body weight per day in sick elderly patients (23). Applying this recommendation to our population (mean weight of 62.8kg), the energy requirements varies from 1218kcal/day to 1281 kcal/day. Another study shows that energy requirements are 18.8 kcal/kg/day among hospitalized elderly subjects (corresponding to 1180kcal in our population) (24). Nevertheless, there is no consensus for the specific population of nursing home residents.

To estimate the amount of nutrients served and consumed, the most accurate method, the weighing food method was used. It is important to measure the energy intake accurately. Indeed, low energy intake may go hand in hand with low intake of nutrients and may lead to deficiencies and malnutrition (1). Elderly people are particularly at risk of malnutrition, which is associated with a high risk of illness (infections, falls, fractures) and the progression of age-related chronic diseases, resulting in a loss of quality of life (25). Because nursing staff members often do not realize nutritional problems (26), it is important to objectify the problem. A recent systematic review and meta-analysis shown that due to their simplicity, low cost, and positive results in protein and calories intake, simple dietary interventions based on the food-based fortification or densification with protein or energy of the standard diet could be considered in patients at risk of malnutrition (27).

Currently, few studies have used food weighing method to accurately measure food intake in nursing homes and to our knowledge, this is the first time that such measurements are performed in Belgium. Our results corroborate those from a Finnish study which showed that meal served in nursing homes provided 1665 kcal on average (28). Note that the meals served in our study provided about the same amount of kcal per day (i.e. 1783 kcal). However, in both studies, residents did not eat all the food that was served (i.e. 1205 kcal in the Finnish study and 1552 in our Belgian study). The Finnish study included subjects with dementia, which could potentially explain the lower food intake observed compared to our study. Indeed, oriented patients perhaps eat more than the disoriented subjects because they are more aware of the importance of diet on health. Another study performed in Australian residential care facilities highlighted that a mean of 1953 kcal per day was served to the residents and mean energy intake for these residents was 1576 kcal (29). So, the amount of energy served was more important than in our study. In the same line, a recent study in Germany shown that elderly home-care receivers have higher energy intake than in our study (i.e. 2017±528 kcal in men and 1731±451 kcal in women) (30). When we multiply the basal metabolism (1116.5 kcal) by a physical activity coefficient (low activity= 1.4) (31), we have a total energy expenditure of 1563.1 ± 258.7 kcal. This corresponds approximately to the energy consumed by residents (1552.4 ± 342.1; p=.82). Nevertheless, once more, residents did not eat all of what was offered. Barr and co also showed in their study, that intakes of nutrients and minerals such as protein and calcium, was below recommended levels (32) and this corroborates our findings. On average, our patients, both men and women eat less than the recommendation (i.e. the actual consumption is 1801 kcal for men and 1465 kcal for women whereas the Belgian recommendation are respectively 2000 kcal and 1800 kcal) and men eat significantly more than women.

The low intake of energy may be due to several reasons. One of them could be the lack of appetite. This could be due to physiological changes related to aging, multiple medications and/or sedentary lifestyle (28). In our population, the number of drugs consumed is 9.5 ± 3.2 and could be a confounding factor in food intake. Environmental factors may also be involved in this loss of appetite (i.e. schedules of the meals, noise and brightness of the lunchroom,…). Attitudes and beliefs of nursing staff may also influence food intake. It seems important to act on these modifiable factors to improve energy intake of the elderly and, in turn, prevent weight loss. Indeed, this is associated with increased morbidity and mortality (33).

In this study, more than 60% of the residents are considered well nourished, which is often high compared to data reported in the literature. Indeed, according to a recent meta-analysis, based on MNA, 21% of institutionalized people are malnourished and 50% are at risk of being (34). This difference can probably be explained by the selection criteria of the study and implies that included patients are certainly less frail. This difference is determinant in food intake. As discussed above, the main strength of this study is the accuracy of the measurements performed using the weighing food method. Furthermore, as Akner (35), we performed data collection on a 5-day period while some other studies settled for a 1-day period (36).

It should be acknowledged that there are limitations to this study. These nursing homes were not randomly selected since this study was only possible in cooperating institutions. Therefore, these institutions may not be representative of all nursing homes. Nevertheless, we included a large number of representative subjects in the selected institutions. Most studies that used the weighing food method were performed on a small number of subjects (i.e. 23 residents in the Suominen's study (28)). A second limitation is that we did not measure the intake of certain micronutrients interesting among frail elderly (i.e. calcium, iron, zinc, vitamin D, vitamins C, vitamin A and vitamin B1). Finally, we did not accurately measure energy expenditure of nursing home residents, using indirect calorimetry for example. On this point/Hereto, few data exist

in the literature and an interesting perspective would be to compare actual energy intake of institutionalized elderly with their actual energy expenditure.

In conclusion, meals served in nursing homes are below daily recommended dietary allowances energy and protein. Another fact observed is that meals are not entirely consumed by residents. This work highlights an important Public Health perspective. Indeed, it shows the need of calculating the exact energy expenditure by an accurate method and the exact nutritional need of the specific population of nursing home residents.

Competing interests: None

Ethical Standards: ?????????????

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