The Journal of Nutrition, Health & Aging©
Volume 10, Number 3, 2006

REPEATED ASSESSMENT OF ENERGY AND NUTRIENT INTAKE IN 52 NURSING HOME RESIDENTS

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Abstract: Background: Studies in Swedish nursing-home patients have shown a high prevalence of protein-energy malnutrition. One potential cause for this may be low food intake. **Objective:** To examine the intake of energy and nutrients in the residents of a nursing home; to investigate changes in dietary intake and body-weight over time and to analyze two-year-mortality. **Design:** Explorative study. Five-day weighed assessment of food intake repeated three times during 1,5 years. Analysis of body composition at baseline and recording of body weight every third month. Analysis of two-year mortality. **Results:** Fifty-two residents had three complete dietary assessments. Mean age 84±7 years, 79 % were female. Mean body weight was stable at 61 kg. Mean energy intake at baseline was 1501 kcal/d (25 kcal/kg/d) and mean protein intake was 53 g/d (0.9 g/kg/d). Mean intake of vitamin D, vitamin E, folic acid, selenium and dietary fibre was less than 60 % of recommended. At the second assessment intake of energy and many nutrients was higher than at baseline, but at the third assessment intake had decreased. There was no correlation between energy intake and body weight over time. Two-year mortality was 52 %. Male gender and low body-weight constituted an increased risk of mortality. Comparing survivors and non-survivors showed that the mean body weight was 9 kg higher in the survivors throughout the study (p=0.02). This group had a relatively lower fat free mass and higher fat mass than the non-survivors. The difference in body composition was only seen in females, possibly due to the low number of males. The survivors had higher intakes of most nutrients but this reached significance only for a few of them. The non-survivors had significantly higher intakes of sucrose. **Conclusion:** Intake of energy and many nutrients was low in these nursing-home patients, and decreased further after one year, without any change in body weight. The significant positive relation between energy intake and body weight at group level disappeared when analyzing data at an individual level. Male gender and low body weight were associated with increased risk of mortality.

Introduction

Moving to a nursing home usually implies major life changes for elderly individuals. Meals may be served at different times of the day than the residents are used to, and they may not like the food. This may cause or worsen a nutritional problem, even though some individuals improve nutritionally by receiving regular meals, which has been seen in hospitalised elderly people (1).

A crucial question is whether the energy and nutrient intake of these patients is sufficient to cover their needs. Studies in Swedish nursing homes have shown a prevalence of protein-energy malnutrition (PEM) varying from 29 % to 50 % (2). These results are uncertain because the definition of PEM varies greatly among studies. Several studies on energy and nutrient intake have been done on healthy elderly, but only a few recent studies have carefully assessed the dietary intake of the elderly nursing home residents with multiple diagnoses (3-5).

Longitudinal studies (time range 6 years) have shown that intake of energy and nutrients declines with age in elderly people aged 70-75 at baseline (6, 7). In this study we wanted to carefully examine the energy and nutrient intake of institutionalised elderly with multiple diagnoses. We also wanted to see if and how energy and nutrient intake and body weight change during the progress of disease and advancing age and if there is any correlation between body composition and later mortality.

Aim of the study

- To study the energy and nutrient intake of elderly nursing home residents with multiple diagnoses and make a comparison with the Swedish Nutrition Recommendations (SNR) (8).
- To follow the intake of these elderly individuals over time through repeated assessments of food intake.
- To compare energy intake with the patients' body-weight development during the study.
- To correlate two-year mortality after the study to parameters measured during the time of the study (age, sex, body-weight, fat-free mass, energy intake, and activities of daily living).
- To test whether individual nutritional intervention can help nursing home residents with nutritional problems.

Materials and methods

We studied 76 elderly nursing home residents with multiple diagnoses from April 2000 to October 2001, in Sundbyberg, a suburb of Stockholm, Sweden. The setting was a general nursing home where the residents had complex combinations of

The Journal of Nutrition, Health & Aging©
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chronic diseases resulting in various functional impairments and the need for functional support and nursing care. After giving informed consent (from relatives when needed), all residents underwent a clinical examination by a geriatrician and were screened for baseline measurements. Time in the nursing home was calculated as the number of months the individual had lived in this nursing home before the first assessment.

Energy and nutrient intake

Energy and nutrient intake was determined by weighed food intake analysis on five consecutive weekdays, carried out by a nutritionist with the assistance of the nursing home staff. All hot meals and the leftovers were weighed to the nearest gram using a digital kitchen scale (PHILIPS HR 2385) with a resolution of one gram within the interval of 0-5 kg. Drinks and breakfast dishes such as porridge and yoghurt were weighed, but weights of sandwiches were standardised and referred to as "normal" or "small". The food intake was recorded from Monday through Friday. It was not practical to include weekends in the weighed food record, as there were fewer staff working on weekends, though two national holidays were included.

There were six wards in the nursing home, and the food intake was assessed in one ward per week. The first assessments were done in April 2000, and the study was concluded in October 2001. Food intake was assessed three times in each ward and only those individuals who had their food intake assessed all three times were included in the study. Reasons for not participating all three times were hospitalisation during the week of nutritional assessment in that ward, or death. Fifty-two individuals were included in the study.

The food intake data was computerised and energy and nutrient content was calculated using StorMATS (RUDANS LÄTTDATA, Västerås, Sweden) and the Swedish national nutrient database, PC-kost (NATIONAL FOOD ADMINISTRATION).

In the analysis of micronutrient intake, only foods, enrichment of foods, and oral fluid supplements were considered. Several of the nursing home residents also received micronutrient tablets, but since we were interested in how much of their needs could be met by food, micronutrient tablets were not included in the analysis.

Body composition

During the first examination the patients, dressed in underwear, were weighed to the nearest 0.1 kg on a digital chair scale (UMEDICO SV-600, Rosersberg, Sweden). Thereafter patients were weighed approximately every third month by the nutritionist, on the same scale, wearing light clothing. A correction of 0.5-1.5 kg was done, considering the kind of clothes the person was wearing. For most residents, height was measured to the nearest centimetre in the standing position using a stadiometer. For the 10 residents unable to stand even with support (due to e.g. contractures of muscles and joints in the extremities), height was approximated by adding the measurements of head-shoulder, shoulder-hip, hip-knee, and knee-heel. In a few cases the latest known height was used. All height measurements were performed by the geriatrician, who also did all the skin fold measurements described below. The body mass index (BMI) was calculated by dividing the body weight (kg) by height^2 (m).

Four skin folds were measured using a Harpenden calliper (BRITISH INDICATORS LTD, Bedfordshire, UK) (9) over biceps, triceps, subscapular and crista iliaca on the left side using the mean of three measurements to the nearest 0.1 mm from each location. Body density and fat mass were calculated from the sum of these four skin folds using prediction equations (10, 11). Fat-free mass (FFM) was calculated as body weight minus fat mass.

Resting metabolic rate

Resting metabolic rate (RMR) was measured with indirect calorimetry using a Delta Trac metabolic monitor (DATEX, Finland) at the time of the first dietary assessment. Measurements were performed in the residents' own flats, first thing in the morning, with the person still in bed, having fasted since midnight. As discussed elsewhere (12), it was difficult to carry out all measurements according to standardised criteria because some of the residents rose before the measurement, talked or fell asleep during the measurement. There was little difference between those who were examined under fully acceptable conditions and those who were not. For this reason we decided to use data on RMR for all residents in this study, except for two individuals who were obviously not fasting and one where no RMR could be obtained due to irregular breathing. The RMR data was used to calculate the ratio between energy intake and RMR to get an estimate of the energy level available for physical activity. A comparison was made between walkers and non-walkers to analyse whether physical activity made any difference.

Activities of daily living

The functional ability in terms of Activities of Daily Living (ADL) was examined according to the Katz Index (13) by a physiotherapist who interviewed nursing home staff. The Katz index tests the level of functional independence in six categories: bathing, dressing, toileting, transferring, continence, and feeding. To facilitate statistical analysis each category was assessed on a three-level scale (0 = independent, 1 = human aid, 2 = totally dependent), with a total score of 0-12, where 0 represents total independence (14, 15).

Dietary intervention

During the time of this study, a project was going on at the nursing home aimed at developing methods to diagnose and treat malnutrition states. All residents of the nursing home were screened for their nutritional status as described above. An individual dietary recommendation was established for each resident and distributed to the ward staff, the nurses and the central kitchen. There were five types of intervention:

- Information about a risk situation and the need for awareness, along with encouragement to the resident and the ward staff regarding the importance of a proper diet
- Fortification of the normal diet
- Oral fluid supplements
- Adjustment of food consistency
- Energy-reduced diet

In concert with the chef, an attempt was also made to improve the nutritional quality of the food on the kitchen menu. The two main changes were i) to decrease the amount of energy derived from saturated fat, and ii) to increase the amount of vegetables served.

Statistical Methods

Comparisons between groups were done using Students' t-test, as were longitudinal comparisons within groups, where $p<0.05$ was considered significant. A Cox proportional hazards model was fitted to investigate how mortality was affected by age, gender, body weight, fat-free mass, energy intake and ADL. All subsets of possible models were investigated using SAS software, score selection procedure. A mixed linear model was used to investigate if weight and energy intake were correlated on an individual level. Energy intake and weight were measured on three occasions for each individual and therefore a longitudinal model could be used to model this relationship. A model with random intercept and/or random slope was fitted. SAS statistical software v. 8.2 was used for all calculations.

Results

Patient characteristics at baseline are shown in table 1. Of the 52 participants, 41 (79 %) were female. The mean age was 84 years, with no significant difference between males and females. The median Katz index was 4 for females and 6 for males. In a subgroup of 33 residents Katz scores were available from the time just before the third dietary assessment. In this group (including 7 males) there was no difference in median Katz score between baseline and the later part of the study.

Body composition

Mean body weight was 61 kg. Thirteen individuals (26 %, data missing for two individuals) had a BMI below 20, indicating underweight. Seven individuals (14 %) had a BMI above 30 and could be defined as obese.

Energy- and nutrient intake – comparison of three assessments

Intake of energy and nutrients at baseline is shown in table 2 (expressed as total intake per day and intake/kg body weight (BW) /day). There were large individual variations. The mean energy intake at baseline was 1,501 kcal/d (25 kcal/kg/d). Mean protein intake was 53 g/d (0.9 g/kg/d). Fourteen percent of the energy derived from protein, 34 % from fat and 51 % from carbohydrates. The mean ratio between energy intake and RMR was 1.24 for females and 1.19 for males. There was no difference in this ratio, or any of the other parameters measured, between walkers and non-walkers. Dietary fibre intake was 11 g/d, less than half of that recommended for adults. Total intake of all macronutrients was significantly higher in males compared to females, as was intake of vitamin D, niacin, and sodium, however, all these differences disappeared when expressing intake per kg body weight.

Of 16 micronutrients considered, males had a mean intake below the Swedish Nutrition Recommendations (8) for nine nutrients and females for eight nutrients. The mean intake for five vitamins (A, B_2, B_3, B_6, and B_{12}) as well as for phosphorus surpassed the SNR. Intake of vitamin D, vitamin E, folic acid and selenium was very low, reaching only 40-60 % of the SNR. Figure 1 shows the mean intake of 13 micronutrients at the time of the three assessments relative to the SNR. Figure 2 shows the intake of energy and macronutrients at the second and third

Table 1
Characteristics of the nursing home residents included in the study.

	n	Age (years) Mean SD (range)	Weight (kg) Mean SD (range)	BMI (kg/m²) Mean SD (range)	Fat Free Mass (kg) Mean SD (range)	Fat mass (%) Mean SD (range)	ADL (Katz) (score 0-12) Median (range)
Total	52	84 ± 7.3 (67-102)	61.3 ± 15.7 (33.1-95.0)	24.4 ± 5.8 (14.6-42.2)	43.4 ± 9.2 (26.2-62.8)	28 ± 7 (15-41)	4 (0-12)
Females	41	85 ± 6.9 (67-102)	59.1 ± 16.1 (33.1-95.0)	24.7 ± 6.4 (14.6-42.2)	40.7 ± 8.1 (26.2-56.5)	30 ± 6 (17-42)	4 (0-12)
Males	11	81 ± 7.8 (71-96)	69.7 ± 10.7 (54-93)	23.6 ± 2.8 (18.4-27.4)	53.3 ± 5.3 (44.8-62.8)	23 ± 5 (15-32)	6 (0-10)

		Baseline																SNR	
		Total intake per day								Intake per kg body weight per day									
		Males			Females			All		Males			Females			All		Males	Females
		Intake	SD	Range	Intake	SD	Range	Intake	SD	Intake	SD	Range	Intake	SD	Range	Intake	SD		
Energy	kcal	1721	241	1487-2222	1442	269	589-1894	1501	255	25	3	20-30	26	6.6	14-40	25	6	2250	1950
Energy	MJ	7.2	1	6.2-9.3	6	1.1	2.6-7.9	6.3	1.2	0.1	0.01	0.08-0.13	0.1	0.03	0.06-0.17	0.11	0.03	9.4	8.2
Protein	g	60	15	47-97	51	13	18-62	53	14	0.9	0.2	0.6-1.2	0.9	0.2	0.4-1.4	0.9	0.2		
Protein	E%	14	2	12-17	14	2	12-17	14	2									10-15E%	
Fat	g	67	17	48-111	55	12	26-81	57	14	1	0.2	0.7-1.3	1	0.3	0.5-1.5	1	0.2		
Fat	E%	35	5	27-45	34	4	25-44	34	5									<30E%	
Saturated fat	g	32	10	21-57	27	6	12-42	28	6	0.5	0.1	0.3-0.7	0.5	0.1	0.2-0.8	0.5	0.1		
Saturated fat	E%	17	4	12-23	17	3	12-23	17	3									10E%	
Mono unsat. fat	g	22	5	17-37	18	4	9-26	19	5	0.3	0.06	0.2-0.4	0.3	0.06	0.2-0.5	0.3	0.06		
Mono unsat. fat	E%	12	2	9-15	11	2	7-15	11	2									10-15E%	
Poly unsat. fat	g	7	1	5-10	5	1	3-8	6	1	0.1	0.02	0.07-0.13	0.1	0.03	0.05-0.15	0.1	0.02		
Poly unsat. fat	E%	3	0.4	3-4	3	0.6	2-5	3	0.6									5-10E%	
Cholesterol	mg	263	85	195-495	222	59	102-365	231	67	3.8	0.9	2.8-5.3	3.9	1.1	2.3-6.3	3.9	1		
Carbohydrates	g	214	27	170-260	183	40	69-265	190	40	3.1	0.5	2.3-3.8	3.3	1	1.7-5.7	3.2	0.9		
Carbohydrates	E%	50	6	38-60	51	5	41-62	51	5									55-60E%	
Sucrose	g	51	18	11-73	47	21	19-126	48	21	0.6	0.3	0.1-1.2	0.9	0.5	0.2-2.2	0.8	0.4		
Sucrose	E%	12	4	2-18	13	6	4-28	13	5									<10%	
Dietary fibre	g	12	3	7-17	10	4	4-23	11	4	0.2	0.04	0.1-0.3	0.2	0.06	0.1-0.4	0.2	0.05	25-35	
Vitamin A	RE	1485	866	624-3763	1341	1000	310-4178	1371	965	21	12	8-55	23	17	7-76	23	16	900	800
Vitamin D	µg	4.5	1.4	2.8-7.4	3.5	1.3	0.5-6.8	3.7	1.3	0.06	0.02	0.04-0.09	0.06	0.02	0.01-0.12	0.06	0.02	10	
Vitamin E	TE	4.6	1.2	3.5-6.9	4.2	1.4	2.2-8.8	4.4	1.3	0.07	0.02	0.05-0.10	0.08	0.03	0.04-0.19	0.08	0.03	10	8
Vitamin C	mg	41	17	19-71	48	26	9-143	46.7	24	0.6	0.2	0.3-1.0	0.9	0.5	0.2-2.3	0.8	0.5	60	
Thiamin	mg	1.1	0.3	0.8-1.8	0.9	0.3	0.3-1.4	0.9	0.3	0.02	0	0.01-0.02	0.02	0.01	0.01-0.03	0.02	0.01	1.1	1.0
Riboflavin	mg	1.4	0.4	0.9-2.2	1.4	0.5	0.3-2.2	1.4	0.4	0.02	0	0.01-0.03	0.03	0.01	0.01-0.06	0.02	0.01	1.3	1.2
Niacin	NE	24	5	19-35	19	5	5-28	20	5	0.3	0.1	0.3-0.5	0.3	0.1	0.2-0.5	0.3	0.1	15	13
Vitamin B_6	mg	1.4	0.3	0.9-1.9	1.2	0.3	0.5-2.1	2.1	0.3	0.02	0	0.02-0.03	0.02	0.01	0.01-0.04	0.02	0.01	1.2	1.1
Vitamin B_{12}	µg	8	6	3-24	8	7	1-25	8	7	0.12	0.08	0.05-0.35	0.15	0.13	0.02-0.49	0.14	0.12	2	
Folic acid	µg	168	50	101-258	162	60	63-314	163	56	2.4	0.7	1.4-3.8	2.9	1.2	1.5-6.7	2.8	1.2	300	
Calcium	mg	791	264	542-1437	812	275	190-1428	808	270	11	3	8-16	14	5	5-29	14	5	800	
Phosphorus	mg	1054	267	850-1740	974	286	300-1693	991	281	15	3	12-20	17	5	7-28	17	5	600	
Iron	mg	7	1	4-9	6	2	3-11	7	2	0.1	0.02	0.06-0.13	0.1	0.04	0.05-0.23	0.11	0.04	10	
Magnesium	mg	220	40	172-310	202	51	75-365	205	49	3.2	0.3	2.7-3.7	3.6	1.1	1.8-6.5	3.5	1	350	280
Zink	mg	8	2	6-12	7	2	3-12	7	2	0.1	0.02	0.08-0.17	0.1	0.04	0.06-0.21	0.12	0.04	9	7
Selenium	µg	26	8	18-47	25	7	9-37	25	7	0.4	0.1	0.3-0.5	0.4	0.2	0.2-1.0	0.4	0.2	50	40
Sodium	mg	2794	707	1993-4531	2197	459	1229-3275	2323	569	41	11	27-66	39	11	21-68	39	11	<1980	
Potassium	mg	2280	422	1775-3204	2130	543	647-3633	2161	520	33	5	26-41	37	9	16-59	36	9	3500	3100

Figure 1

Total mean daily intake of micronutrients at three assessments shown as a percentage of current Swedish Nutrition Recommendations (SNR). The horizontal line represents the relative recommended level (100 %) for each nutrient.

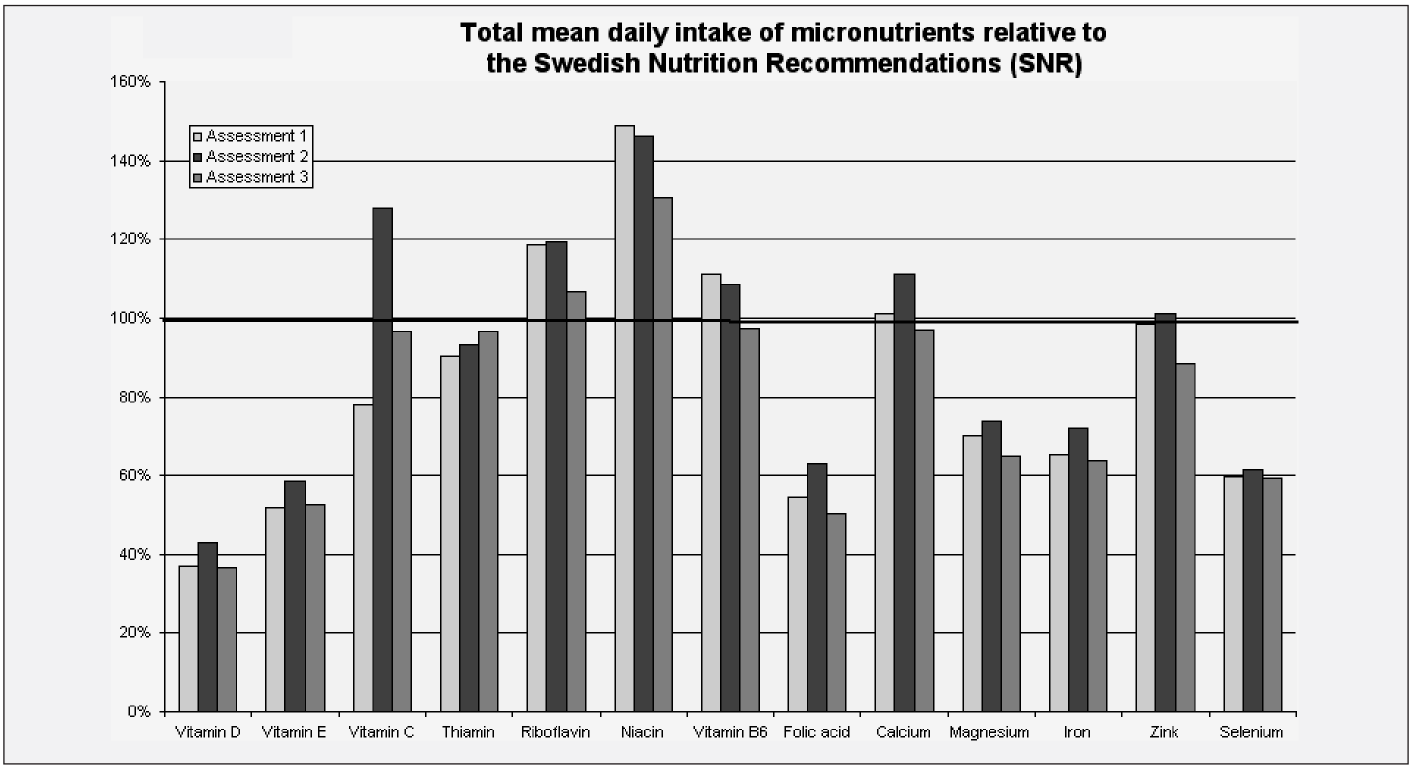
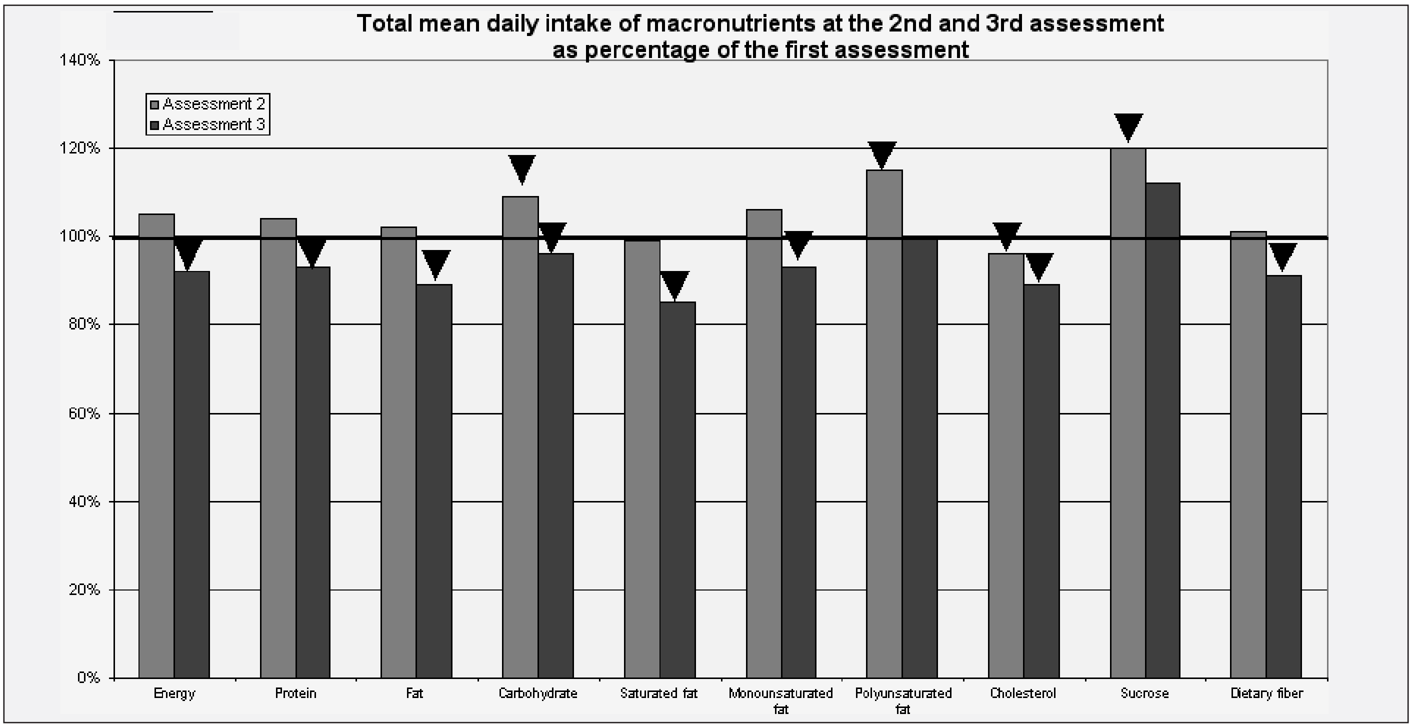


Figure 2

Changes in total mean daily intake of macronutrients at second and third assessments compared to baseline. Intake at second and third assessments is shown as a percentage of the first assessment. Black arrows show significant differences between assessments.



assessments relative to the first assessment. At the second assessment, intake of carbohydrates, polyunsaturated fat and sucrose was significantly higher compared with the first assessment. Intake of cholesterol was significantly lower. At the third assessment, intake of energy and all macronutrients, except polyunsaturated fat and sucrose, was significantly lower than at baseline.

Body weight during the study

The mean body weight was stable at 61 kg for the whole study population throughout the study. Despite this, there were individuals who gained or lost weight. In a longitudinal model preliminary plotting showed large differences in intercept between individuals but modest differences in slope. In figure 3 raw data for each individual are plotted and joined by lines. The intercept is where a regression line would cross the y-axis and the slope describes how strong the relationship between body weight and energy intake is. A mixed linear model with random intercept showed large differences in individual intercept, i.e. individuals seemed to sustain the same body weight on very different energy intakes. These differences were also statistically significant. At an individual level there seemed to be little change in body weight with change in energy intake (p=0.15). This indicates that even if there is a clear positive relationship between body weight and energy intake looking at the whole data set, this relationship is not evident when looking at the data at an individual level. This is also obvious by simple visual inspection of figure 3 since most individuals have flat, almost horizontal, lines when connecting the data points for energy intake and body weight.

Mortality

Two years after the study was completed, in October 2003, twenty-seven (52 %) of the 52 individuals in the study had died. The mean body weight was stable in both groups throughout the study, but the mean body weight of those who died was 9 kg lower (57 kg vs. 66 kg, p=0.04). Table 3 compares survivors and non-survivors at baseline. The difference in body weight was related to a higher fat mass in the survivors (p<0.01). A gender analysis showed that the observed difference in body composition was significant only for women. The surviving females had higher absolute fat-free mass and higher fat mass. Relative to their body weight these females had lower fat free mass and higher fat mass. There was no difference between the two groups in age, time in nursing home, or the energy intake/RMR-ratio. There was a trend towards a lower ADL capacity (KATZ score) at baseline in the non-survivors (p=0.06).

For a Cox proportional hazards model, three explanatory variables, gender, weight and ADL, yielded the highest log likelihood for mortality at two years. For a model with two explanatory variables, gender and weight were the best choice. These models fit equally well, considering the Akaike Information Criterium. Given this result, one would normally choose the simplest model, which is the model with gender and weight as explanatory variables. Males had a hazard ratio of 3.4, meaning that men had a substantially higher risk of dying in this group of patients, p=0.014. Higher weight at baseline indicated a lower risk of mortality, hazard rate 0.97, p=0.02. The hazard reduction connected with higher initial weight may seem modest, but it must be noted that this hazard reduction

Figure 3

Body weight vs. energy intake on an individual level.

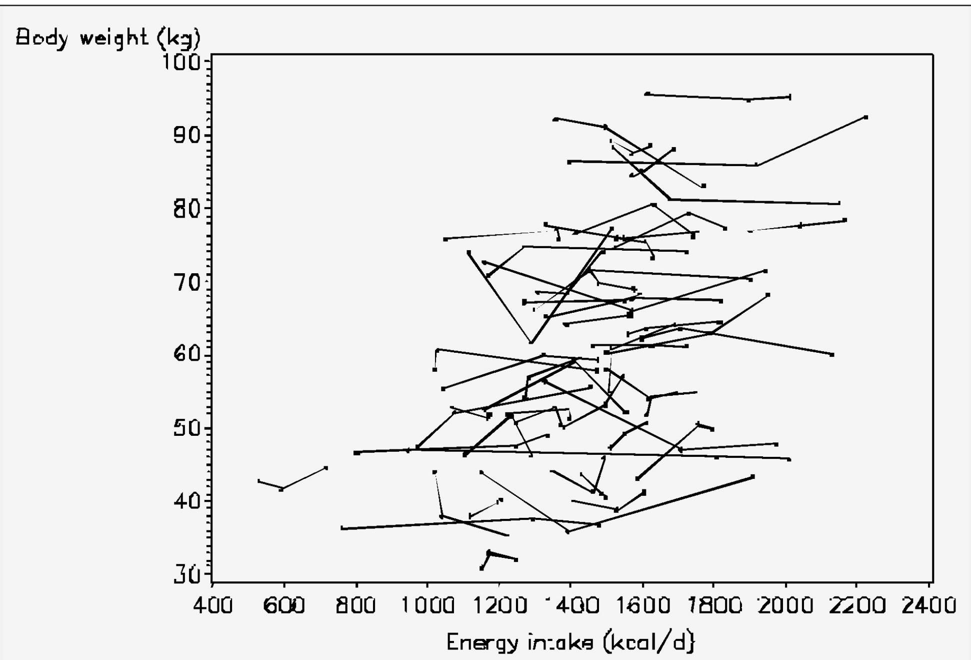


Table 3
Baseline comparison of mean or median1 values between survivors and non-survivors.

		Survivors			Non-survivors		
		All	**Males**	**Females**	**All**	**Males**	**Females**
N		25	3	22	27	8	19
Age	(years)	83	81	84	86	81	88
Time in nursing home	(months)	36	9	40	36	35	36
ADL-score1	(Katz)	3	3	3	5	8	4
Weight	(kg)	66*	70	66**	57	70	52
Body mass index	(kg/m2)	26	24	26	23	24	23
Fat free mass	(kg)	45	54	44**	42	53	37
Fat free mass	%	69**	78	68**	74	77	73
Fat mass	(kg)	21**	16	22**	15	17	15
Fat mass	%	31**	22	32**	26	23	27
Energy intake/RMR		1.25	1.13	1.27	1.21	1.21	1.20

* p<0.05; **p<0.01

refers to reduction per kg of higher body weight. A 10-kg higher body weight would therefore correspond to a hazard of about 0.70. In the model with three explanatory variables, Katz was not statistically significant, p=0.17.

There were small differences in intake of energy and nutrients between the survivors and non-survivors. The survivors had a higher intake of most nutrients, but the difference was significant only for polyunsaturated fat at the first assessment; and at the third assessment for cholesterol, vitamin D and sodium; as well as for riboflavin and folic acid expressed per kg body weight. In the survivors there was also a trend towards a higher intake of protein, phosphorus, and mono- and polyunsaturated fat. An interesting finding was that despite the fact that the survivors had a higher intake of practically all nutrients at all assessments, those who died had a higher intake of sugar at all three assessments, which even reached significance at the second and third assessments when expressed per kg body weight.

Intervention

The intervention at the kitchen level, to improve the nutritional quality of the menu, seemed to have had the effect that the mean intake of vitamin C and folic acid were significantly higher at the second assessment (figure 1), whereas there was a decrease in cholesterol (p=0.05) intake (figure 2). Regarding the individual dietary recommendations no changes in intake was observed for any of the five different intervention groups (see "Materials and Methods").

Discussion

Intake of energy and nutrients

In these elderly subjects with multiple diagnoses intake of energy and several nutrients was generally low with large variation between individuals. The mean ratio of energy intake to RMR of 1.2 could be sufficient for those who are bed or chair-bound (16). Of the 52 individuals in this study, 23 (44 %) were practically chair-bound. The other 56 % who could walk would be expected to have a higher ratio to cover their needs, but there was no difference between walkers and non-walkers. This may indicate an energy intake insufficient to cover their needs, or a generally very low physical activity. Despite this, and despite the fact that mean energy intake was significantly lower at the third assessment, no change in mean body weight could be seen. Investigating this relationship on an individual level with a mixed linear model showed that there was no correlation between energy intake and body weight. We do not know the explanation for this; there could be adaptive metabolic mechanisms, e.g. water retention with subclinical edema formation, or a delayed reaction in body weight to a low energy intake, as well as recent changes in energy intake or physical activity. Underreporting of intake is also a possible explanation for this lack of correlation between energy intake and change in body weight, but we do not consider it very likely since the elderly subjects in this study ate all their meals in the nursing home and we used weighed food intake analysis to determine intake.

The generally higher intake of most nutrients at the second assessment is probably a result of the intervention in general, and the attention that was given to nutrition in the entire nursing home at this time. There was a large intake of vitamin A and B_{12} at the first assessment with a decline in intake at the second and third assessments. This was caused by the liver stew served for lunch once during the first assessment at one of the wards, which yielded very high intakes of these vitamins in some individuals. For this reason, vitamin A and B_{12} are not included in figure 1. In addition to the attempts to improve the

The Journal of Nutrition, Health & Aging©
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menu described above, the increased intake of vitamin C may also have been caused by higher intakes of fortified desserts and drinks. As an example, some wards tried to offer more orange juice instead of other sweet drinks.

The generally lower intake at the third assessment may be due to the natural process of aging and progression of disease. It should be noted that more than 50 % of these elderly individuals died within two years of the third assessment. Physical function with loss of ability to self-feed could cause a lower intake, but a closer analysis did not confirm this. Katz score did not change in the subgroup of 33 residents were repeated measures were available; the median Katz score was 4 at both occasions. For those 19 residents where no repeated measures were available, an analysis of the nutritional situation was done for all residents at the time of the 3rd assessment and from these results we can conclude that there was only one female that needed full feeding assistance, and she had Katz score 12 already at baseline. Nine individuals needed some assistance with feeding (like cutting and supervision), and in these the median Katz score at baseline was 10.

The low intake of some micronutrients is of concern. The recommended daily allowances are set to cover the needs of 95 % of a population. A nutrient intake well below the recommended level may still be above the biological requirement. Still, a mean intake at about 50 % of the SNR - as for some nutrients in this study - implies that half of the individuals had an intake even lower than that. Some of the residents received micronutrient tablets that would have improved the intake reported here, however, as mentioned in "Methods and Materials" above, this supplementation was not included in the analysis. The current Swedish nutrient recommendations for the age group 75 years and over refers to healthy elderly. The biological requirements for elderly with several comorbid conditions and functional impairments are not known.

Mortality

Being male was found to be the highest hazard risk for mortality in this study. Life expectancy at birth is shorter for males than females, and there were few males in this nursing home. It is possible that there is a selection of males in poor medical condition, and/or who are widowed or alone, that come to live in a nursing home. Furthermore, a low body weight was associated with an increased mortality (p=0.02). BMI was not significantly related to mortality, possibly because height also decreases in many elderly people, which renders a smaller change of BMI than in body weight in the aged (17). Using height instead of weight in the Cox model actually showed that being taller reduced the risk of mortality as well. As mentioned above, measuring height in frail elderly is sometimes problematic, which makes BMI a less reliable factor than body weight.

Persson et al. observed that undernourished females had a higher mortality, and they seemed to have lost fat mass, but not fat-free mass (18). In our study the female survivors had significantly higher fat mass and fat-free mass at baseline, however, the relative difference was greater for fat mass than for fat-free mass. No conclusion can be drawn regarding the males since there were only three male survivors. Frisoni, et al. found a significant correlation between low intake of macronutrients and mortality during a 28-month follow-up (19). One reason why we did not find such a correlation could be that the intake was generally low in all residents in this nursing home. Persson, et al. found that a low ADL capacity was related to a higher mortality risk (18). In our study, this relation was close to significance when comparing the groups directly (p=0.06), but not in the Cox model (p=0.17).

The differences in nutrient intake of survivors and non-survivors could indicate that the survivors ate more of the hot meals served, and that the non-survivors ate more snacks, like sandwiches, cakes, desserts and sweet drinks. If so, we do not know if these eating patterns have been part of the lifestyle of these individuals or if they were a result of their present condition.

Intervention

Attempts at making individual dietary interventions for all residents were difficult to put into practice. Despite the written and oral information given, it happened that the staff serving the meals were totally ignorant of the new routines a few weeks later. It took about six months before the central kitchen had working routines for preparing the correct number of the proper kind of dishes for each ward. Not until the third dietary assessment did all individuals receive approximately what had been recommended. At the end of the study we realised that those who should have received a fortified normal diet had only received a minimal amount of fortification, due to the fact that it was difficult to "hide" the fortification in food of normal consistency. We could not expect this to increase their intake of energy or nutrients. Accordingly, we could see no changes in intake within the five different intervention groups described in "Materials and Methods" above. No conclusion can be drawn from this part of the study regarding the use of individual dietary interventions in a nursing home, except that it would demand a well-designed organisation to make such a system work. In a single-case study, Christensson, et al. had reasonable success with individual dietary interventions, but then one patient at a time was treated in a highly specific way (20). We also observed two such cases in our nursing home, where the staff had noticed a large weight loss, and the nurses had prescribed massive nutritional treatment before the beginning of this study. These two females received much attention and had all food fortified, and were served numerous supplements every day. They gained 7-10 kg and later the supplementation could be discontinued by the research staff.

Another problem was observed in a few individuals with dementia, dependent in all ADL except eating. They got exhausted from sitting in their wheelchairs all day, and it was very difficult to get the staff to serve them something in bed. These individuals (at least 3 of those included in this study) could be left without anything to eat for up to 18 hours.

Nutrient recommendations to elderly

The optimal macronutrient balance of a diet served to institutionalised elderly people is not known. According to current Swedish recommendations, chronically ill elderly at risk for malnutrition should be served an energy and protein-rich diet with 45 % of the energy from fat and 20 % from protein (21).

On the other hand, there is concern over the high intake of fat, protein and alcohol in elderly residents. In a Spanish study on institutionalised elderly the authors suggested a change toward the recommended dietary allowances for healthy people with 30 % of the energy intake from fat and 15 % from protein (3).

It has been shown that nutritional support reduces mortality and improves function in underweight hospital patients (22). A Cochrane review by Milne, et al. concluded that energy and protein supplementation in the form of commercially available supplements with a balanced nutritional content in elderly people at risk for malnutrition produces a small but consistent weight gain in older people and there may also be a beneficial effect on mortality. However, there was no evidence of improvement in clinical outcome, functional benefit or reduction in length of hospital stay with supplements (23).

More research is needed to establish the optimal macro- and micronutrient composition for elderly people with multiple progressive chronic diseases in various phases. One question to consider is, at what age and at which clinical stage does the beneficial effect of a low-fat diet decline in favour of an energy and protein-rich diet, often with high amounts of saturated fat? This age-related shift in nutrition recommendations raises an intriguing issue, since the main cause of death in many countries is atherosclerosis-related diseases.

From this study, we can conclude that intake of energy and nutrients is low in many nursing home residents, and this could partially explain the high prevalence of malnutrition in this group. More research is needed regarding reasons for the low intake. In this study it was not caused by a poor supply of food. Possible explanations for the low intake could be quality and choice of food, meal time frequency, effects of disease and medications on appetite and energy metabolism, social, psychological and environmental factors.

Acknowledgements: The authors wish to thank biostatistician Anna Törner at the Swedish Institute of Infectious Diseases for valuable discussions and help with the statistical analyses. We also thank physiotherapist Elisabeth Rydwik for assessing functional ability by Katz index, and for help with analysing these data.

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