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RESEARCH PAPER

Nutrient density and variation in nutrient intake with changing energy intake in multimorbid nursing home residents

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Abstract

Background: The low energy intake seen in some institutionalised elderly has led to a focus on energy dense diets. The present study aimed to investigate nutrient density in the diet of nursing home residents, and calculate how changes in energy intake affect nutrient intake.
Methods: The investigation comprised a longitudinal observational study analysing the relation between energy and nutrient intake in a general nursing home in Sweden. Food intake was weighed for 5 days every sixth month over 1.5 years and nutrient density was calculated. The 52 multimorbid residents [mean (range) age 84 (67–102) years] with three complete 5-day weighed food records were included in the study. A mixed linear model was used to calculate changes in nutrient intake with changing energy intake.
Results: Nutrient density was adequate for vitamins A, B_{12}, thiamine, riboflavin and niacin, and low for vitamins D and E, folate, potassium, magnesium and iron. The mixed linear model showed that the fat-soluble vitamins, as well as folate and vitamin B_{12}, increased the most with increasing energy intake, whereas sodium, potassium, thiamine and selenium had the smallest increase.
Conclusions: Nutritional density of the food should be considered when planning diets for elderly patients with poor appetite.

Introduction

Institutionalised elderly people often have a low intake of energy and nutrients (Van Houten & Löwik, 1995; Schmuck *et al.*, 1996; Van der Wielen *et al.*, 1996; Lumbers *et al.*, 2001; Berner *et al.*, 2002; Akner & Flöistrup, 2003; Suominen *et al.*, 2004; Lammes & Akner, 2006). This may be caused by many different factors, such as changes in appetite, smell and taste, dentition, eating ability, swallowing, etc. These factors in turn are often associated with multimorbidity, multiple treatments and the social situation.

A diet with a high nutrient density is required to meet the nutrient needs of frail and disabled elderly people. This is of special concern for those planning diets for this population group, where an energy-dense diet is recommended. The current Swedish recommendations regarding patients with signs of or at risk of malnutrition and poor appetite state that 15–25% of the energy should derive from protein, 40–50% from fat and 24–45% from carbohydrates (National Food Administration, 2003). This type of diet has been shown to increase energy intake in elderly patients (Olin *et al.*, 1996; Ödlund Olin *et al.*, 2003), but it can be difficult to cover the needs of micronutrients when mainly adding oils and/or high-fat dairy products.

A study of elderly people living independently or in institutions investigated the frequency of consumption of nutrient-dense foods. It was concluded that only 22% of the elderly had a sufficient intake, appropriate variety and no important group of foods or nutrients missing (Frauenrath *et al.*, 1989). It has been observed that a high dietary variety is positively related to both a high intake of energy and nutrients as well as nutritional state in frail elderly people (Bernstein *et al.*, 2002).

Elderly people are recommended a nutrient intake level equal to or higher than for younger adults; however, there are no recommended levels of nutrient density for the elderly. The Nordic Nutrition Recommendations (NNR) only recommend levels of nutrient density when planning diets for mixed ages (6–60 years) (Nordic Council of Ministers, 2004). Berner *et al.* (2002) calculated recommended nutrient densities for the elderly using the American Recommended Dietary Allowances (Food and Nutrition Board, 1989) and the Estimated Safe and Adequate Daily Dietary Intake (Food and Nutrition Board, 1989, 1998, 1999, 2000) or other sources, and related the recommended intake for elderly people to the median energy intake in 31 studies on the elderly.

Few studies have investigated what happens with nutrients when energy intake is increased in a frail elderly population. No data are available in the literature considering nutrient intake in relation to energy intake in a longitudinal perspective in elderly people.

In the light of these facts, the present study aimed to address the following issues:

- Does the diet served in a Swedish nursing home provide nutrient density (defined as nutrient intake in grams per unit of energy) sufficient to cover the nutritional needs of its residents, at their actual energy intake level?
- To what extent can an increased energy intake be expected to also cover the recommendations for protein, dietary fibre and micronutrients, and how do these results differ for various nutrients?
- Can a linear mixed model more accurately model and describe how nutrient intake varies with energy intake on an individual level and on group level?

This study was a part of a large nutritional project at the nursing home, which aimed to assess nutritional state and treat those at risk of malnutrition. As described elsewhere, there was no effect of the individualised nutritional treatment (Lammes & Akner, 2006).

Materials and methods

This observational, longitudinal study included all 76 residents of a nursing home from April 2000 to October 2001. The setting was a general nursing home in Sundbyberg, a suburb of Stockholm, Sweden, where the residents had complex needs due to complex multimorbidities resulting in various functional impairments and the need for functional support and nursing care. All individuals, or their next of kin, provided their written informed consent. Ethical approval was obtained from the ethics committee at Karolinska Institutet in Stockholm. All residents underwent a clinical examination by a geriatrician and were screened for baseline measurements. Only those individuals who had their food intake assessed three times were included in the analysis (52 individuals). Reasons for not participating all three times were hospitalisation during the week of nutritional assessment in that ward.

Anthropometric measurements

The residents, dressed in underwear, were weighed to the nearest 0.1 kg on a digital chair scale (SV-600; Umedico AB, Rosersberg, Sweden). Weighing was carried out every third month during the data collection period. For most residents, height was measured to the nearest centimetre in the standing position using a stadiometer. For the 10 residents who were unable to stand even with support (e.g. due to 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. Body mass index (BMI) was calculated by dividing the body weight (kg) by height^2 (m).

Diet served at the nursing home

The diet served at the nursing home mainly consisted of traditional Swedish food, with some contribution of more modern food trends. The menu was planned by the chef for 6 months at a time, with regard to seasonal changes. Details regarding the menu were planned monthly. The diet was designed to be rich in energy but there was no requirement to fulfil the Swedish recommendations regarding residents with signs of or at risk of malnutrition (National Food Administration, 2003). All residents were receiving a full pension and ate all their meals as served in the nursing home. At each meal, one main dish was served and, at lunch, there was dessert. Residents who had informed the staff that they would not eat certain dishes (e.g. due to allergy or dislike) were served an alternate dish. In the afternoon, coffee and buns or cookies were served and in the evening coffee with a sandwich. One intention of the nutrition project was to improve the nutritional quality of the food on the menu, mainly by increasing the amount of vegetables served and to decrease the amount of energy derived from saturated fat in the diet. Any effect of an improved nutritional quality of the food served would be seen as an improving nutrient density and higher nutrient intake in relation to energy intake during this study.

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 (HR 2385; Philips Electronics, Wien, Austria) with a resolution of 1 g within the range 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 because there was a reduced staff available on weekends, although two national holidays were included.

There were six wards in the nursing home, and the food intake was assessed three times per ward (one ward per week) with approximately 6 months in between. The food intake data was computerised, and the energy and nutrient content was calculated using StorMATS, version 4.05a (Rudans Lättdata, Västerås, Sweden) and the Swedish national nutrient database, PC-kost (NATIONAL FOOD ADMINISTRATION, Uppsala, Sweden). Most missing values in the database were extrapolated from similar products, whereas, in some cases, less nutritious products (e.g. fruit-flavoured desserts made from powder) were registered with only the nutritional content brought by the producer.

In the analysis of micronutrient intake, only foods, enrichment of foods and oral fluid supplements were considered. Several of the nursing home residents received micronutrient tablets, but these were not included in the analysis because the study focused on how much of their needs could be met by food alone. Intake of protein was included in the longitudinal analysis because it is often discussed whether protein intake is sufficient in the frail elderly. In the calculation of nutrient density, dietary fibre was included because more fibre is often advocated to nursing home patients due to constipation, whereas it is also noted that a high fibre intake will increase the volume of the portions.

Nutrient density

The nutrient density of the diet for each individual was calculated as mean intake of each nutrient for 5 days, per MJ. The results were compared with the NNR (Nordic Council of Ministers, 2004) and the nutrient densities calculated as described by Berner *et al.* (2002). These references were chosen because there are no official recommendations regarding nutrient density levels for the elderly.

Longitudinal analysis

Intake of different nutrients may be assumed to be linearly related to energy intake if a larger amount of the same food is eaten. However, nutrient density varies between different food items and there may be large inter-individual variability in how much the intake of different nutrients increases with increased energy intake. This is related to individual preferences for different foods, and what foods are offered. Consuming food with higher nutrient density may give a larger increase in nutrient intake as energy intake increases. Adding fat to increase energy intake would give a smaller increase in nutrient intake. To investigate whether a higher energy intake was caused by a higher fat content in the diet, an analysis of whether the increase in energy intake was correlated with the percentage of energy from fat in the diet was performed.

To investigate whether a statistical linear mixed model could improve the visualisation and analysis of longitudinal data considering both individual and group effects on nutrient intake, a mixed linear model was applied to the data on energy intake and nutrient intake. Information on energy intake and nutrient intake was obtained from the three assessments. A mixed linear model has a fixed effect slope, common to all individuals, and an individual component of the slope, which is estimated separately for each individual. The equation is:

$$y_i = \alpha_0 + (\beta_0 + \beta_i) \cdot x_i + \varepsilon$$

The fixed effect is denoted by β_0 and the individual effect is denoted by β_i. The estimated nutrient intake for individuals (i) at energy consumption x_i is designated y_i. The model has a common intercept, α_0,and a residual variance term, ϵ. Ideally, the intercept in the model should be zero because, at zero energy intake, the intake of a specific nutrient should also be zero. The data at hand, however, are limited to energy intake in the range 2.1–9.6 MJ day^{-1} and linearity can therefore only be assumed in this range.

The linear mixed model investigated the linear relationship between intake of energy and different nutrients. Data points for each individual were therefore sorted in order of increasing energy intake, regardless of at which time point the highest energy intake was observed. After this rearrangement, a linear model exploring the relationship of increasing energy intake and nutrient intake for each nutrient was fitted. Because time was not part of this analysis, only the relationship between energy intake and nutrient intake was investigated.

The longitudinal linear mixed model was chosen because it is a model that can capture the change within individuals, but, at the same time, utilise information from the group. Initially, a model with random slope and random intercept was investigated, but it was difficult to achieve convergence, probably because of the high number of parameters in relation to number of observations. Random slopes gave a significantly larger increase in log likelihood and a model with random slopes was therefore chosen. Different covariance structures were considered, specifically unstructured and AR(1). The likelihoods for these were almost identical and the unstructured matrix was chosen to induce a minimum amount of parametric constraints on the model.

All data were quantitative. Data were normally distributed by review of histograms, with a few outliers for vitamin A and vitamin B_{12}, due to a liver dish served at a single meal during the food record in one ward. The study was not powered with specific objectives in mind because the analysis was purely explorative in nature. $P < 0.05$ was considered statistically significant.

SAS statistical software, version 8.2 (SAS Institute, Cary, NC, USA) was used for all calculations.

Results

Table 1 shows the characteristics of the study population at the start of the study.

Of the 52 participants, 41 were female (79%). The mean age was 84 years, with no significant difference between males and females. Twenty-five percent of the study population had a BMI < 20 kg m^{-2}, indicating being underweight, and 13% had a BMI > 30 kg m^{-2} and could be defined as being obese. Mean body weight for the total study population did not change during the course of the study.

Energy intake was generally low in the nursing home residents, as was the intake of several nutrients. Mean intake of energy at baseline was 6.3 MJ day^{-1} (1501 kcal - day^{-1}), with a standard deviation of 1.2 MJ day^{-1} (285 kcal day^{-1}). Energy intake decreased significantly at the third assessment to 5.7 MJ day^{-1} (1357 kcal day^{-1}). Of 17 micronutrients considered, mean intake was below the recommended intake for nine of them (vitamins D, E and C, thiamine, folic acid, iron, zinc, magnesium and selenium) using the Swedish Nutrition Recommendations (National Food Administration, 1997). Intakes were especially low for vitamins D and E, folic acid and selenium (less than 60% of the recommended level). The result of the attempts to improve the nutritional quality of the menu could be seen as an increasing intake of unsaturated fat and a decreased intake of cholesterol during the study. Intake of vitamin C and folic acid also increased, which could also be due to a higher use of products such as orange juice. Further details on energy and nutrient intake are provided elsewhere (Lammes & Akner, 2006).

Table 1 Characteristics of the study population at the start of the study [mean (SD)]

	n	Age (years)	Body weight (kg)	BMI (kg m^{-2})
All subjects	52	84 (7.3)	61.3 (15.7)	24.4 (5.8)
Range		67–102	33.1–95.0	14.6–42.2
Females	41	85 (6.9)	59.1 (16.1)	24.7 (6.4)
Range		67–102	33.1–95.0	14.6–42.2
Males	11	81 (7.8)	69.7 (10.7)	23.6 (2.8)
Range		71–96	54–93	18.4–27.4

Nutrient density is shown in Table 2. Compared to the estimated recommendations by the NNR (Nordic Council of Ministers, 2004), nutrient density was sufficient for nine nutrients (vitamins A, B_6 and B_{12}, thiamine, riboflavin, niacin, calcium, phosphorus, and zinc). At baseline, nutrient density was low for vitamins D and E, folate, potassium, magnesium and iron. Selenium, which is scarce in Swedish soils had borderline density in the diet. Compared to the calculated recommendations by Berner *et al.* (2002), nutrient density was also low for vitamin B_6, calcium and zinc. At the second and/or third assessment, nutrient density significantly increased for vitamins C, D and E, folate, calcium and selenium. There was a decrease in nutrient density for vitamin A, vitamin B_{12} and niacin at the second and/or third assessment, but all three nutrients were still above the recommended levels.

Dietary fibre intake was approximately half of the recommended amount when related to energy intake (1.6 g MJ^{-1}) and even less (11 g day^{-1}) compared to the absolute recommendation of 25–35 g per day in the NNR.

In the mixed model analysis, considering how nutrient intake changes when energy intake is increased, protein was included as a nutrient. Protein (Fig. 1a–c) and vitamin A (Fig. 2a–c) were chosen to show the results of applying the linear mixed model to both a macro- and a micronutrient with small versus large inter-individual variation in raw data.

In Fig. 1a, the raw data were plotted for protein intake versus energy intake. Data points for each individual were joined by lines to emphasise that the data were longitudinal. In Fig. 1b, a linear regression model was applied individually to each person. The variability among individuals was moderate, which also could be expected for a macronutrient such as protein. In Fig. 1c, the linear mixed model predictions with group and individual corrections for slope have been applied. The mixed model estimated the most likely population averages for the given data, at the same time as adjusting to some degree for individual variation. The results of the mixed model indicated that the intake of protein increased by a mean of 8.2 g per MJ (range 6.0–16.6 g MJ^{-1}) increase in energy intake.

Table 2 Nutrient density in 52 nursing home residents expressed per MJ of ingested energy

		Nutrient density						
				Present study				
		Recommendations		Assessments 1–3 combined		Individual assessments		
Nutrient	Unit	RDA‡	NNR†	Mean	95% confidence interval	1	2	3
Potassium	mg		350	348	340–356	344	345	352
Calcium	mg	148	100	135	129–140	128	137*	137*
Phosphorus	mg		80	159	155–164	157	160	160
Magnesium	mg	53	35	33	33–34	33	33	33
Iron	mg	1.2	1.6	1.1	1.0–1.1	1.0	1.1	1.1
Zinc	mg	1.8	1.1	1.1	1.1–1.2	1.2	1.2	1.1
Selenium	μg		4	4.1	4.0–4.3	4.0	4.0	4.4*
Vitamin A	RE	120	80	184	167–202	214	177	164*
Vitamin D	μg	1.8	1.0	0.62	0.60–0.65	0.59	0.65*	0.65
Vitamin E	TE	2.6	0.9	0.73	0.70–0.76	0.69	0.75*	0.76*
Thiamin	mg	0.14	0.12	0.16	0.15–0.16	0.15	0.15	0.17*
Riboflavin	mg	0.17	0.14	0.23	0.22–0.24	0.23	0.23	0.23
Niacin	NE	2.0	1.6	3.1	3.0–3.2	3.2	3.0*	3.1
Vitamin B_6	mg	0.22	0.13	0.19	0.19–0.20	0.20	0.19	0.19
Folate	μg	49	45	27	26–28	26	29*	27
Vitamin B_{12}	μg	0.3	0.2	1.0	0.9–1.1	1.3	0.9*	0.9*
Vitamin C	mg	11	8	9.9	9.2–10.6	7.5	12*	10*
Dietary fibre	g		3	1.6	1.5–1.7	1.7	1.5*	1.5*

*Significant changes ($P < 0.05$) between assessments 2 and/or 3 compared with assessment 1.
†Nutrient density according to Nordic Nutrition Recommendations (NNR) (Nordic Council of Ministers 2004).
‡Nutrient density according to Recommended Dietary Allowances (RDA) as calculated by Berner *et al.* (2002)
RE, retinol equivalents; TE, tocopherol equivalents; NE, niacin equivalents.

Fig. 2a–c shows similar data for vitamin A. The large variation in intake of vitamin A (Fig. 2a), was due to the liver dishes served at the nursing home. This gave very steep individual regression lines in some individuals, as can be seen in Fig. 2b. However, in the mixed model, this random variation is smoothed and the predictions show that vitamin A is a nutrient that on average was very closely correlated to energy intake (Fig. 2c). The average increase of vitamin A intake was 278 retinol equivalents (RE) per MJ energy intake (range 252–558 RE/MJ). Vitamin A showed the largest relative increase with increasing energy intake (Table 3).

Table 3 shows the results from the mixed model for the nutrients studied. The total mean nutrient intakes were practically identical to the intake calculated by the mixed model. For this reason, only the calculated figures are provided in Table 3. The largest increases relative to an increasing energy intake were found for the fat-soluble vitamins and for folate and vitamin B_{12}, whereas sodium, potassium, thiamin and selenium showed the smallest relative increases with increasing energy intake (not shown). All nutrients increased significantly with energy intake ($P < 0.001$). Also, the random slopes (i.e. how nutrient intake changed with energy intake on an individual level) varied significantly between patients, with some individuals having significantly lower or higher intake of nutrients per unit of energy.

There was no correlation between energy intake and percent fat in the diet, neither at each assessment or as changes over time.

Discussion

To our knowledge, this is the first study of nutrient density in elderly nursing home residents based on weighed food record analysis. There are few studies in the scientific literature that deal with nutrient density in the elderly. Berner *et al.* (2002), studied nutrient intake and density in 50 nursing home patients by structured food frequency questionnaires and also considered 30 other studies on energy and nutrient intake in elderly people. The results showed a low nutrient density in a majority of the studies for vitamins D, E and B_6 and thiamine, as well as for calcium, magnesium, zinc and copper.

In a population study conducted in elderly Europeans, the nutrient density was low for some nutrients. Longitudinal nutrient intakes decreased, whereas the changes were small for nutrient density (Amorim Cruz *et al.*,

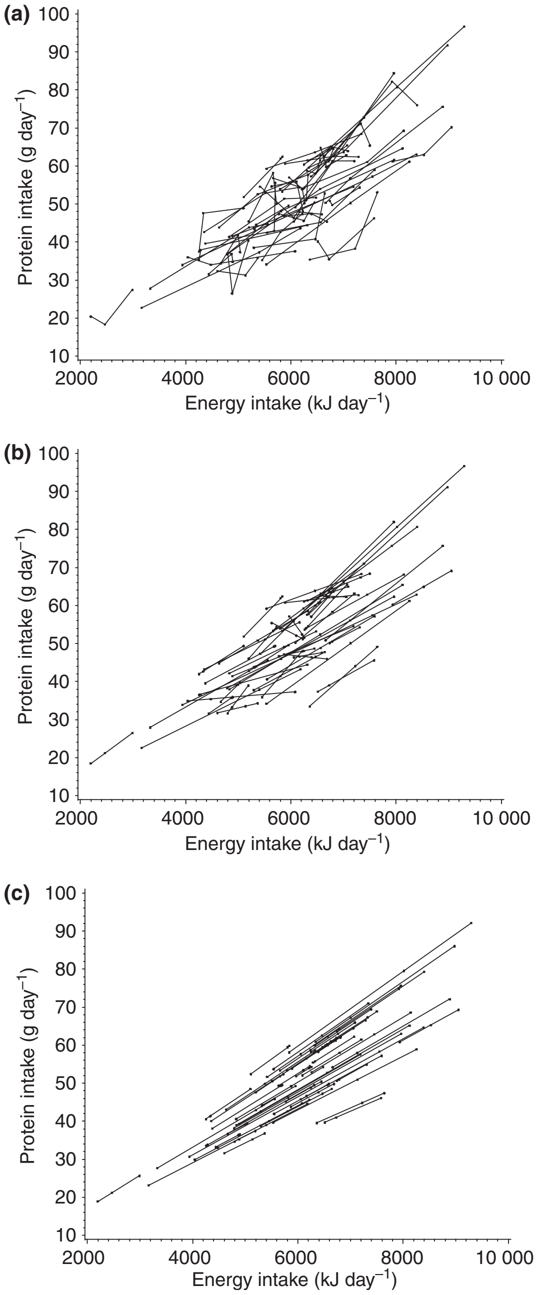

Figure 1 (a) Plot of raw data for protein intake. (b) Individually plotted regression lines for protein intake. (c) Mixed model with random slope for protein intake.

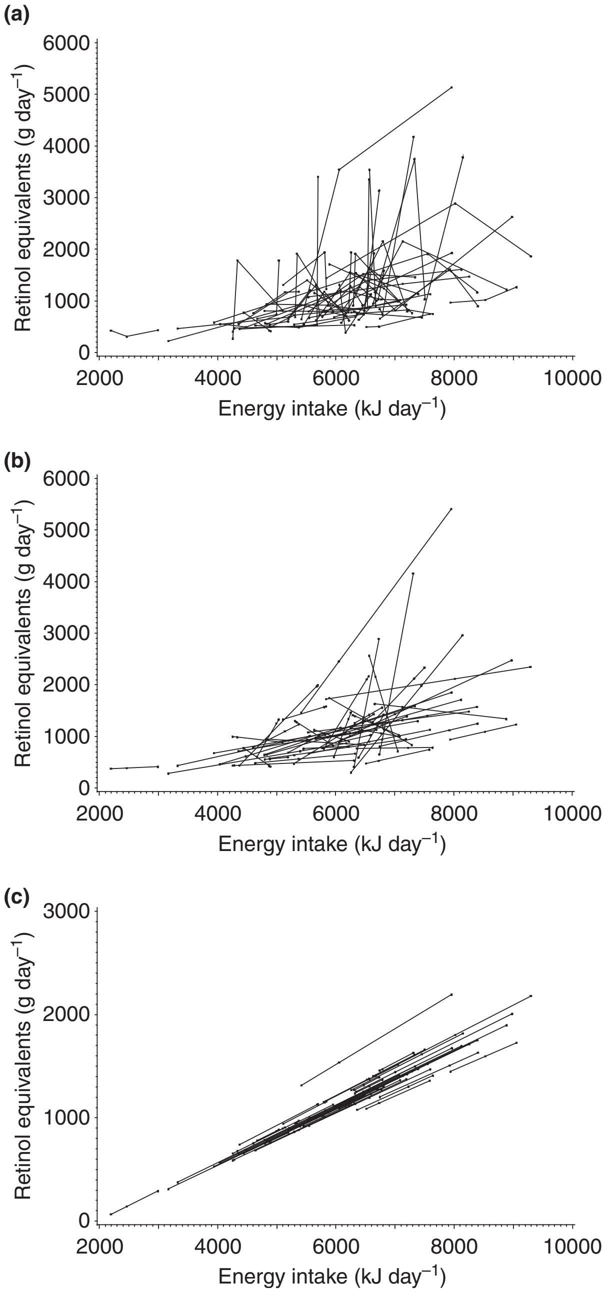

Figure 2 (a) Plot of raw data for vitamin A intake. (b) Individually plotted regression lines for vitamin A intake. (c) Mixed model with random slope for vitamin A intake.

1996). This demonstrates the importance of a nutrient dense diet for frail elderly with low or decreasing food intake.

The present study compared nutrient density to the NNR, but these recommendations are only meant to be used for planning diets for people aged 6–60 years, and at energy intakes above 8 MJ (1900 kcal) per day. At lower energy intakes, the NNR will not cover the recommendations of all nutrients. The nutrient density levels calculated by Berner *et al.* (2002) show that nutrient densities for the elderly need to be higher for all nutrients to reach the RDA for this age group. In the present study, the mean energy intake at baseline was 6.3 MJ day^{-1}. Consequently, if the nutrient density

Table 3 Increase in nutrient intake with increasing energy intake.

Nutrient		Nutrient intake adjusted to mean energy intake*	Mean increase in nutrient intake per MJ increase in energy intake	10th percentile†	90th percentile†
Sodium	mg	2246	310	263	357
Potassium	mg	2122	307	264	345
Calcium	mg	824	128	97	162
Phosphorus	mg	975	152	124	179
Magnesium	mg	203	32	28	36
Iron	mg	6.7	1.2	1.1	1.3
Zinc	mg	7.1	1.2	1.0	1.4
Selenium	μg	25	3.8	3.2	4.4
Vitamin A	RE	1157	279	267	294
Vitamin D	μg	3.9	0.8	0.7	0.9
Vitamin E	mg	4.6	0.9	0.8	1.0
Thiamin	mg	0.95	0.13	0.10	0.17
Riboflavin	mg	1.4	0.22	0.18	0.26
Niacin	NE	19	3.0	2.8	3.4
Vitamin B_6	mg	1.2	0.20	0.18	0.22
Folate	μg	168	35	30	41
Vitamin B_{12}	μg	6.3	1.3	1.2	1.4
Vitamin C	mg	61	9	7	11
Protein	g	51	8.3	7.1	9.4
Dietary fibre	g	9.7	1.7	1.4	2.0

*Mean energy intake of three assessments (6.14 MJ).
†Refers to increase in nutrient intake per MJ increase in energy intake.

cannot be improved, patients with poor appetite who eat small amounts might need supplements of micronutrients. The low energy intake was not a result of a poor food supply, but rather of poor appetite. Personal preferences could affect food intake at an individual level but, with a varied menu, this should not give a total low mean intake. Three residents with dementia, who were dependent in all aspects except eating, could not manage to sit in their wheelchairs all day, and were brought to bed early. It was difficult to serve them in bed, which reduced their total food intake.

The results of the mixed model analysis show that there are differences in how nutrient intake is affected by changes in energy intake, both among nutrients and among individuals. The reason for the large increase in folate and vitamin B_{12} intake with increased energy intake could be related to the intake of liver dishes, which could also explain the increase in vitamin A. Otherwise, it seems logical that the highest increases with increasing energy intake are observed for the fat-soluble vitamins because they are mostly present in energy-dense fatty foods, even though this contradicts the observation that there was no correlation between energy intake and percent energy from fat in the diet. This finding could be explained by those residents with a better appetite eating more of all types of foods served, including fruits and vegetables, whereas those with poor appetite ate more dessert, cakes etc. This interpretation is supported by the fact that there was a correlation of ≥0.70 between intake of energy and intake of nutrients such as zinc, magnesium and folate, whereas the correlation between energy and sugar intake was only 0.24. It is encouraging that the smallest increase was seen for sodium intake, considering the attempts to lower sodium intake in the population. However, the difficulties with respect to analysing sodium intake correctly make these results uncertain.

Dietary fibre intake is low in the general Swedish population (National Food Administration 2002). The nursing home residents in the present study also had a very low fibre intake of 1.6 g MJ^{-1}. In Sundbyberg, where the study was completed, local recommendations regarding quality of the food served in nursing-home care had been passed, stating that a fibre intake of 10 g per 1000 kcal (2.4 g MJ^{-1}) would be realistic if the food volume was not to become too large (Kangas *et al.*, 2002). Interestingly, the relative fibre intake of the elderly in the study by Berner *et al.* (2002) was even lower than in the present study.

One of the limitations of the present study is that it investigates a single nursing home with typically Swedish food. However, in the study by Berner *et al.* (2002), the differences between studies from different countries were rather small. The main limitation when discussing nutrient density for ill elderly people is the lack of scientifically-based recommendations specified for this group.

One conclusion from the present study is that nutrient density is an important issue when planning diets for frail elderly and this should be emphasised in the recommendations regarding the energy-dense diets used in hospitals and nursing homes. Encouraging results were found in a study where hospital food was enriched with various fats to create an energy-dense diet. At the same time, the meals were changed to consist of several small dishes with varying contents, texture and flavour (appetiser, soup, main dish and dessert). This resulted in a significantly higher intake of energy and protein, and also improved the intake of several micronutrients, as well as dietary fibre (Lorefält *et al.*, 2005). This could be a solution to the problem of nutrient density versus energy density, instead of only adding fats and using micronutrient supplements to cover the needs of vitamins and minerals. Unfortunately, the need for more kitchen resources could inhibit a desirable change in this direction.

Further studies are important with respect to developing dietary methods that can provide both the energy and the nutrients needed by institutionalised elderly people. The specific needs of multimorbid and disabled elderly should be targeted because recommendations are often extrapolated from studies in younger populations.

Conflict of interest, source of funding and authorship

The authors declare that they have no conflicts of interest. The study was financed within the regular budget of Research Unit for the Elderly, NW. This research unit is now closed down and has been integrated with the Department of Geriatric Medicine, Jakobsbergs Hospital.
GA, together with EL, was responsible for the conception and design of the study. EL conducted the collection of data in the nursing-home residents (analysis of food intake and nutritional intake). She also wrote the core of the manuscript. GA performed clinical examination of all participants. He was also involved in the preparation of the manuscript, especially the Discussion and data interpretation. AT performed the statistical analysis including the mixed linear model, and she wrote the statistical parts of the manuscript. All authors critically reviewed the manuscript and approved the final version submitted for publication.

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