J Nutr Health Aging
Volume 19, Number 3, 2015

DIETARY INTAKE OF ENERGY, NUTRIENTS AND WATER IN ELDERLY PEOPLE LIVING AT HOME OR IN NURSING HOME

S. ENGELHEART[1], G. AKNER[2]

1. Municipality of Örebro, Health and Social Care and Örebro University, School of Health and Medical Sciences, Sweden; 2. Professor in Geriatric Medicine, physician, Örebro University, School of Health and Medical Sciences, Örebro, Sweden. Corresponding author: Stina Engelheart, PhD-student, dietitian, Municipality of Örebro, Health and Social Care and Örebro University, School of Health and Medical Sciences, 701 82 Örebro, Sweden, Telephone +46-76-551 47 56, e-mail: stina.engelheart@oru.se

Abstract: *Objectives:* There is a lack of detailed information on dietary intake in elderly people at an individual level, which is crucial for improvement of nutritional support. The aim of this study was to investigate the dietary intake in elderly people in two types of living situations. *Design:* Observational study, analysing prospective data. *Setting:* The dietary intake was studied in elderly people living at home or in nursing home, in different cities of Sweden. *Participants:* A total of 264 elderly people (mean age 84) participated in the observational study. *Measurements:* Dietary intake was measured using weighed food records and food diaries, comparing females and males. The observed dietary intake was related to Recommended intake and Lower intake level. *Results:* All dietary intake and patient characteristic variables showed large individual differences (ranges). We found no significant differences (p>0.05) between those living at home and nursing home residents regarding the average intake of energy, protein and water when expressed as total intake per kg of body weight. A very low daily intake of energy (<20 kcal/kg body weight/day) was observed in 16% of the participants. For vitamin D and iron, 19% and 15%, respectively, had intakes below the Lower intake level. There was no correlation between intake of energy, protein or water and resident characteristics such as age, autonomy, morbidity, nutritional state or cognition. *Conclusions:* The large individual differences (ranges) in energy, nutrients and water show that the use of mean values when analysing dietary intake data from elderly people is misleading. From a clinical perspective it is more important to consider the individual intake of energy, nutrients and water. Ageism is intrinsic in the realm of 'averageology'.

Key words: Energy intake, dietary intake, water intake, aging, homes for the aged, nursing homes.

Introduction

The ongoing demographic changes resulting in a rapid increase of elderly people constitute big challenges for most countries (1). During the last twenty years, more of the older people in need of health care and social care in Sweden stay and receive care in their own homes instead of moving to a nursing home. Thus, a large number of frail, multimorbid elderly people with high risk of malnutrition now reside in their home (2, 3).

The intake of energy, nutrients and water has frequently been reported to be below recommended levels in elderly people, both those living at home (self managing) and those in nursing homes (4-8). However, even though the energy intake is low, the intake of most vitamins and minerals have been reported to be sufficient, expressed as nutrient density (6). The observed low intake of energy and nutrients has been described as anorexia of aging (9), but it is unclear if this represents an effect of normal ageing, or if it is a consequence of accumulation of diseases and/or injuries affecting regulation of appetite and hunger. In contrast, there are also reports of generally adequate intake of energy and nutrients in older people according to recommendations (10). Nowson et al (11) compared dietary intake in relation to housing between Australian residents living in nursing homes and those living in low-level care facilities. They found a somewhat higher energy intake in the nursing home residents, but no difference in nutrient density for protein. The contrasting results may be explained by differences in inclusion criteria in various studies, for example definition of older people or the prevalence of frailty among the participants. An inadequate dietary intake in elderly people is often multifaceted (12), and may be due to multiple reasons such as problems in planning and preparing meals, lack of social stimulation, reduced appetite, eating difficulties, olfactory and gustatory reasons, dysphagia or symptoms such as nausea or constipation. These potential reasons may be related to different diseases and/or injuries, psychosocial problems and adverse drug reactions, and require a thorough evaluation.

The aim of the present study was to investigate the intake of energy, nutrients and water in elderly people, and to compare the intake among those living in nursing homes with those living at home, and also to compare females and males. Another aim was to graphically illustrate (visualize) the individual dietary intake and compare it with the Recommended intake as well as with Lower intake level, defined by Nordic Nutrition Recommendations, NNR (13).

Materials and methods

The study was an observational study of five cohorts, totalling 264 elderly people: 136 living at home and 128 living in nursing homes. Data collection of the cohorts was made in four different Swedish municipalities between 2000 and 2010, and the selection methods are described in Table 1. All participants were considered to be clinically stable, as none had

Received December 20, 2013
Accepted for publication March 11, 2014

acute illnesses at the time of measurements.

Assessment of health status

Activities of daily living (ADL) were measured using the Katz Index (14), which is frequently used to determine the degree of autonomy, and has been shown to predict mortality (15). In the personal Katz, index ADL is categorised as: A: independent; B–G: dependent in one or more of the following activities: bathing, dressing, toilet, transfer, continence and feeding.

Morbidity was indicated by the number of continuous prescription drugs, using data from the participants' medical records.

Cognitive function was assessed using the Mini Mental State Examination, MMSE (16), with scores between 0-30, with 30 being the maximum score (full cognitive capacity). The MMSE was conducted in 141 of the included 264 elderly people, excluding those for whom examination was considered unnecessary due to seemingly adequate cognition (n=118) or in those opposing participation (n=5).

Body mass index, BMI, was calculated by dividing the body weight (kg) by square height (m^2). Body weight was measured in the morning, when the patient was dressed in underwear, to the nearest 0.1 kg on a digital chair scale. Body height was measured to the nearest 0.5 centimetres in the standing position using a stadiometer. For ten residents who were unable to stand (even with support), height was approximated by adding the measurements of head-shoulder, shoulder-hip, hip-knee, and knee-heel (17). For five participants in cohorts 1, 2, 4 and 5, where body height could not be measured in a standing position, the last note during the last year in the medical journal was used.

Risk of malnutrition was screened using the Mini Nutritional Assessment, MNA (18), resulting in a score of 0-30, with 30 being the maximum score (no risk of malnutrition).

Muscle strength was assessed as handgrip strength using a Jamar hand dynamometer (Lafayette Instrument Company, USA), measuring the power (in kg) of the hand grip. The best score of three trials with each hand was chosen. In 22 participants the result of the measurement was 0 kg handgrip strength, which was considered unreasonably low, and was excluded. The zero hand grip strength was due to cognitive impairment or inability to perform the measurement.

A physiotherapist made the assessment of ADL and muscle strength, a medical doctor/geriatrician made the assessment of prescription drugs and MMSE, and a trained dietitian or nutritionist performed the rest of the described assessments.

Assessment of dietary intake

Table 1 shows the methods used to assess dietary intake in the five cohorts. The desirable method for assessing dietary intake is considered to be the weighed food record (19), used in cohort 3, but food diaries is shown to provide a good estimate of the food intake (20). This method requires a lot of support from the research team and was not possible for the other four cohorts.

Cohort 1: A food diary was kept for four consecutive days including either a Saturday or a Sunday, according to instructions by a dietitian, as previously described (21). To obtain accurate information, a trained dietitian/researcher completed the diary by questioning each participant in their home, within 3 days after completing the food diary.

Cohorts 2, 4 and 5: The same food diary as in cohort 1 was kept for three consecutive days, including either a Saturday or a Sunday. Due to the study conditions, it was not possible to record dietary intake for four days. The diaries were filled in by the home care or nursing home staff and completed (if necessary) by a trained dietitian/researcher along with the staff.

Cohort 3: A food record was kept for five consecutive weekdays (excluding weekends for practical reasons) using a weighed food record, carried out by the staff at the nursing home in collaboration with a nutritionist (4).

The dietary records of cohorts 1 and 3 were coded in MATs den flexible (Rudans Lättdata, Sweden) and for cohorts 2, 4

Table 1
Description of the five cohorts

Cohort number (year of data collection)	Housing form	n	Inclusion criteria	Method for evaluation of dietary intake
Cohort 1 (2002-5)	At home	92	Participants in an intervention study regarding nutritional status and physical activity (21). Recruited through the inclusion criteria of a) body mass index <20 kg/m^2 and/or reduction of body weight >5% the last year and b) reduced physical activity. All participants lived in a suburb of Stockholm, Sweden.	4-day food diary
Cohort 2 (2009-10)	At home	44	Residents living in service flats, with their own household, but in need of assistance in activities of daily living (ADL). 44 of 53 accepted participation, all living in a small town in the middle of Sweden.	3-day food diary
Cohort 3 (2000-01)	Nursing home	78	All residents living in a nursing home in a suburb of Stockholm, Sweden (4).	5-day weighed food record
Cohort 4 (2009-10)	Nursing home	22	Residents living in a nursing home in a small town in the middle of Sweden. 22 of 25 accepted participation.	3-day food diary
Cohort 5 (2010)	Nursing home	28	Residents living in a nursing home in a mid-sized city in the middle of Sweden. 28 of 38 accepted participation.	3-day food diary

Table 2

Characteristics of residents living at home and in nursing homes. A significant difference in men and women between (+) and within (*) the two types of housing is indicated

		Living at home (n=136) Men (n=52)	Living at home (n=136) Women (n=84)	range	Nursing home (n=128) Men (n=35)	Nursing home (n=128) Women (n=93)	range
		mean (SD) or median (q1-q3)	mean (SD) or median (q1-q3)		mean (SD) or median (q1-q3)	mean (SD) or median (q1-q3)	
Age[1]	years	82.4 (5.4)	83.4 (5.3)+	64-100	83.3 (7.0)*	86.5 (6.3)+	66-103
ADL[2] (md)	A-G#	A (A-B)+	A (A-B)+	A-G	E (C-F)+	D (B-F)+	A-G
Drugs[3]	number	6 (3)	7 (4)	0-17	5 (4)*	7 (3)	1-17
Body weight[4]	kg	69.1 (13.4)*	61.1 (15.7)	38.6-116.2	74.8 (14.5)*	59.3 (14.0) 3	5.0-116.0
BMI[5]	kg/m^2	23.2 (4.2)+	24.0 (5.3)	16.0-45.0	25.3 (4.4)+	23.9 (5.5)	15.0-42.0
MNA[6] (md)	0-30	23.5 (22.5-25.5)	23.5 (21.5-25.5)+	14.5-30.0	23.0 (20.0-23.5)	20.0 (17.0-22.5)+	9.0-27.5
Hand grip strength[7]	kg	26.7 (6.0)**	16.0 (5.0)	5-44	22.1 (8.1)**	12.4 (5.4)	1-40
MMSE[8] (md)	0-30	24.0 (16.5-26.0)+	25.5 (19.5-28.0)	10-30	17.5 (11.0-24.0)+	16.0 (11.5-21.0)	0-30

1. n=258; 2. Activity of daily living, n=247; 3. n=255; 4. n=255; 5. Body mass index, n=253; 6. Mini Nutritional Assessment, n=223; 7. n=229; 8. Mini Mental State Examination, n=141; # A=independent; B–G=dependent in one or more of the following activities: bathing, dressing, toilet, transfer, continence and feeding. P-values: * p<0.05, ** p<0.001

and 5, the dietary records were coded in Dietist XP (Kost- och näringsdata AB, Sweden). The latest versions of PC Kost software (Swedish National Food Agency) were used in all calculations. The change in the coding system was due to lack of support and upgrades of the system used in cohort 1 and 3. The use of two coding software systems is not expected to affect the results, since they both used the same energy and nutrient database at the Swedish National Food Agency. When calculating energy and nutrient intake, the use of prescription drugs, oral nutritional supplementation and herbal remedies was not included. To calculate the intake of energy, nutrients and water, the mean of all 3-5 analysed days for each person was used to represent that person's dietary intake, and this was used to calculate mean, standard deviation (SD) and ranges for the whole group.

To graphically illustrate the dietary intake, the results of the combined five cohorts, were displayed in relation to a Recommended intake and Lower intake level (horizontal line in figure 1-8) for energy, each nutrient and water. For energy intake, the upper line indicates 30 kcal/kg body weight (BW)/day (estimated total metabolic rate) and the lower line indicates 20 kcal/kg BW/day (estimated basal metabolic rate, BMR). For protein intake, the two lines are defined by the NNR (13), stating that people with a low energy intake (<1600 kcal/day) need a protein intake of at least 1.0 g/kg BW/day (upper line) with the lowest requirement (without supplements of amino acids) about 0.6 g/kg BW/day (22) (lower line). The corresponding limits for water intake were estimated as an average requirement of 30 ml/kg BW/day (upper line) and Lower intake level of 20 ml/kg BW/day (lower line), both defined according to clinical experience. For vitamins (ascorbic acid and vitamin D) and minerals (calcium and iron) the upper line corresponds to Recommended intake and the lower line to Lower intake level according to NNR (13).

Statistics

Data are presented in descriptive statistics, as mean and standard deviation or as median and 1st and 3rd quartile. The Student's t-test or chi^2 -test was used to identify statistical differences between type of housing and gender. Possible correlations between health status (Table 2) and dietary intake of energy, protein and water was analysed by bivariate linear regression in collaboration with a statistician. All statistics calculation was made in the IBM SPSS Statistics 20 (IBM, 2011).

All participants were informed about the study procedures and gave written informed consent for participation. In participants with cognitive impairment, the relatives were informed and gave informed consent. The research ethics committee at Karolinska Institutet, Sweden approved the study.

Results

The characteristics of the participants are shown in Table 2, separated according to type of housing and gender. All variables showed large range as individual differences. The participants were old (mean age 84, range 64-103 years), had 5-7 continuous prescription drugs, were at risk of malnutrition (median MNA score <23.5) and had cognitive impairments (median MMSE 16-25). Females in nursing homes were significantly older than women living at home. As expected, both men and women in nursing homes had a significantly higher level of dependence, indicated by ADL scores. The number of continuous drugs, body weight and hand grip strength, showed large individual differences (ranges), but no significant differences between the means. A total of 27 people had an MNA score <17 (indicating malnutrition): six living at home (5 women, 1 man) and 21 nursing home residents (18 women, 3 men).

Table 3 shows the mean results of the dietary intake analyses

Table 3

Intake of energy, nutrients and water presented as mean, standard deviation (SD) and range for residents living at home and in nursing homes, divided up by men and women. Data are supplemented with the Nordic Nutrition Recommendation, NNR (13) for people over age of 75. A significant difference in men and women between (+) and within (*) the two types of housing.

		Total daily intake									
		Living at home (n=136)				Nursing home (n=128)					
		Men (n=52)		Women (n=84)		Men (n=35)		Women (n=93)		NNR (>75 yrs)	
		mean (SD)	Range	mean (SD)	Range	mean (SD)	Range	mean (SD)	Range	Men	Women
Energy	kcal	1739 (377)**	1023-2649	1495 (356)	815-2371	1910 (432)**	959-2865	1538 (341)	589-2896		
	kcal/kg	26 (7)	16-46	26 (8)	14-48	27 (7)	10-45	27 (8)	8-55		
	MJ	7.3 (1.6)**	4.3-11.1	6.3 (1.5)	3.4-9.9	8.0 (1.8)**	4.0-12.0	6.5 (1.4)	2.5-12.3		
Protein	g	64 (16)*	34-107	56 (14)	28-104	63 (15)**	35-110	53 (12)	18-82		
	g/kg	1.0 (0.3)	0.5-1.9	1.0 (0.3)	0.5-1.8	0.9 (0.2)	0.4-1.3	0.9 (0.3)	0.2-1.6		
	E%	15 (2)	11-20	15 (2)	11-25	13 (2)	10-17	14 (2)	9-20	10-20 E%	
Fat	g	68 (17)*	39-102	60 (19)	27-118	77 (24)**	30-146	62 (19)	26-158		
	E%	35 (5)	23-51	35 (5)	19-53	36 (5)	27-45	36 (5)	23-49	25-35 E%	
Saturated fatty	g	31 (8)*	14-46	28 (9)	10-60	38 (12)*	14-70	32 (11)	12-87		
acids	E%	16 (3)	10-25	17 (3)	5-29	17 (3)	12-23	18 (3)	10-27	<10 E%	
Monounsaturated	g	23 (5)*	13-35	20 (7)	8-49	25 (8)**	10-49	20 (6)	8-47		
fatty acids	E%	12 (2)	8-19	12 (2)	6-19	12 (1)	9-15	11 (2)	7-15	10-15 E%	
Polyunsaturated	g	8 (3)*	4-20	7 (3)	3-21	8 (3)**	3-15	6 (2)	2-13		
fatty acids	E%	4 (1)	2-8	4 (1)	2-8	4 (1)	3-6	3 (1)	2-6	5-10 E%	
Cholesterol	mg	290 (99)*	125-538	235 (96)	82-567	309 (82)**	180-495	249 (86)	102-579		
Carbohydrates	g	206 (52)**	108-340	176 (43)	88-292	232 (49)**	125-332	188 (41)	69-283		
	E%	47 (5)	33-58	48 (6)	32-66	49 (5)*	38-60	49 (6)	37-65	50-60 E%	
Sucrose	g	45 (23)*	9-131	34 (15)	6-85	59 (22)*	11-117	48 (22)	8-126		
	E%	10 (4)	3-22	9 (3)	2-19	12 (4)	2-20	13 (5)	3-30	<10 E%	
Dietary fiber	g	15 (5)	7-27	14 (5)	5-30	14 (4)**	5-24	11 (4)	4-23	25-35	
Water	g	1692 (451)	1060-2997	1622 (491)	796-3409	1848 (396)**	1217-2729	1543 (362)	909-2717		
	g/kg	25 (7)	14-51	28 (10)	12-70	26 (5)	17-38	27 (7)	12-55		
Alcohol	g	5 (8)*	0-36	2 (5)	0-27	2 (4)*	0-13	1 (1)	0-7		
	E%	2 (3)*	0-18	1 (2)	0-10	1 (2)*	0-6	0 (1)	0-3		
Retinol eq.	µg	1181 (714)	295-3344	1021 (790)	274-5478	1147 (607)	401-3783	1144 (772)	289-4178	900	700
Vitamin D	µg	5.8 (4.6)*	1.7-31.7	4.1 (2.4)	1.3-12.7	4.3 (1.7)*	2.2-10.4	3.7 (1.4)	0.5-7.5	10	
Tocopherol	mg	6.7 (2.3)	3.2-13.9	6.0 (2.7)	2.6-17.9	6.5 (2.8)*	3.2-14.3	5.1 (2.1)	2.0-12.4	10	8
Ascorbic acid	mg	76 (34)	19-156	81 (43)	7-218	68 (41)	19-142	60 (33)	9-177	75	
Thiamine	mg	1.1 (0.4)	0.5-2.9	1.0 (0.3)	0.5-2.0	1.0 (0.3)*	0.5-1.9	0.9 (0.2)	0.3-1.4	1.2	1.0
Riboflavin	mg	1.5 (0.5)*	0.7-3.8	1.4 (0.4)	0.7-2.2	1.6 (0.4)	0.9-2.5	1.4 (0.3)	0.3-2.3	1.3	1.2
Niacin eq.	mg	25 (6)*	14-40	22 (6)	11-38	25 (6)**	12-45	20 (5)	8-28	15	13
Vitamin B6	mg	1.6 (0.6)	0.9-4.4	1.4 (0.5)	0.5-2.5	1.3 (0.3)*	0.9-2.1	1.2 (0.3)	0.5-2.1	1.6	1.2
Vitamin B12	µg	6.9 (5.0)*	2.0-23.2	5.3 (4.0)	1.7-25.4	6.5 (4.1)	2.8-23.9	6.7 (5.4)	1.2-25.3	2.0	
Folic acid	µg	191 (67)	117-546	177 (55)	72-324	192 (61)*	97-378	166 (58)	63-336	300	
Sodium	mg	2546 (609)*	1460-4352	2200 (713)	1021-4351	2845 (1675)*	1665-11837	2098 (502)	1059-3275	<2800	<2300
Potassium	mg	2739 (647)	1604-4444	2528 (606)	1286-3971	2728 (761)*	1264-4990	2309 (596)	647-3815	3500	3100
Calcium	mg	862 (312)	328-2031	798 (245)	278-1349	936 (318)	450-1714	883 (290)	190-1748	800	
Phosphorus	mg	1177 (329)*	698-2335	1057 (270)	514-1885	1172 (288)*	631-1961	1024 (271)	300-1893	600	
Magnesium	mg	267 (69)*	178-539	242 (63)	113-440	256 (62)**	140-414	214 (54)	75-365	350	280
Iron	mg	9 (3)*	5-20	8 (2)	3-13	8 (2)*	4-12	6 (2)	3-11	9	
Zinc	mg	9 (2)	4-14	8 (2)	3-14	9 (3)*	3-18	7 (2)	3-12	9	7
Selenium	µg	34 (13)*	12-85	28 (10)	9-63	30 (9)*	17-50	27 (8)	9-42	50	40

* p<0.05, ** p<0.001. Total numbers of participants is 264, but for parameters per kg BW, n=255.

for all five cohorts combined. The dietary intake of energy, nutrients and water were all normally distributed, however, with large individual differences. There were no significant differences between those living at home and nursing home residents regarding intake of energy, protein and water, when expressed as total intake per kg BW. There were some small, but significant, differences in intake of some vitamins and minerals between the two types of housing (indicated in Table 3).

For five vitamins and minerals (retinol equivalents, riboflavin, niacin equivalents, vitamin B12 and phosphorus), the mean intake for both men and women in both types of housing exceed the NNR (13), indicating a sufficient mean intake. The mean intake of vitamin D, tocopherol, folic acid, magnesium and selenium was below the Recommended intake in both men and women, indicating a risk or manifest deficiency.

The linear regression showed no correlations between the intake of energy, protein and water with any of the characteristics in Table 2. Similar results were previously reported (6, 23).

The ranges in Table 3 show large ranges in individual intake of energy, water and all nutrients in both types of housing. Some examples: The intake of vitamin D in men living at home varied more than 15 fold (2-31 µg/day). Similarly, the intake of ascorbic acid in women living at home varied more than 30 fold

(7-218 mg/day). The calcium intake in nursing home women varied 9 fold (190-1700 mg/day).

Figure 1
Box plot showing the median daily intake of energy (kcal/kg body weight), protein (g/kg body weight), water (ml/kg body weight), ascorbic acid (mg), vitamin D (μg), calcium (mg) and iron (mg). The horizontal line corresponds to 100 percent of Recommended intake, according to Nordic Nutrition Recommendations (13)

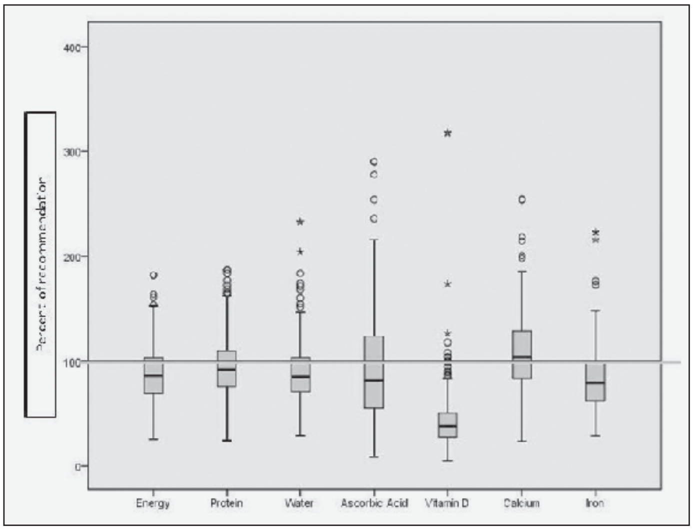
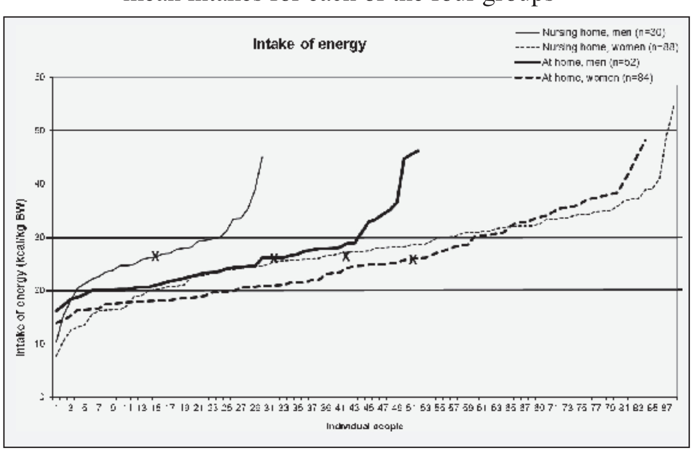
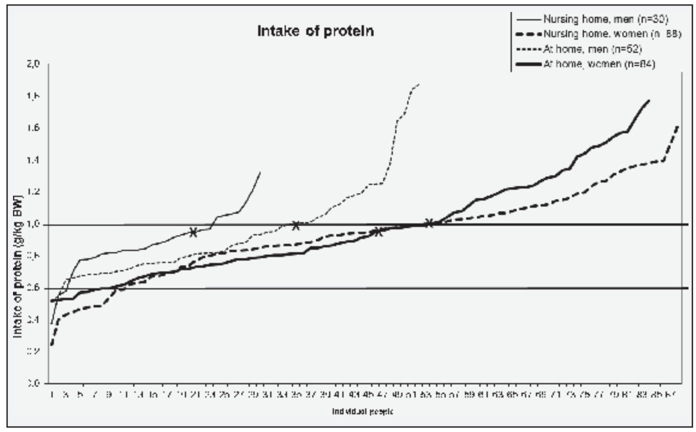


Figure 2
Intake of energy (kcal/kg body weight/day) in 255 individuals, separated for type of housing and gender. The upper horizontal line indicates an estimated average need of energy (of 30 kcal/kg body weight/day) and the lower line the estimated basal metabolic rate (of 20 kcal/kg body weight/day). X indicates the mean intakes for each of the four groups»



A total of ten people (4%) used oral nutritional supplements. Since the aim of the study was to study the dietary intake of energy, nutrients and water, they were not included in the analysis. The elderly people who received the supplements had a range of energy intake from 16 to 37 kcal/kg BW. Due to the few individuals and the large range in energy intake, we believe that these supplements did not affect the overall results.

Figure 3
Intake of protein (g/kg body weight/day) in 255 individuals, separated for type of housing and gender. The upper horizontal line indicates an estimated average need of protein (1,0 g/kg body weight/day) (13) and the lower line indicates the estimated Lower intake level of protein (0,6 g/kg body weight/day). X indicates the mean intakes for each of the four groups



The box plot in Figure 1, where the Recommended intake of energy and nutrients are standardized to 100 %, shows the large ranges in the dietary intake of all nutrients, with median intakes below, but close to, 100 percent of Recommended intake, except for calcium. For vitamin D the median intake was about 50 percent of Recommended intake. A small number of residents far exceeded the recommendation for most nutrients.

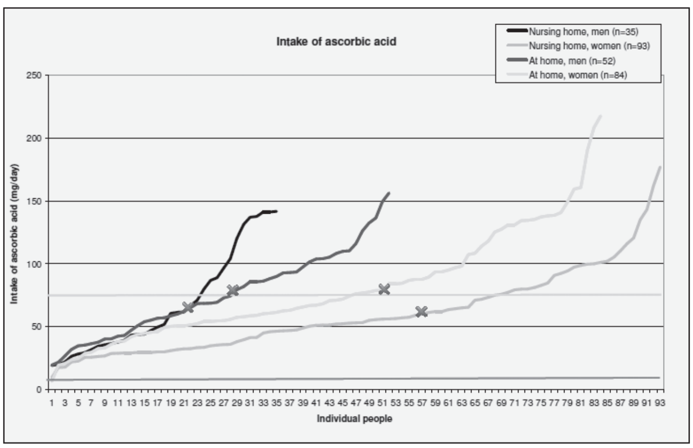
Figure 2-4 show the large individual differences in the body weight adjusted dietary intake of energy, protein and water, separated on types of housing and gender. The mean intake for each type of living and gender has been indicated by an x. A dietary intake of energy <20 kcal/kg BW/day was observed in 43 residents (16%) and an intake of protein below 0.6 g/kg BW/day was found in 16 residents (6%). Dietary intake of ascorbic acid, vitamin D, calcium and iron, where 1 (0.4%), 49 (19%), 8 (3%) and 39 (15%) residents, respectively, had an intake below the Lower intake level. Figure 2-4 as well as supplementary material regarding ascorbic acid (figure 5), vitamin D (figure 6), calcium (figure 7) and iron (figure 8) may be found on www.gunnar-akner.se, clinical nutrition.

Discussion

To our knowledge, this is the largest observational study of dietary intake in elderly people, using weighed food records or food diaries. The results show very large ranges (individual differences) for energy, all analysed nutrients and water as well as for all assessed resident characteristics, clearly showing that the use of mean values for this group of elderly people is misleading. It should be emphasized that the large heterogeneity for dietary intake of energy, protein and water remained after adjusting for body weight. Our results are in line with two previous studies of dietary intake in elderly nursing home patients using a 5-day weighed food record. Both studies showed a large heterogeneity with at least 2 or 3 fold variation in intake of energy, nutrients and water (4, 5).

Figure 4

Intake of water (ml/kg body weight/day) in 255 individuals, separated for type of housing and gender. The upper horizontal line indicates an estimated average need of water (30 ml/kg body weight/day) and the lower line an estimated Lower intake level of water (20 ml/kg body weight/day). X indicates the mean intakes for each of the four groups



No correlations dietary intake vs. resident characteristics

There was no correlation between on the one hand dietary intake of energy, protein or water and on the other hand resident characteristics such as age, autonomy (represented by ADL), morbidity (number of continuous prescription drugs), aspects of the nutritional state (body weight, BMI, MNA, hand grip strength) or cognition (MMSE). The observed lack of cross-sectional correlation between body weight and intake of energy, protein or water is in line with previous studies of elderly people (4, 6, 23, 24). Moreover, a lack of correlation has been found between energy intake and autonomy, number of eating episodes as well as subjective lack of appetite (25). However, in longitudinal studies, a decrease in body weight has been found to correlate with a decrease in energy intake (26). This underlines the importance in both research and clinical practice of studying each individual and monitoring change over time, rather than relying on group comparisons.

High dietary intake for some nutrients

Although we did not include oral prescription drugs, oral nutritional supplementation and herbal remedies, the upper dietary intake level was quite high for some nutrients, for example retinol equivalents (4178 μg), vitamin D (31.7 μg) and ascorbic acid (218 mg), where the intake largely exceeded the recommended dietary intake. This was due to some individuals eating specific foods containing high amounts of the vitamin or mineral, one or several times during recording of the dietary intake.

Correlations related to type of living

There were some statistically significant, but probably clinically irrelevant, differences in the mean dietary intake of a number of nutrients related to type of housing. From a clinical perspective, we emphasize the importance of considering the individual dietary intake of energy, nutrients and water.

In accordance with previous studies, we observed a significantly lower BMI in nursing home residents compared to those living at home (7). However, contrary to what could be expected, we observed no difference in energy intake between the two types of housing, even though, the nursing home residents had lower scores for indicators of low energy intake such as ADL, MNA (women) and MMSE (men), compared with those living at home. This may be related to the fact that residents in nursing homes were multimorbid with accompanying pathologies such as chronic inflammation, catabolism and changes in energy and nutrient utilization, and at the same time more staff available to support energy intake. The lack of difference could also be a result of underreporting, although we estimate that underreporting was similar in both nursing home residents and those living at home. Another possible reason may be that the offer to move into a nursing home for elderly people in Sweden in most cases are due to cognitive impairment and thus, many frail, multimorbid elderly remain in their normal home with home care and service.

Medical drugs

The observed intake of water may be skewed by use of drugs affecting water balance and the state of hydration, for example diuretics. Similarly, and as mentioned earlier, the medical drug treatment may have influenced body composition by affecting for instance appetite regulation and energy metabolism.

Mini Nutritional Assessment

According to the MNA manual, an MNA score <23.5 implies Risk for malnutrition and a score <17 implies Malnutrition. We observed a median MNA score of 23.5 (or below) for residents in both types of housing, indicating an average risk of malnutrition. In women living at home, the MNA score was significantly higher than in women in nursing homes, probably partly due to the fact that living in a nursing home yields an MNA-score of zero, thus decreasing the total score. However, this is probably not the only explanation, since there was no significant difference among men in the different types of housing. MNA is designed as a screening tool for assessment of risk of malnutrition, and not for diagnosis of a defined malnutrition state, which is a common misconception in both clinical practice and research. The lower the MNA score, the stronger the risk of developing malnutrition state, i.e. a stronger indication for a more complete clinical and nutritional examination.

We observed no cross-sectional correlation between the MNA score and the intake of energy, protein or water, possibly indicating that changes in energy and nutrient metabolism might be more important as an underlying cause of malnutrition than energy and nutrient intake in elderly people. This emphasizes the importance of not routinely treating low or decreasing body weight or BMI with increased intake of energy and/or nutrients, but calls for completing a thorough clinical work-up. The lack of cross sectional correlation between age and energy intake may serve as a possible argument against anorexia of aging.

For comparison, we related the observed dietary intake to intake of ascorbic acid, vitamin D, calcium and iron using categories set according to NNR (13). The Recommended intake was defined as the amount of a nutrient that according to present knowledge can meet the known requirement and maintain good nutritional state among practically all healthy individuals, and includes a margin of safety of two standard deviations or more, compared to an average requirement in a group of people (13). The Lower intake level was defined as a cut-off intake value below which an intake over time could lead to clinically important deficiency in most individuals (13). The Recommended intake is based on an estimated Average requirement, but it is unclear how Average requirement and Lower intake level relate to the biological requirement of a nutrient for an individual and how that biological requirement is distributed in the population. It is important to emphasize that the used dietary intake limits only apply to groups of people (also pointed out by the NNR), and therefore are unreliable at the individual level.

Thus, the concept Lower intake level indicates a probability on a group level for an intake of a specific nutrient to be adequate or not and thus the risk of deficiency of the specific nutrient. Presently, there is no method available to determine the biological requirement of a certain nutrient for a specific person. Therefore, data on dietary intake must be compared to other variables such as changes in body composition, energy metabolism, physical function, metabolic and endocrine regulation, biochemistry and how the variables change over time.

Recommended intake levels for energy, protein and water are usually related to body weight; however, micronutrients (vitamins and minerals) are recommended as total intake, regardless of body weight. The reason for this is seldom discussed, but it seems highly unlikely that a heavy weight person has the same biological requirement as a lightweight person, since the biologically active cell mass is probably quite different. This practice makes the comparison of dietary intake data and the individual requirement even more uncertain.

We conclude that the very large individual differences in intake of energy, nutrients and water show that the use of mean values when analysing elderly people is misleading. From a clinical perspective it is much more important to consider the individual intake of energy, nutrients and water, which should be evaluated repeatedly.

Limitations of the study

Our dietary intake data have some limitations. We collected data from five different cohorts of elderly residents during almost ten years. Dietary intake was registered using two different methods (weighed food record and food diaries) for different numbers of days (3-5 days) in the different groups. Also, two different software were used to calculate intake of energy, nutrients and water. Since the same research group performed all data collection and analyses, we believe that the results are as reliable and comparable as can be. We believe that the ten year time span for collecting dietary intake data is not a problem, since there were no changes in the national recommendations during this time. Moreover, there was no systematic change in social determinants of health during this time, such as transportation services or access to high quality foods. The mean dietary intake for only 3-5 days was estimated as the average intake for each person and we did not investigate neither the variability between the individuals or types of living for longer time periods.

The weaknesses of food diaries and food records are well known and problems of underreporting and misreporting are frequently discussed. Despite the method weaknesses, we believe that the results adequately represent the dietary intake in the studied cohorts. In cohort 1, 59 of the 92 participants were included by the criteria of body weight reduction by >5% during the last year. Theoretically this cohort could have had an intake of energy below their energy expenditure, explaining the weight loss. However, cohort 1 had a mean energy intake of 26 kcal/kg/d (SD 7), which corresponds very well with the energy intake of the whole group, indicating no impact on the overall results.

Acknowledgements: The authors wish to thank the four Swedish municipalities for their cooperation in data collection. We also a thank statistician Anders Magnuson at Clinical Epidemiology and Biostatistics unit, Örebro University Hospital, for support and advice on the statistical analyses.

Conflict of interests: SE and GA designed and conducted the study and wrote the paper. SE analysed the data; GA had primary responsibility for the final content. Both authors read and approved the final manuscript. There was no conflict of interest for any of the authors.

Ethical approval: This observational study complies with current laws of ethical considerations in Sweden.

References

1. Christensen K, Doblhammer G, Rau R, Vaupel JW. Ageing populations: the challenges ahead. Lancet 2009;374(9696):1196-1208.
2. Lennartsson C, Heimerson I. Elderly people's health: Health in Sweden: The National Public Health Report 2012. Chapter 5. Scand J Public Health 2012;40(9 Suppl):95.
3. Szebehely M, Trydegard GB. Home care for older people in Sweden: a universal model in transition. Health Soc Care Community 2012;20(3):300-309.
4. Lammes E, Akner G. Repeated assessment of energy and nutrient intake in 52 nursing home residents. J Nutr Health Aging 2006;10(3):222-230.
5. Akner G, Flöistrup H. Individual assessment of intake of energy, nutrients and water

in 54 elderly multidiseased nursing-home residents. J Nutr Health Aging 2003;7(1):1-12.
6. Andersson J, Gustafsson K, Fjellstrom C, Sidenvall B, Nydahl M. Five-day food intake in elderly female outpatients with Parkinson's disease, rheumatoid arthritis or stroke. J Nutr Health Aging 2004;8(5):414-421.
7. Leslie WS, Lean ME, Woodward M, Wallace FA, Hankey CR. Unidentified under-nutrition: dietary intake and anthropometric indices in a residential care home population. J Hum Nutr Diet 2006;19(5):343-347.
8. Iuliano S, Olden A, Woods J. Meeting the nutritional needs of elderly residents in aged-care: Are we doing enough? J Nutr Health Aging 2013;17(4).
9. Morley JE. Anorexia of aging: physiologic and pathologic. Am J Clin Nutr1997; 66(4):760-773.
10. Nydahl M, Andersson J, Sidenvall B, Gustafsson K, Fjellstrom C. Food and nutrient intake in a group of self-managing elderly Swedish women. J Nutr Health Aging 2003;7(2):67-74.
11. Nowson C, Sherwin A, McPhee J, Wark J, Flicker L. Energy, protein, calcium, vitamin D and fibre intakes from meals in residential care establishments in Australia. Asia Pac J Clin Nutr 2003;2(2):172-177.
12. de Boer A, Ter Horst GJ, Lorist MM. Physiological and psychosocial age-related changes associated with reduced food intake in older persons. Ageing Res Rev 2013;12(1):316-328.
13. Nordic Council of Ministers. Nordic Nutrition Recommendations 2004. Integrating nutrition and physical activity. 4th edition ed. Copenhagen: Nordic Council of Ministers.
14. Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of illness in the aged. the index of ADL: a standardized measure of biological and psychosocial function. JAMA 1963;185:914-919.
15. Worrall G, Chaulk P, Briffett E. Predicting outcomes of community-based continuing care. Four-year prospective study of functional assessment versus clinical judgment. Can Fam Physician 1996;42:2360-2367.
16. Folstein MF, Folstein SE, McHugh PR. «Mini-mental state». A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12(3):189-198.
17. Lammes E, Törner A, Akner G. Nutrient density and variation in nutrient intake with changing energy intake in multimorbid nursing home residents. J Hum Nutr Diet 2009;22(3):210-218.
18. Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: The Mini Nutritional Assessment as part of the geriatric evaluation. Nutr Rev 1996;54(1 Pt 2):S59-65.
19. Gibson RS. Principles of Nutritional Assessment. 1st ed. New York: Oxford University Preee, Inc, 1990.
20. Gariballa SE, Forster SJ. Dietary intake of older patients in hospital and at home: the validity of patient kept food diaries. J Nutr Health Aging 2008;12(2):102-106.
21. Lammes E, Rydwik E, Akner G. Effects of nutritional intervention and physical training on energy intake, resting metabolic rate and body composition in frail elderly. a randomised, controlled pilot study. J Nutr Health Aging 2012;16(2):162-167.
22. Millward DJ. Metabolic demands for amino acids and the human dietary requirement: Millward and Rivers revisited. J Nutr 1988;128(12 Suppl):2563S-2576S.
23. Chidester JC, Spangler AA. Fluid intake in the institutionalized elderly. J Am Diet Assoc 1997;97(1):23-8.
24. Ödlund Olin A, Armyr I, Soop M, Classon I, Cederholm T, Ljungren G. Energy-dense meals improve energy intake in elderly residents in a nursing home. Clin Nutr 2003;22(2):125-131.
25. Engelheart S, Lammes E, Akner G. Elderly peoples' meals. A comparative study between elderly living in a nursing home and frail, self-managing elderly. J Nutr Health Aging 2006;10(2):96-102.
26. Zhu K, Devine A, Suleska A, Tan CY, Toh CZ, Kerr D. Adequacy and change in nutrient and food intakes with aging in a seven-year cohort study in elderly women. J Nutr Health Aging 2010;14(9):723-729.