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INDIVIDUAL ASSESSMENT OF INTAKE OF ENERGY, NUTRIENTS AND WATER IN 54 ELDERLY MULTIDISEASED NURSING-HOME RESIDENTS

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Abstract: PURPOSE: Examination of the individual intake of energy, nutrients and water in clinically stable multidiseased nursing-home residents. METHODS: Comprehensive clinical assessment of 54 elderly nursing-home residents (80 ± 10 years, mean ± SD). The intake of food and beverages was measured by the weighed food intake method during five consecutive week days followed by computerized transformation to energy, 21 different nutrients, dietary fiber, alcohol and water. The resting energy expenditure was determined by indirect calorimetry. RESULTS: There was at least 2-3-fold, variation in intake of energy, nutrients and water, present also when expressed per kg body weight. For some micronutrients the relative intake variation was more than 8-fold. The results are compared with the present swedish recommended dietary allowences as well as with seven other studies of dietary intake in elderly using the weighed food intake method. The residents had on average 14.1 (range 6-31) different current clinical problems and were treated with a mean of 9.5 different drugs. The nursing staff spent 40 % of the total daytime working hours (7 am to 7 pm) on nutrition related issues. CONCLUSIONS: The nursing-home residents exhibited a large interindividual heterogeneity regarding intake of energy, nutrients and water. More emphasis should be given to individualized nutrition assessment in clinical geriatric care as a more solid base for nutrition treatment programmes integrated with the regular medical management and evaluation.

Key words: Weighed dietary analysis, nutrition, multidiseased, elderly, nursing-home, clinical analysis.

Introduction

Undernutrition states (malnutrition) are systemic conditions frequently found in elderly patients in home care, nursing-homes or in hospitals. The prevalence has been reported to vary between 30-65 % (1-4). The large variation depends on a number of factors, such as differences in diagnostic assessment criteria for undernutrition and differences in patient selection in different studies.

In spite of the known high prevalence of undernutrition in elderly patients, there has been little emphasis on both individual nutritional assessment and intervention in elderly multidiseased patients, even though deficient dietary intake is one of the principal mechanisms for the development of malnutrition states. To our knowledge, there are four published randomized controlled trials (RCTs) regarding the effect of treatment of established undernutrition states in multidiseased, elderly patients (5-8). There are also a number of RCTs where mixed elderly patient populations with and without undernutrition states (1, 9-10) and some controlled, but not randomized, trials of elderly malnourished patients (11-12).

We decided to conduct an inventory study of the individual intake of energy, nutrients and water in a large nursing-home located in Sundbyberg, a suburb of Stockholm, Sweden. The reason for the study was two-fold: i) to establish a baseline for our planned treatment studies of established malnutrition states in elderly multidiseased patients; ii) to compare the results with on the one hand the present swedish recommended dietary allowences (swedish nutrient recommendations, SNR) for this age group (13) and on the other previous dietary intake studies for elderly multidiseased patients. The individual weighed food inventory method was chosen since it is considered to be the most accurate and precise method for determining individual dietary intake (14-16).

Materials and methods

Fifty-eight residents living in five different wards at a nursing-home in Sundbyberg were invited to participate in the study. The residens had lived in the nursing-home on average 30.4 (range 1 - 275) months. One resident declined to participate. Three residents did not participate since their relatives declined the offer claiming that they felt that the residents would not benefit from the study.

Written informed consent was thus obtained from 54 subjects or their relatives (93 %), 35 women and 19 men. Their mean age was 79.9 years (range 51-96) and the median age 82.0 years. The collection of data of the residents was performed during two months in november and december 1998. Ethical approval was obtained from the ethical comittee of the Karolinska Hospital in Stockholm

The residents´ eating habits and nutrition states were analyzed as follows:

Food intake

Fifty-four residents were analysed by weighed food intake analysis during five consecutive week-days using a digital

precision scale (Philips HR 2385) with a resolution of one gram within the interval of 0-5 kg. All subjects were clinically stable and devoid of evidence of current infection or newly developed cardiovascular or cerebrovascular disease. A dietitian (HF) was present during lunch, dinner and in-between meal snacks in the afternoon for all residents and weighed and registered all food and drinks served including the left overs (if any) and recorded the actual intake of food and beverages for each resident. The ward staff weighed and registered the breakfast meal and the remaining in-between meal snacks including evening meals and left-overs. The weighing procedure was performed at a serving counter and was not readily visible to the residents.

The registered food intake was transformed to intake of energy, nutrients and water using the computer program StorMATS (Rudans Lättdata, Västerås, Sweden). This software uses the database produced by the Swedish National Food Administration, which contains ≈ 50 different nutrients. This database is the national standard nutrient database in Sweden.

For each resident, the total registrered food intake per day was transformed to intake of energy, nutrients and water. The mean of the registered intake during five consecutive week-days was calculated for each nutrient and taken as the average intake of a particular nutrient for that individual. These data on the individual level was then used when calculating the mean intake of each nutrient for all 54 residents. Due to the clinical condition of the residents, it was not possible to obtain 24 hour urine urea samples as a marker for protein intake.

Eating

The residents were analysed during meals regarding eating position, length of meal and need of assistance during meals. All residents/relatives and staff members were asked to fill in a similar 10 item questionnaire regarding their opinion of the food and meals at the nursing-home.

Body

The body analysis included the following:

a. Physical examination: All residents had their medical/social history taken and physical examination performed by a geriatrician (GA). All available medical records were analysed and a "current clinical problem list", i.e. a summary of all current clinical problems, was established for each resident.

b. Anthropometry: Body weight was measured by a digital chair scale (Umedico BWB-620). For most residents, body length was measured in the standing or lying position using a stadiometer. For 10 residents, however, it was not possible to measure body length by this technique due to e.g. contractures of muscles and joints in the extremities. In these cases the body length was determined by a measuring tape where the distance between head-hip, hip-knee and knee-foot respectively was measured separately and added. All body length measurements were performed by the same investigator (HF). The body mass index (BMI) was calculated by dividing the body weight (kg) by the body length2 (m).

We were not able to determine weight changes, since not all residents had previous weight records and existing body weight determinations were not standardized.

c. Energy metabolism: Resting energy expenditure (REE) was measured by indirect

calorimetry using a MBM-200 Deltatrac II metabolcomputer (Datex, Engström) calibrated by the alcohol burning test kit according to instructions by the manufacturer. Calibration was validated before each measurement by infusion of a test gas of known composition provided by the manufacturer. REE was measured during 15-20 minutes in the morning in the recumbent position in the resident´s own bed after an overnight fast using a rigid, transparent ventilated hood. The examination was terminated when stable values of oxygen consumption and carbon dioxide production had been obtained for at least five minutes.

Results

Clinical characterization

The residents´ "current clinical problems" were defined as organ-, system- or functional problems that implied diagnostic or treatment considerations which influenced management and/or affected the activities of daily living of the residents. Thus, in case of e.g. a stroke, several clinical problems related to the stroke such as paralysis, dysphasia, hemianopsia, dysphagia and chronic neuropatic pain were defined as different "current clinical problems". Calculated in this way, the residents had an average of 14.1 current clinical problems (range 6-31, SD 4.7). Table 1 shows a summary of the current clinical problems for all 54 individuals included in the study occuring at the organ/system-level together with a specification of all current clinical problems occuring in ≥ 5 residents. A larger number of less frequently occuring problems were also detetcted, e.g. Parkinson´s disease, chronic schizophrenia, manic depressive disorder, Turner´s syndrome, post-herpetic neuralgia, asbestosis, tracheomalacia, pulmonary fibrosis, retroperitoneal fibrosis, rheumatoid arthritis, meningeoma, dyslipidemias and previous alcoholism (without evidence of ongoing alcohol abuse in any of the residents). An example of a "current clinical problem list" for one of the analyzed residents is presented in table 2.

The various diseases and clinical problems indicated in table 1 were treated with an average of 9.5 drugs (range 0-28, SD 5.7), of which 6.5 drugs/resident were standing drug prescriptions and the remaining prescriptions taken only when needed.

The distribution of body mass index (BMI) is shown in figure 1 where the results have been sorted from low to high. The BMI varied three-fold and ranged between 12.8 – 34.0 kg/m2 with a mean of 21.7, SD 5,3. The median was 22,2.

Twenty-two individuals (40 %) had a BMI < 20 kg/m2 and 11 (20 %) BMI < 17 kg/m2.

Table 1

Summary of "current clinical problems" at the organ-, system or functional level for all 54 individuals included in the study. Under each organ/system/function heading all current clinical problems occuring in more than ≥ 5 residents are specified. BMI = body mass index.

Type of current clinical problems	Number of patients	% av all patients
Neuropsychiatric disorders	**49**	**91 %**
Dementia, all types	39	
Depression	26	
Post stroke condition	15	
Epilepsy	6	
Cardio-vascular system	**36**	**67 %**
Chronic heart failure	15	
Hypertension	12	
Post myocardial infarction	10	
Atrial fibrillation	8	
Pacemaker	5	
Hypotension	5	
Respiratory system	**10**	**19 %**
Chronic obstructive lung disease	8	
Gastrointestinal system	**43**	**80 %**
Chronic constipation	35	
Liver disease	6	
Urogenital system	**47**	**87 %**
Urinary incontinence	36	
Recurring lower urinary tract infection	5	
Endocrine/metabolic system	**44**	**81 %**
Vitamin B12 deficiency	20	
Folic acid deficiency	17	
Thyroid diseases	11	
Diabetes mellitus	10	
Hyperuricemia	8	
Hematological system	**13**	**24 %**
Anemia	12	
Gait disturbance	**43**	**80 %**
Musculo-skeletal system	**30**	**56 %**
Contractures of large joints	14	
Post-fractures of femural neck	10	
Osteoporosis	7	
Post vertebral fractures	7	
Dermatological system	**13**	**24 %**
Itchy skin	6	
Decubital wounds (feet or sacrum)	5	
Pain	**32**	**59 %**
Back/thorax	13	
Legs	13	
Visual impairment	**21**	**39 %**
Hearing imparment	**18**	**33 %**
Previous malignancies (without sign of recurrence or metastasis)	**7**	**13 %**
Nutrition	**41**	**76 %**
Protein-energy malnutrition	18	
Reduced appetite	12	
Dysphagia	10	
Obesity (BMI > 30)	5	

Table 2

Example of a "current clinical problem list" in one of the analyzed residents.

76 year old woman with 16 "current clinical problems":

1. Demented behaviour including aggressiveness and paranoid delusions. Assessed as "atypical dementia".
2. Stroke with left hemiparesis.
3. Pain in the left part of the body
4. Dizziness
5. Polyneuropathy
6. Glaucoma in both eyes, surgically treated. Impaired vision.
7. Walking disturbance, assessed as being caused by a combination of stroke, dizziness, impared vision, pain and polyneuropathy.
8. Hypertension.
9. Constipation with recurring fecalomas
10. Chronic hepatitis B with probable statosis
11. Urinary incontinence
12. Dry, itching skin
13. Atoxic goiter, surgically treated, not T4-substituted
14. Vitamin B12-deficiency, periodically treated
15. Vitamin folate deficiency, periodically treated
16. Severe protein-energy malnutrition with ongoing negative energy balance for several years.

Pharmacotherapy

Presently treated by 11 different drugs, 6 continuously and 5 intermittently.

75 year old man

1. Depression
2. Chronic cardiac failure
3. Atrial fibrillation
4. Diabetes mellitus
5. Chronic obstructive lung disease/emphysema. Treated with systemic corticosteroids for 9 years
6. Osteoporosis with multiple fractures of spine + ribs
7. Pain, widespread
8. Colonic cancer, surgically treated 5 years previously. No metastases known.
9. Inguinal hernia with chronic pain
10. Polyneuropathy in both lower legs
11. Cataract, surgically treated in both eyes
12. Weakness in left leg, assessed as sciatica
13. Walking disturbance

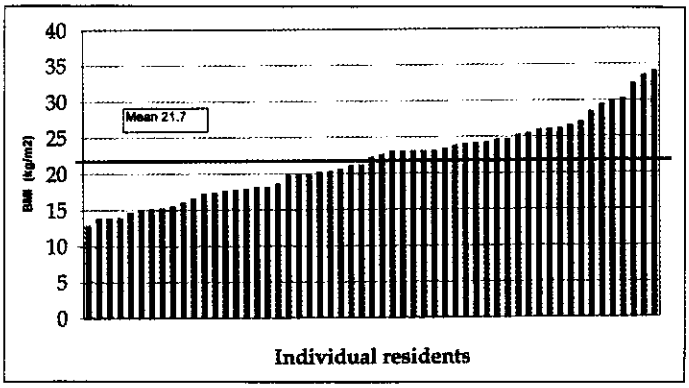
Nutrition

Assessed as adequate nutrition state. Slight ongoing inflammatory reaction.

Pharmacotherapy

Presently treated with 16 different drugs, 15 continuously and 1 intermittently

Figure 1
Distribution of Body Mass Index (BMI) for all 54 residents sorted from low to high? Bold line indicates mean BMI



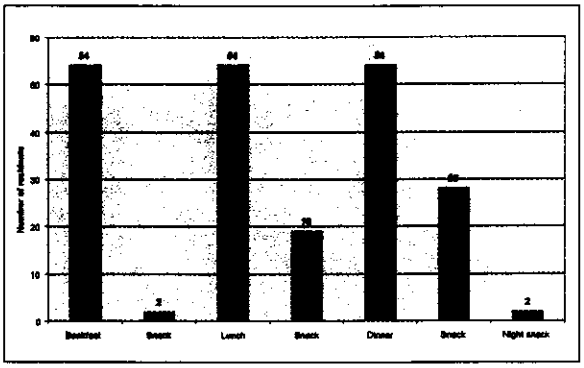
Management of food and nutrient supplementation

The nursing-home kitchen produced a five week rolling menu decided by the kitchen manager and largly consisting of plain food. The residents and their relatives had an opportunity to influence the choice of food by regular meetings with the kitchen staff. The nurse in charge at each ward decided together with the residents (if possible) and the nursing staff which type of food should be given to the individual residents (modified consistency, specific contents etc.) including whether energy-rich drinks should be given. Various vitamin- and mineral supplements were prescribed by doctors or sometimes purchased over the counter by the relatives. Otherwise, no physician or geriatrician was involved in the nutrition management of the residents, neither for analysis, prescription of food or evaluation of the nutrition states over time.

Food intake

The residents were served three main courses and 2(-3) in-between meal snacks per day. Figure 2 shows the number of residents that ate the different meals. All subjects participated daily in all three main courses whereas less than 50 % had in-between meal snacks. The night fasting period varied between 12 - 15 hours and was partly dependent on different local routines at the five different wards.

Figure 2
Number of residents who ate different meals

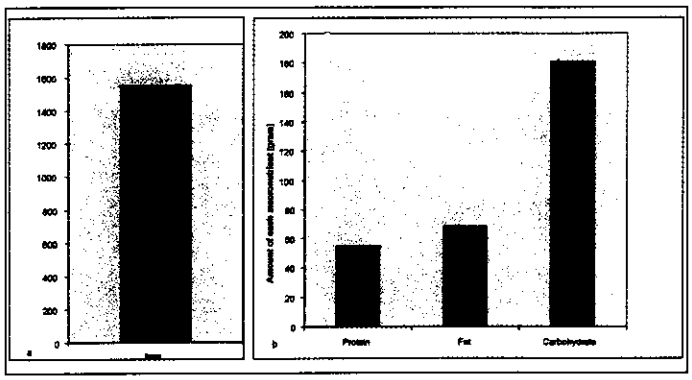


Forty-two percent of the residents ate a so called "normal diet". 47 % consumed a diet with modified consistency and 18 % had some kind of specific diet content; energy rich diet, diabetes diet, elimination diet (no fish) or want diet. Four residents ate food with both modified consistency and specific content. One resident had complete enteral nutrition through a percutaneous endoscopic gastrostomy (PEG) because of dysphagia due to multiple sclerosis.

Seventy-five percent of the residents were given dietary supplements of various types, both energy-rich drinks and vitamin/mineral tablets, alone or in combination. Altogether 19 different vitamin/mineral/trace-element preparations were used.

Twenty-one residents (38 %) were served energy-rich drinks (one glass per day = 200 ml) as meal drinks prepared at the nursing-home kitchen from milk, cream and ice cream with added fruit and containing 94 kcal/100 ml, 3 g protein/100 ml (13 energy %), 5.4 g fat/100 ml (52 E%) and 8.3 g carbohydrate/100 ml (35 E%). Only one resident received a commersially available dietary supplement. The amount of energy, protein, fat and carbohydrate derived from these energy drinks is shown in figure 3. The drink provided on average 17 % (range 2 - 34 %) of the total energy intake in these 21 residents.

Figure 3
a. Amount of energy (kcal) derived from energy-rich drinks (dark) in relation to total energy intake for 21 residents
b. Amount of protein, fat and carbohydrate (gram) derived from energy-rich drinks (dark) in relation to total intake for 21 residents



All but five residents (91 %) had their three main courses in the dining room. 67 % of the residents were not able to sit in a chair without support, however, no subject was lying in bed during meals. 27 residents (49 %) needed assistance during meals and 11 residents were fed by the staff with an average feeding time of about 20 minutes. However, for 10 residents, the feeding time was > 30 minutes per meal.

It was estimated that the nursing-home staff spent at least five hours per 12 hour daytime work (7 am to 7 pm) on nutrition related issues, e.g. preparation, serving, cooking, cleaning and washing for the 5-6 meals and snacks served

every day of the week (preparation of the lunch and dinner meals not included). This corresponds to ≈ 40 % of the total daytime working hours.

Intake of energy, nutrients and water

In table 3 (see in appendix), the shaded area shows the average intake of energy, protein, fat, carbohydrate, dietary fiber, alcohol, 10 vitamins, 8 minerals and water for the 19 males and 35 females separately as well as for all 54 participants together in the present study. The 10 and 6 residents that were prescribed vitamin B12- and folate supplementation, respectively, were excluded when calculating the mean intake of these two vitamins. For the other vitamins and minerals the intake levels represent the total intake from food and supplements.

For comparison, table 3 also contains results from seven other weighed food intake studies in elderly from six different countries as well as the present swedish nutrient recommendations (SNR) for healthy elderly >75 years of age (13), see also Discussion.

Since there are very few published reports of nutrient intake in multidiseased, elderly, nursing-home residents using a 5-day weighed food registration analysis we also show the distribution of the individual 5-day mean total and relative (intake per kg body weight) nutrient intakes for energy, protein, fat, carbohydrate and water in addition to the group mean data in table 3 (fig. 4-9). Regarding micronutrients, we show the individual 5-day mean total and relative intakes of some nutrients that were substantially lower or higher than SNR (fig. 10-13). The group mean intake level is indicated in all figures.

Energy (figures 4, 5 a+b): Figure 4 shows the ratio between the total energy intake (TEI) and the resting energy expenditure (REE). The residents ranged 1.0 – 2.4 with an average of 1.5. 12 residents (22 %) had a TEI/REE-ratio < 1.3 implying a risk of negative energy balance (17). The mean energy intake was 1640 kcal/day or 29.1 kcal/kg body weight/day with a large variation between the individuals; 3-fold when expressed as total intake and 2-fold as body weight related intake. 64 % of the residents ate less than 30 kcal/kg/day.

Figure 4

The ratio between the total energy intake (TEI) and the resting energy expenditure (REE) for all residents sorted from low to high. Bold line indicates mean ration

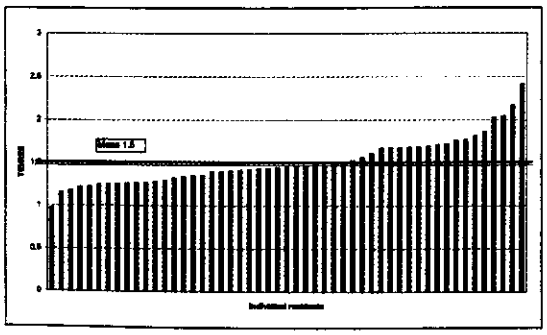


Figure legends

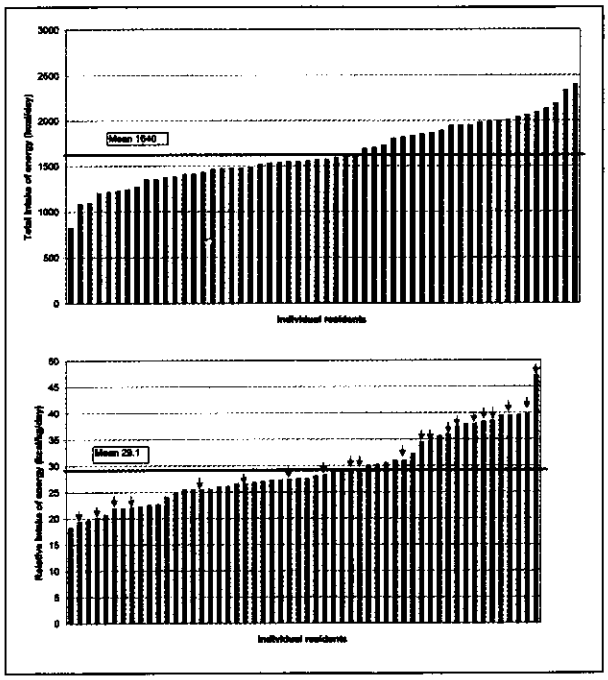
Figures 5-9

Left column (figs 5a-9a): Total daily intake of energy, protein, fat/saturated fat, carbohydrate/sucrose and water for all residents sorted from low to high. Bold lines indicate mean total intake for the respective nutrient for the whole group.

Right column (figs 5b-9b): Relative daily intake (per kg body weight) of energy, protein, fat/saturated fat, carbohydrate/sucrose and water for all residents sorted from low to high. Bold lines indicate mean relative intake for the respective nutrient for the whole group. the residents who were given energy-rich drinks are indicated by arrows in figure 5b.

Both columns: In figure 7 and 8, the intake of saturated fat and sucrose, respectively, are indicated by dark bars.

Figure 5a+b



The individuals that were taking energy rich drinks (see above) are indicated by arrows in figure 5b. It can be seen that most of the residents having a relative energy intake > 30 kcal/kg/day were given such drinks.

Protein (figure 6a+b): The mean protein intake was 58 g/day or 1.0 g/kg/day corresponding to 14 % of the energy intake (E%) from protein with a 2-3 fold variation between the individuals for both total and relative protein intake. Twenty-two percent ate less than 0.8 g protein/kg/day, implying a risk of negative nitrogen balance (17).

Fat (figure 7a+b): The mean total fat intake was 68 g/day or 1.2 g/kg/day. The variation between the residents were 3-fold both for total and relative intake. The fat intake provided 37 E%, which is higher than SNR, partly since 38 % of the residents were given energy rich drinks (see above). The mean intake of saturated fat is also shown and was on average 43 % of the total fat intake.

Figure 6a+b

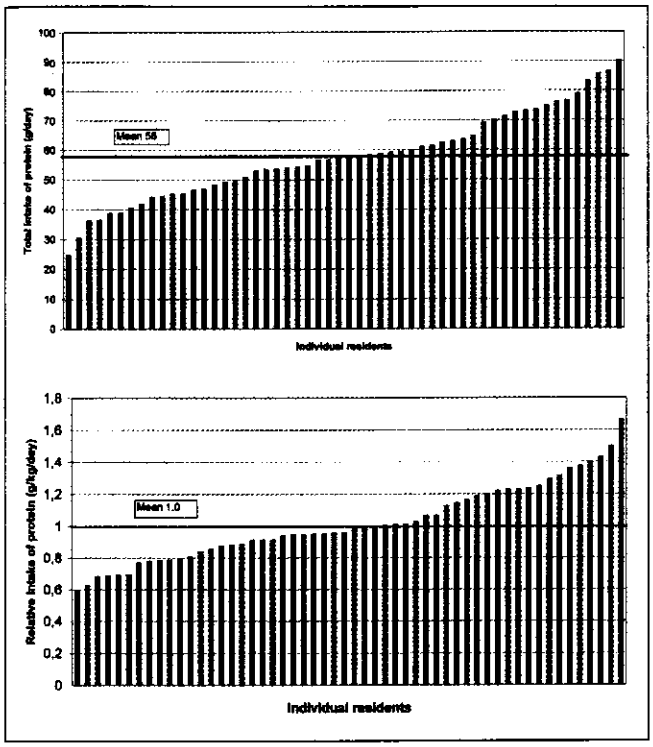
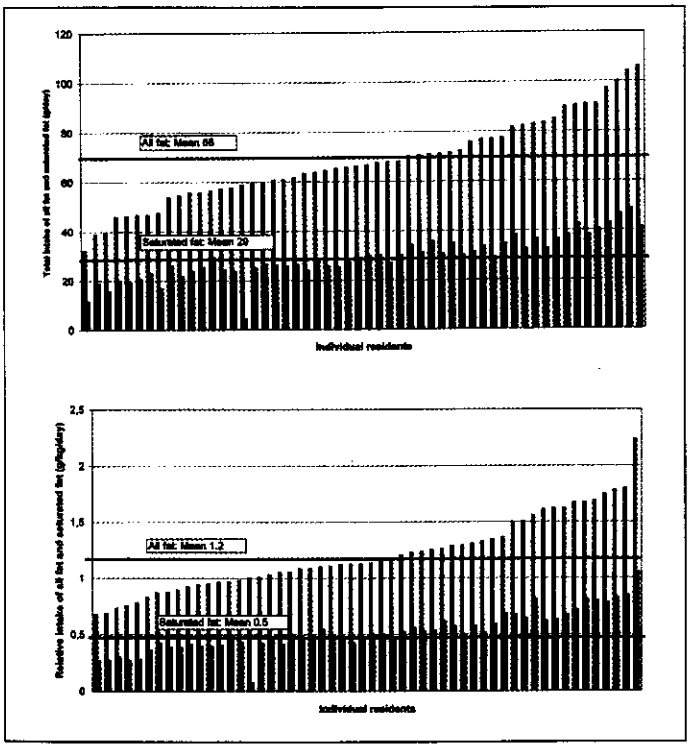


Figure 7a+b



Carbohydrates (figure 8a+b): The mean total carbohydrate intake was 197 g/day or 3.5 g/kg/day with a 2-3 fold variation between the individuals. The mean intake of sucrose is also shown and was on average 22 % of the total carbohydrate intake.

Water (figure 9a+b): The mean water intake was 1586 ml/day or 28 ml/kg/day. A 2-3-fold variation was found for total and relative fluid intake. 71 % of the residents drank less than 30 ml/kg/day. 41 % residents had a relative water intake < 25 ml/kg/day which implies increased risk of dehydration, especially under stressful conditions such as diuretic treatment or febrile illness.

Figure 8a+b

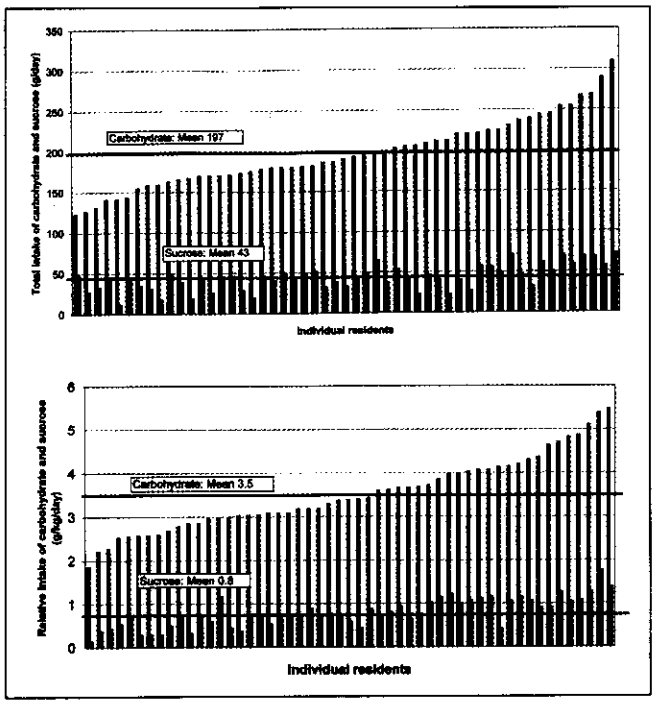


Figure 9a+b

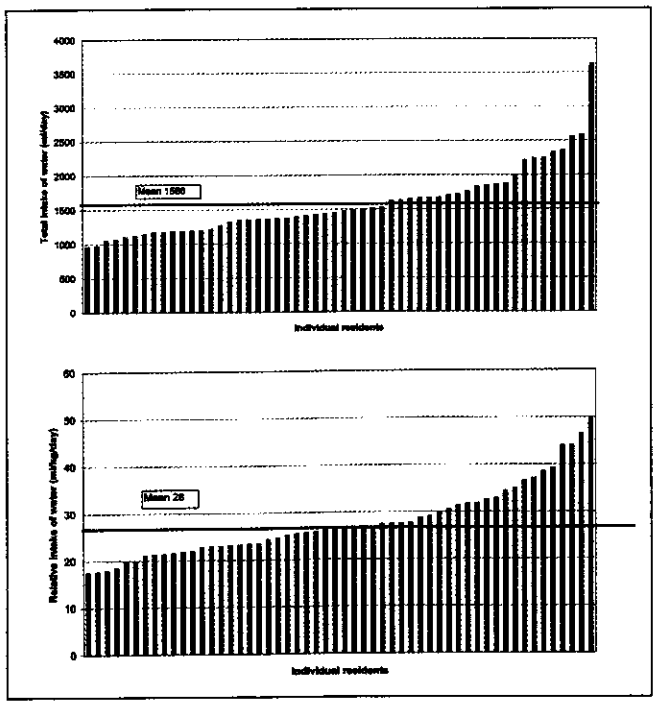


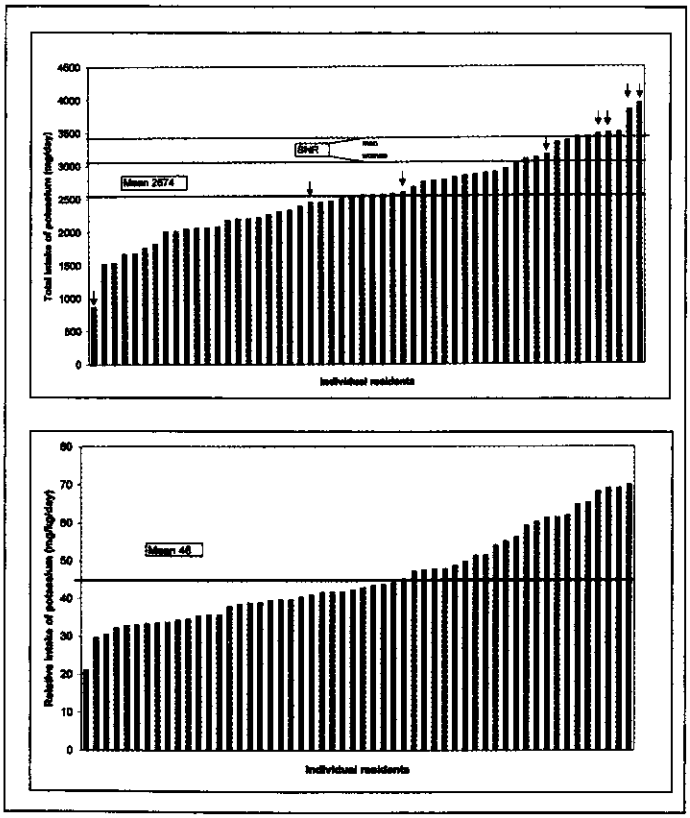
Figure legends

Figure 10-13

Left column (figs 10a-13a): Total daily intake of potassium, vitamin D, vitamin A and vitamin C for all residents sorted from low to high. Bold lines indicate mean total intake for the rsspective nutrient for the whole group. Thin lines indicate the swedish nutrient recommendations (SNR) for the respective nutrient. The residents who were taking potassium-, vitamin D-, vitamin A- or vitamin C-supplements are indicated by filled arrows in figure 10a-13a, respectively. The open arrows in figure 12a corresponds to the residents taking energy-rich drinks.

Right column (figs 10b-13b): Relative daily intake (per kg body weight) of potassium, vitamin D, vitamin A and vitamin C for all residents sorted from low to high. Bold lines indicate mean relative intake for the respective nutrient for whole group.

Figure 10a+b



Micronutrients (fig. 10-13): The residents at the nursing-home had a lower average intake of potassium (fig. 10), vitamin D (fig 11), magnesium and selenium compared to the SNR. Eight of the 54 residents were taking potassium supplements, five of which were among the 10 residents with the highest potassium intakes. Two of the four residents with a vitamin D intake > 10 µg/day (indicated by arrows in fig. 11a) were taking vitamin D supplements. In contrast, the mean intake of vitamin A (fig. 12) and vitamin C (fig. 13) was substantially higher than recommended in the SNR. Of the 16 residents with vitamin A intake of > 2000 _g retinol equivalents (RE) per day, only four were taking vitamin A containing energy rich drinks or vitamin A supplementation (indicated by open and filled arrows in figure 12, respectively). There was a large variation for both total and relative intakes of micronutrients. For the vitamins A, C and D, the relative intake varied at least 8 times between the residents.

Figure 11a+b

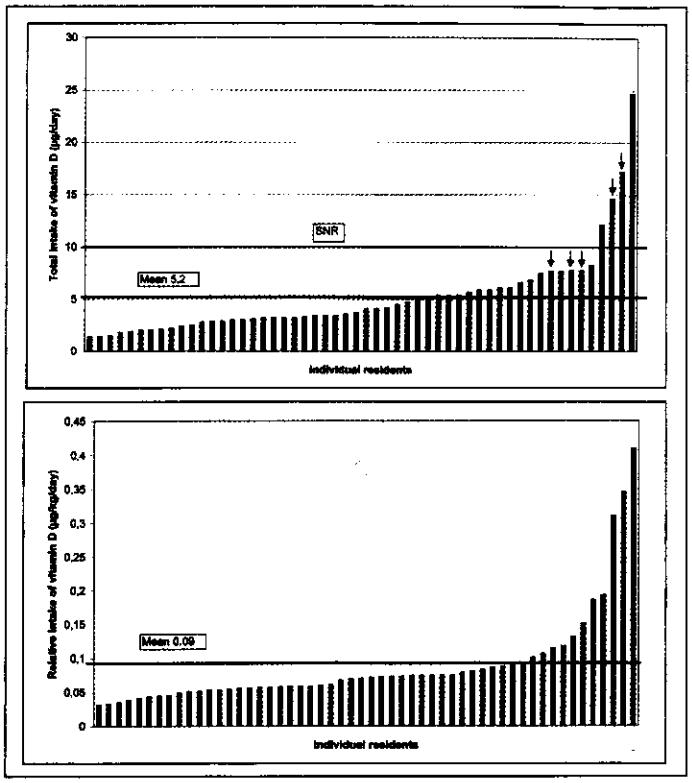


Figure 12a

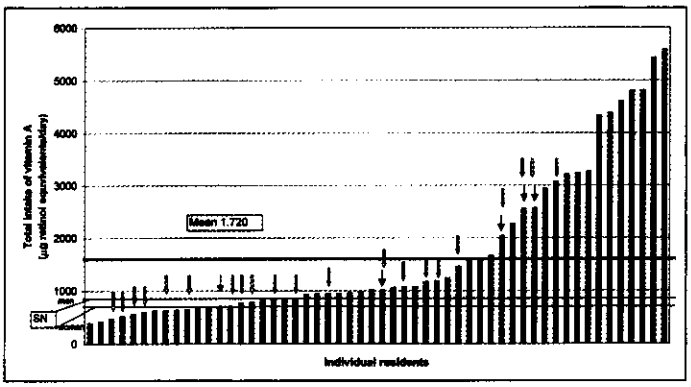


Figure 12b

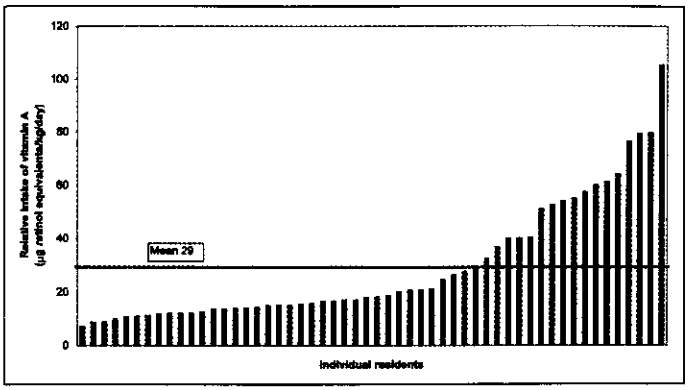
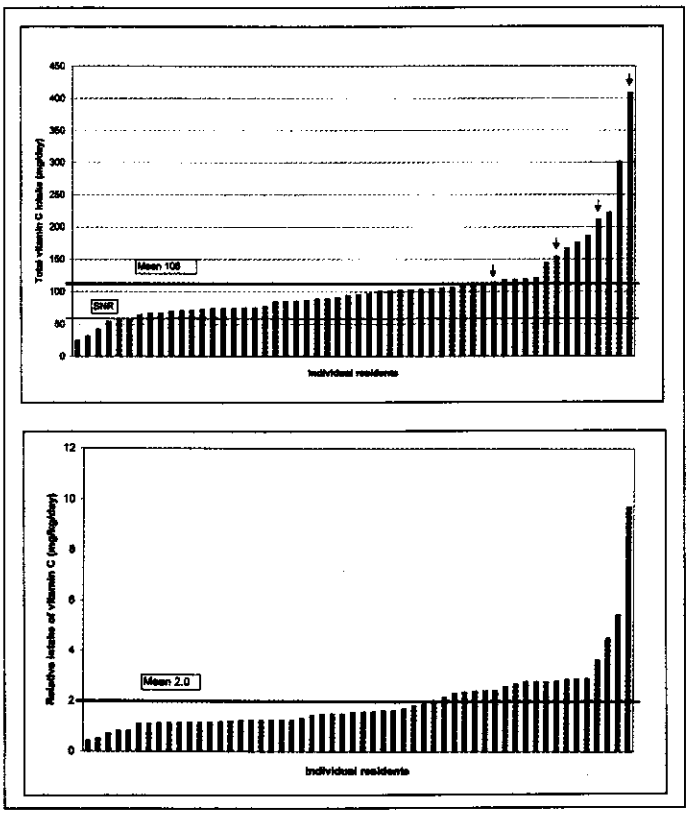


Figure 13a+b



Questionnaire

17 residents (31 %) were able to answer the questionnaire along with 27 staff members (one nurse and 26 nursing assistants). Because of the low response rate, we do no not show the results in detail. The responding residents were mostly satisfied with ordering and delivery, type, taste, quality and amount of food. The answers from the staff were usually in accordance with those of the residents. The staff had a somewhat more positive view regarding ordering and delivery of food than the residents. The opposite was true regarding food choices, portion sizes and attitudes to food service in the nursing-home.

Discussion

In this report we present the results of a 5-day weighed food intake analysis with subsequent transformation to mean intake of energy, macro- and micro-nutrients, dietary fiber, alcohol and water for 54 elderly, multidiseased nursing-home residents. The method of prospective weighing and recording of food intake was chosen since it is considered to be the method of choice to determine the food- and nutrient intake in humans (14-16). The dietary intake analysis used in this study could be considered a so called "precise individual weighing technique" (18).

The optimal length of time that food intake should be measured to determine habitual food intake is unknown. A 3-day period is frequently judged to be too short for adequate measurements of long-term intake of micronutrients and most macronutrients (19-21). It has been claimed that 7-day weighed food intake may underestimate energy intake in older women (22). It is, however, assumed that elderly people in general have a more stable food-pattern (smaller day-to-day variation) than younger adults (23).

In the present study we used a period of five week days excluding holidays. Since all subjects were residents at the nursing-home and ate all their meals there according to a rolling menue, it seems unlikely that our omitting food-registration on holidays would have affected the results significantly.

We have searched the Medline database as well as the Dietary Assessment Calibration/Validation Register (24) and to our knowledge this is the first study of energy and nutrient intake in multidiseased elderly nursing-home residents using a 5-day weighed food analysis. The elderly residents studied here had stable food habits and were eating essentially all their meals at the nursing-home where all food was produced from the same kitchen according to a 5-week recurring meal plan. The fact that a dietitian weighed and recorded all eaten food during the meals out of sight for the residents essentially eliminated the potential problem that the weighing and recording procedure would have had a restrictive effect on the food intake.

Taken together, we believe that the presented 5-day food intake analysis probably represents a quite accurate determination of the individual habitual intake of energy, nutrients and water in these multidiseased elderly residents.

The mean intake of energy, dietary fiber, vitamin D, potassium, magnesium and selenium was found to be lower than the present swedish nutrient recommendations, SNR, for individuals > 75 years old (13). The clinical significance of this finding is unclear. First, the recommendations are constructed such that the recommended mean intake level is 2 SD above the estimated minimal requirement for each nutrient. Thus, if an individual is found to have a mean intake below the SNR for one or more nutrients this may still imply that the intake is well above the minimal requirement. Second, most dietary

assessment methods tend to result in an underestimation of energy intake (22, 25), so the actual energy intake in our residents may have been higher. Third, recommendations of nutrient intake such as the Recommended Dietary Allowences, RDA (26) or the SNR, (13) are aimed at healthy elderly > 51 years (RDA) or > 75 (SNR) years. There are currently no nutrient recommendations for diseased elderly subjects, particularly not for multidiseased elderly in nursing-homes. The mean intake of the remaining nutrients were at or above the level of SNR.

The energy-rich drinks provided on average 17 % of the total energy intake in the 21 residents that were given such drinks. It was not possible to analyze the effects of the energy supplement for any of the residents up until the study, neither as effect on e.g. body composition, function, quality of life or mortality. In no case was the energy supplement part of a structured nutrition programme integrated with other parts of patient management.

Weighed food intake analysis in elderly has been used in evaluation of nutrition state (27-33); as a standard for relative validation of various other dietary intake analysis techniques such as food frequency analysis (28, 30, 31) and diet history (23) as well as in correlation studies regarding biomarkers (22, 25). However, the two latter studies reported only energy intake.

In table 3 we have summarized the results of seven previously published studies using weighed food intake analysis in elderly from six different countries. Two of these studies (both from Sweden) examined multidiseased elderly nursing-home patients (32, 33). In one of these studies (32) only the main diagnoses of the patients were briefly summarized and the number of current clinical problems per patient was not defined. In the other study (33) no clinical characterization of the patients was reported. The mean intake of most nutrients in these two studies was substantially lower than in our study, which may be due to e.g. differences in patient populations or in the used methods of collecting or analyzing food intake data (22). Another possibility is that the difference represents an actual increase in average intake in elderly nursing-home residents between the late 1980s to 1998 due to e.g. increased resident- and staff awareness of the risk of developing malnutrition states.

In the remaining five studies (27-31) the patients were 55 - 89 years and were recruited from groups of relatively healthy out-patients (hypertension, eye-diseases) or were invited healthy volunteers. The patients in these studies were thus much healthier than our nursing-home residents and they exhibited a higher mean intake of many, but not all, nutrients, problably due, in part, to differences in physical activity level. In one of these studies a number of diagnoses that were common in our study were explicitly excluded from participation in the studie (27).

It should also be noted that only in this and the two other cited studies from elderly nursing-home patients (32, 33) was the weighing of food intake performed objectively by a nutritionist. In all other studies, the weighing was carried out by the individual subjects themselves. This difference in "subjective" or "objective" weighing may have a large impact regarding the accuracy in determining the individual dietary intake and may explain some of the differences in the cited studies.

It is evident from the cited literature and from the present study reported here that elderly nursing-home residents constitute a very heterogeneous population with substantial variations in e.g. age, health-, mental- and nutrition status, physical activity level as well as activities of daily living. This demonstrates a need for better individual characterization of the clinical states of the studied patients, since not only the "main diagnoses", but also a number of other diagnoses or related clinical problems as well as pharmacological treatment, may influenze the intake of energy, nutrients and water. In this study the presented aggregated current clinical problem list (table 1) represents an extensive characterization of the vast clinical complexity that resides behind the term "multidiseased" nursing-home patients. It seems important, however, to encourage future research to develop standardized methods of producing a cumulative quantitation of the degree of the total clinical disease/problem-load in the studied patients.

This study also illustrates that the intake levels of energy and all measured nutrients varied considerably between the residents. Even when expressed per kg body weight, the variation was at least 2-3 fold for most nutrients and for some micronutrients > 8 fold. This interindividual heterogeneity regarding both the current clinical situation and dietary intake needs to be emphasized and implies difficulties regarding development of standardized quality demands to elderly residents at various levels of function and institutional care.

It should also be stressed that the highest age-group in the SNR is > 75 years and that SNR only serves as a guide for meal planning on a group basis to healthy elderly. There are no research-based recommendations regarding dietary allowences for diseased elderly.

Taken together, we conclude that there is a strong need of research on individual food/nutrient intake in the multidiseased elderly as an essential component of a nutrition analysis integrated with regular medical management programs. This in turn implies a need for the development of user-friendly, valid and reliable individual dietary analysis methods. The lack of such methods is probably one main reason why nutrition related issues are often overlooked in elderly patients, even in cases of obvious under- or overnutrition states.

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APPENDIX

Table 3

The average intake of energy, 21 nutrients, dietary fiber, alcohol and water in the present study (shaded area) compared with the corresponding results of seven previously published studies using the weighed food intake method in elderly. The present swedish nutrient recommendations (SNR) for healthy elderly > 75 years are also included. The results are shown for males (M), females (F) and the whole group (M+F) for each study. Multidis=multidiseased. Hypertens=hypertension, 4-d weigh=4-day weighed food intake study.

References	Present study			Sweden (32)	(33)	Denmark-90 (27)	Norway-92 (28)	Spain-95 (29)			Netherl.-98 (31)	Australia-88	SNR-97 (30)	(13)
Age (years)	80 (51–96)			84-85 (72-96)		70-75	71 (67-80)	72 (65-89)			55-75		65-85	> 75
Health status	Multidiseased			Multidiseas		Healthy	Healthy	Healthy			Hypertens.	Eye disease		
Type of study	5-d weigh			4-d weigh		3-d weigh	14-d weigh	5-d weigh			15-d weigh	4-d weigh		
Sex	M	F	M+F	F	M+F	M+F	F	M	F	M+F	M+F	M+F	M	F
Number	19	35	54	28	38	194	38	23	37	60	80	80		
Energy (kcal/d)	1882	1508	1640	1247	1468	2000	1864	1944	1538	1694	2036	1790	2240	1950
Protein (g/d)	68	52	58	50	61	68	71	83	71	75	86	77.5		
Protein (E%)	14	14	14				14.8	17	19	18			10 – 15	
Fat (g/d)	76	64	68	41		89	73	75	65	69	83	66		
Fat (E%)	36	38	37				35.7	34	38	36			≤ 30	
Carbohydrate (g/d)	226	181	197	162		216	224	236	173	197	218	214		
Carbohydrate (E%)	48	48	48				48.9	45	42	43			55 – 60	
Fiber (g/d)	13	10	11			20	19	21	20	20	16	23	25 – 35	
Alcohol (g/d)	8.2	5.5	6.7				7				11			
Alcohol (E%)	1.6	0.9	1.2				2.5							
Vit A (_g RE/d)	2421	1340	1720	1300	2700	1656	1424					496	900	800
Vit D (µg/d)	6.5	4.5	5.2	2.0	1.9		5.5	2.3	2.1	2.2			10	
Vit E (mg __TE/d)	7.4	7.1	7.2				9.5	8.6	9.0				8	
Thiamine (mg/d)	1.4	2.0	1.8	0.8	1.0		1.0	1.1	1.0	1.1	1.1	1.2	1.1	1.0
Riboflavine (mg/d)	2.2	2.7	2.6	1.4			1.5	1.5	1.4	1.5	1.5	1.8	1.3	1.2
Niacin (mg NE/d)	18.4	17.3	20.0				30.7	27.5	28.7				15	13
Pyridoxine (mg/d)	2.1	2.3	2.3		0.9		1.6	1.4	1.5		1.5		1.2	1.1
Vit B12 (µg/d)	14.2	7.8	9.7		6.1		12.9	6.9	9.3				2.0	
Folate (µg/d)	219	171	187				195	202	199				300	
Vit C (mg/d)	94	115	108	75	77	70	114	122	133	129	91	118	60	
Sodium (mg/d)	3123	2199	2524								2522		800 – 2000	
Potassium (mg/d)	2975	2355	2573								3550		3500	3100
Calcium (mg/d)	1063	821	906	952		1135	925	785	790	788	1022	721	800	
Phosphate (mg/d)	1255	986	1080								1677		600	
Magnesium (mg/d)	274	222	240				330	250	237	242	308		350	280
Iron (mg/d)	16.2	14.5	15.1	8.3			12	12.6	10.3	11.2	12	12	10	
Zinc (mg/d)	8.9	7.7	8.1					10.2	8.4	9.1	10.5	10	9	7
Selenium (mg/d)	33	27	29										50	40
Water (ml/d)	1752	1496	1586								2171			