The Nutritional Status of Finnish Home-living Elderly People and the Relationship between Energy Intake and Chronic Diseases

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Summary
The nutritional status and the impact of non-progressive chronic diseases on energy intake were determined in 90 home-living people aged from 73 to 94 years. The nutritional status was assessed by dietary, anthropometric, biochemical and haematological methods. Energy intake (6.0, SD 1.7 MJ) in women was low compared with the Nordic Nutrient Recommendation but in men it (8.0, SD 2.1 MJ) was in keeping with this recommendation. Despite the low energy intake the mean BMI value of women was moderately high (27, SD 5.3 kg/m²). In men the mean was 26, SD 4.0 kg/m². The intakes of vitamins and minerals met the recommendation, except for those of folic acid and zinc. The blood levels of both these two nutrients were within reference limits. Men suffering from chronic diseases received less (p < 0.015) energy (7.5, SD 1.76 MJ) than other men (8.9, SD 2.0 MJ). This relationship was not found in women. In conclusion, the nutritional status of people aged over 70 years old living at home was good. The presence of chronic diseases affected the energy intake in men but not in women.

Introduction
Much attention has been paid to identifying nutritional risk groups in the elderly population [1]. Elderly people are vulnerable to malnutrition and are the fastest growing group in Western societies; 13.5% of the population of Finland were ≥65 years old in 1990 and by 2030 this age group will comprise 23.9% of the population [2]. It is also reported that community-dwelling as well as hospitalized and institutionalized elderly people can be at high risk of malnutrition [3–5]. This is important as adequate nutrition helps elderly people to maintain their activities of daily living and thus preserve functional autonomy [6]. Sufficient energy intake is essential since low food intake is the major cause of nutrient deficiency in the elderly population [7, 8]. According to the American Dietetic Association, about 85% of older persons have one or more chronic, potentially debilitating diseases [9]. A common question in the field of nutrition is the extent to which poor nutrition may be contributing to the prevalence of chronic ailments [10]. On the other hand some researchers have questioned the degree to which undernutrition is a consequence of disease. Roubenoff and co-workers [11] reported that chronic inflammation in rheumatoid arthritis can lead to hypermetabolism and relative anorexia predisposing to loss of body cell mass. Mowe' and co-workers [12] considered that low serum album levels of recently hospitalized elderly patients were partly attributable to acute illnesses like stroke, pneumonia and heart attack.

Nutritional assessment of older adults, especially the very old, is difficult owing to the limited availability of reference standards for older populations. In addition, many of the physiological changes that accompany ageing result in biochemical values and clinical features that are indistinguishable from those observed in particular nutrient deficiencies. A comprehensive evaluation of nutritional status is based upon anthropometric, biochemical and haematological data, in addition to clinical and dietary information [13]. In previous studies nutritional status has been evaluated by comparing food intakes with the recommended dietary allowances [14–17]. In some studies anthropometric or biochemical and haematological measurements have been made [4, 18–20] but there are few reports where all four assessment components have been included in the study protocols [21, 22]. The aim of the present study was to assess the nutritional status of home-living elderly people by utilizing the versatile approach; to collect both dietary, anthropometric, biochemical and haematological data. In addition, we wanted to investigate whether there are any relationships between energy intake and chronic diseases.

Subjects and Methods
Subjects: The subjects were aged over 70 years and living at
home in the city of Kuopio in Eastern Finland. A questionnaire on health status, standard of dwelling, drug use and food consumption was sent to 539 persons in 1986 [23]. The arthritics were selected randomly from 5660 inhabitants in this area. The questionnaire was returned by 433 persons. From these respondents a random sample of 138 persons was drawn, 69 men and 69 women. Ninety-two persons (67%) agreed to participate in the study. The main reasons for non-participation were refusal (50%), death (13%) and relocation (37%). Two participants interrupted the study because of admission to hospital. The final number of participants was 90.

**General study design:** All participants were visited first at home by a nutritionist who collected questionnaire data on food consumption (by 24-hour recall), history of diagnosed diseases, use of prescribed and over-the-counter drugs, vitamin and mineral supplements and socio-economic variables. During a second interview at the research unit, data on food consumption were collected again by a 24-hour recall and anthropometric measurements and blood samples were obtained.

**Physical activity and chronic diseases:** Physical activity was defined in terms of ability to go outdoors (Table I). It was classified as poor or good according to the need of help. Need for walking aids or assistance in going out of doors led to physical activity being rated as poor. Ability to walk alone outdoors was rated as good physical activity. Chronic diseases of interest were those known to be common among elderly people and known to affect nutritional status either directly or indirectly [24]. Diseases that met these criteria were: chronic arthritis, chronic bronchitis, emphysema, coronary heart disease (angina pectoris, previous myocardial infarction), cardiac failure and cerebrovascular disease. Study participants who had any of these were categorized in the chronic disease group and those who did not have any of the diseases into the non-chronic disease group.

**Dietary assessment:** Food consumption was collected by the 2×24-hour recall, excluding Saturdays and Sundays. Food models were used to help subjects estimate the sizes of servings, but the participants could also report the portion sizes in grams, household measures or as a fraction of a known food portion. The volumes of cups, spoons, glasses and plates were measured during the home visit. The analyses of nutrients were made using the software program developed at the National Public Health Institute, Helsinki [25]. In these calculations the nutrient intake provided by the supplements is not taken into account. Mean intakes of nutrients were compared with the Nordic Nutrient Recommendations (NNR) for persons above the age of 75 years [26].

**Anthropometric measurements:** Standing height was measured to the nearest 0.1 cm. When a person had kyphosis height was not measured. Weight was measured to the nearest 0.1 kg in the morning after 12 hours fast with the subject clothed in light undergarments. Seca-scale (Vogel & Halke GmbH & Co, Germany) was used for the measurements. Weight and height values were missing for 12 women and six men. Body mass index (BMI) was calculated. The triceps skin-fold was measured at the midpoint of the posterior aspect of the right arm with the arm hanging loosely at the side. Arm muscle circumference (AMC) was calculated as arm circumference (cm) −0.314 triceps skin-fold (mm) [27].

It was defined as reduced for men and women when it was less than 23.0 cm and 18.9 cm respectively. These were the 5th percentile values in a study of 426 Finnish home-living elderly people [22].

**Biochemical and haematological measurements:** A fasting venous blood sample was obtained for biochemical and haematological analyses. The concentration of folate in erythrocytes was determined by the radio-labelled binding assay of folate using the Quantaphase II® Folate Radioassay method Bio-Rad Diagnostic Group (Hercules, CA., USA). The concentration of vitamin B12 in serum was determined by radio-labelled binding assay of B12 using the Quantaphase II® Radioassay method of Bio-Rad Diagnostic Group (Hercules, CA., USA). The concentration of ferritin in serum was determined as an immuno luminometric LIARmat® Ferritin assay of Byk-Santek Diagnostica GmbH (Dietzenbach, Germany). The concentration of albumin in serum was measured by a dye-binding method of brom-cresol purple with a Hitachi 717 Analyzer (Tokyo, Japan). Blood haemoglobin was measured as a part of the output of a Coulter STKS Analyzer (Coulter Instruments, Inc., Hieleah, FL, USA). The concentration of selenium in serum was determined with the graphite-furnace technique, the Zeeman background correction and coated graphite tubes with the platform inside (Zeeman 5000 atomic absorption spectrophotometer, HGA 500, Perkin-Elmer, Norwalk, CT) [28]. The concentration of zinc in serum was assayed by flame atomic absorption spectrometry.

**Ethical permission and consent procedure:** The study protocol was approved by the Ethics Committee at the University of Kuopio. Verbal consent was obtained from all subjects after a detailed explanation of the study protocol.

| Table I. Characteristics of the 73- to 94-year-old women and men living at home |
|---------------------------------|----------------|
| Mean age (SD) (n)               | 79 [5] (45) 78 [4] (45) |
| **Most common diseases (%)**    | cardiovascular system: 73 69 | skeletal system: 20 36 |
| **Most common prescription drugs (%) for treatment of** | pulmonary system: 16 18 | diabetes mellitus: 9 11 |
| **Daily use of vitamin and mineral supplements (%)** | no diseases: 11 7 |
| **Ability to go outdoors (%)** | alone: 76 67 | with walking aids: 11 24 |
| with personal help: 11 0 | with walking aids and personal help: 2 7 |
| not at all: 2 0 |
**Table II.** Anthropometric variables of the 74- to 94-year-old women and men living at home

<table>
<thead>
<tr>
<th>Variables</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>41</td>
<td>64.6 (11.9)</td>
</tr>
<tr>
<td>Height, cm</td>
<td>35</td>
<td>155 (4.4)</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>33</td>
<td>27.1 (5.3)</td>
</tr>
<tr>
<td>Triceps skin-folds, mm</td>
<td>45</td>
<td>22.0 (6.4)</td>
</tr>
<tr>
<td>MAC, cm</td>
<td>45</td>
<td>31.7 (4.6)</td>
</tr>
<tr>
<td>AMC, cm</td>
<td>45</td>
<td>24.8 (3.1)</td>
</tr>
</tbody>
</table>

The • 5th and † 95th percentiles for the healthy 75-year-old or older subjects from the study of Rajala [22].

MAC—mid-upper arm circumference. AMC—mid-upper arm muscle circumference.

**Statistical methods:** Statistical analysis of the data was carried out using SPSS-X programs [29]. Means and standard deviations (SD) were calculated for each variable for each sex. Analysis of variance (ANOVA) was used to detect the effect of chronic disease on energy intake in both sexes and to determine the differences between men and women in energy and nutrient intakes, blood nutrient levels and energy stores. Student’s t-test was used to test differences within sex. Statistical significance was set at p < 0.05.

**Results**

The characteristics of the subjects are summarized in Table I. The mean age of women was 79 years and of men 78 years. Five women and three men did not report any diagnosed diseases: the others had two diseases on average; the most common being diseases of the cardiovascular, skeletal and nervous systems. The physical capability was good in both sexes, since 76% of women and 67% of men were able to walk alone outdoors. Only one woman was house-bound (owing to vertigo). Dietary supplements were consumed daily by 44% of women and 29% of men. Multivitamin and mineral preparations were the most popular supplements (70%). They contained doses of 100% to 200% of the Nordic Nutrient Recommendation (NNR) and typically included zinc, folic acid, vitamins D and E. Nine per cent of subjects taking supplements consumed 100 mg or more daily of vitamin E.

Nine (27%) women and three (8%) men could be classified as obese (BMI above 30 kg/m²). None of the men and two (6%) of the women had BMI lower than 19 kg/m². Women more often had arm muscle circumferences above the 95th percentile reference value; 11 (24%) women and five (11%) men were above these values (Table II). None of the women but five (11%) men had arm muscle circumference values below the 5th percentile reference value.

The average energy intake for men was within recommended limits, but for women it was 0.5 MJ/day below the lower recommended limit (Table III). There were no differences between the sexes in the proportion of energy derived from protein, carbohydrates and fat. The proportion of energy derived from fat was high (37%) compared with the NNR, while that from carbohydrates was lower than recommended. Protein intakes were in accordance with the NNR. Mean intakes of dietary fibre differed significantly between the sexes (p = 0.02), but diets of both men and women met the recommended fibre density.

Mean intakes of vitamin E, thiamine, riboflavin, niacin, pyridoxine and calcium for men exceeded those for women p < 0.02 (Table III). The intakes of vitamins D and E, folic acid and zinc were below recommended levels in both sexes. The intakes of vitamin D were especially low in women; 52% of the NNR on average.

Haemoglobin (Hb) values varied between 96 and 175 g/l for men and between 123 and 162 g/l for women (Table IV). Using the WHO criteria; Hb < 130 g/l for men and < 120 g/l for women [30] 11% of the men were anaemic. One of the anaemic men was a vegetarian, one had no diagnosed diseases, but the rest had chronic
Table IV. Haematological and biochemical laboratory measurements of the 73- to 94-year-old women and men living at home

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Women Mean (SD)</th>
<th>Range</th>
<th>Normal values*</th>
<th>Men Mean (SD)</th>
<th>Range</th>
<th>Normal values*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood haemoglobin (g/1)</td>
<td>137 (9.5)</td>
<td>123-162</td>
<td>125-160</td>
<td>143 (13.4)</td>
<td>96-175</td>
<td>135-180</td>
</tr>
<tr>
<td>Serum vitamin B12 (pmol/l)</td>
<td>335 (141.5)</td>
<td>74-865</td>
<td>150-560</td>
<td>336 (117.7)</td>
<td>74-627</td>
<td>150-560</td>
</tr>
<tr>
<td>Erythrocyte folate (nmol/l)</td>
<td>524 (196.7)</td>
<td>262-1287</td>
<td>300-1550</td>
<td>471 (112.9)</td>
<td>306-761</td>
<td>300-1550</td>
</tr>
<tr>
<td>Serum ferritin (mg/l)</td>
<td>97 (55.0)</td>
<td>18-207</td>
<td>12-115</td>
<td>110 (80.8)</td>
<td>15-465</td>
<td>25-175</td>
</tr>
<tr>
<td>Serum transferrin (g/l)</td>
<td>2.89 (0.39)</td>
<td>2.25-3.76</td>
<td>1.55-3.55</td>
<td>2.76 (0.34)</td>
<td>1.92-3.38</td>
<td>1.55-3.55</td>
</tr>
<tr>
<td>Serum albumin (g/l)</td>
<td>41 (3.2)</td>
<td>31-49</td>
<td>39-50</td>
<td>42 (2.5)</td>
<td>36-47</td>
<td>41-53</td>
</tr>
<tr>
<td>Serum selenium (µg/l)</td>
<td>133 (15.1)</td>
<td>110-176</td>
<td>86-124†</td>
<td>130 (16.6)</td>
<td>82-160</td>
<td>86-124†</td>
</tr>
<tr>
<td>Serum zinc (µmol/l)</td>
<td>15 (1.8)</td>
<td>11-20</td>
<td>11-23†</td>
<td>15 (2.6)</td>
<td>11-24</td>
<td>11-23†</td>
</tr>
</tbody>
</table>

* Reference values of the University Hospital of Kuopio.
† Reference values based on the studies of Versieck [33] and Varo et al. [34].

In spite of the fact that the intake of folic acid was lower than recommended, only one woman had erythrocyte folate acid level below the cut-off value of 300 nmol/l. The mean levels of vitamin B12 met reference values, but two women (4%) and two men (4%) had values less than 111 pmol/l, which has been used to indicate high risk of vitamin B12 deficiency [31, 32]. However, three of these four persons had normal Hb concentrations and mean corpuscular volumes, while one woman, who had been examined for suspected coeliac disease, had also low erythrocyte folate acid level and increased mean corpuscular volume. Blood Hb, serum ferritin, serum vitamin B12 and erythrocyte folate did not differ significantly between the users and non-users of nutrient supplements (data not shown). Only one woman had a serum albumin value below 35 g/l. One man suffering from Parkinson’s disease and chronic bronchitis had a serum transferrin value less than 2.0 g. The average serum selenium levels were high. There were no differences in serum selenium concentrations between users and non-users of selenium supplements. The mean zinc levels were within the reference values.

Men with chronic diseases received significantly less energy (7.5, SD 1.76 MJ) than those who did not suffer from chronic diseases (8.9, SD 2.0 MJ) in the Figure (p = 0.015). This difference was not seen in women.

Discussion

Our results reveal that our sample of home-living people aged 70 or older had a good nutritional status as evaluated by anthropometric, laboratory, clinical and dietary means. These elderly people were physically active in spite of many chronic diseases. Blood zinc and folic acid levels met reference values, even though dietary intake was less than recommended in both sexes. Vitamin and mineral supplements were consumed daily by 44% of women and 29% of men.

The results of this study indicate that diseases may be associated with decreased food intake in the elderly population [35-37]. The mean energy intake was significantly lower among men suffering from chronic diseases than among men not suffering from such diseases. This phenomenon was not seen in women. We have not found other studies where the relationship between the energy intake and chronic diseases in elderly subjects has been investigated. In other studies interest has focused on acute diseases like pneumonia, myocardial infarction and stroke even though elderly people mainly have chronic ailments [12]. The decreased energy intake in the group of chronically ill men could be caused by two factors. Chronic pulmonary and chronic cardiac diseases are seen to limit physical activity and thus reduce energy requirement. In chronic inflammatory conditions such as rheumatoid arthritis, relative anorexia leads to a lower than appropriate food intake. Surprisingly, the energy intake did not differ in women with or without chronic diseases. A plausible explanation may be the overall low...
energy intake by women so that no differences between the groups could be observed. Also the sizes of the groups were different; twice as many women were included in the chronic diseases group as in the non-chronic diseases group.

Good nutritional status in this study may be explained by the good functional capabilities; 76% of women and 67% men could go alone outdoors. Nutritional well-being represented by the BMI has been reported to be related to functional capabilities. Galanos and co-workers [6] indicated that when the BMI was lower than 19.6 kg/m² or more than 29.3 kg/m² the relative risk for functional impairment increases. In this study the mean BMI was 26 kg/m² in men and 27 kg/m² in women.

The mean energy intake of 8.0 MJ for men and 6.0 MJ for women was low compared with subjects in other studies [16, 20, 22, 38, 39]. The average BMI values and arm muscle circumference values indicate that the energy intake was sufficient. Differences in energy intake between surveys may arise from different dietary assessment methods. All the studies cited above used the dietary history method, which gives approximately 20% higher intake estimates than the food record method [40, 41]. When the diet is assessed by a single 24-hour recall method energy intake appears slightly lower than when it is assessed by a 2 × 24-hour recall [42]. Also incorrect memory may cause differences in energy intake due to decreased reporting of food consumption. Nes and co-workers [4] omitted mentally impaired persons from their study. In the present study none of the subjects was excluded for that reason, but a spouse or a personal assistant checked the recall of a person suffering from dementia or impaired short-term memory.

Even though our respondents consumed less folate than the NNR, their erythrocyte folate levels were normal. A similar result emerged from a study of elderly people living in institutions [22]. Usually folic acid nutrition has been good in home-living elderly people [22, 43]. Jagerstad et al. [44] showed that many elderly people are capable of maintaining normal folate nutrition despite low intakes (100–200 μg/day) but age-associated changes in folate metabolism or absorption have not been demonstrated [32]. In terms of real need the Nordic folic acid recommendation for healthy elderly people may be unnecessarily high.

The dietary zinc intake was low, as in many studies reported in the literature [17], but serum zinc concentrations were normal. Metabolic balance studies have revealed that zinc intake of 9 mg/day maintains positive zinc balance in healthy elderly people [45, 46]. The Nordic zinc recommendation of 12 mg/day, devised by extrapolation from zinc needs of younger individuals, may be higher than necessary for healthy elderly people. In our study selenium intake was not measured since the selenium content of foods varies annually. Serum selenium values indicate that the selenium intake of elderly people has much improved in Finland. In 1984, 4% of elderly men (n = 528) from eastern Finland had a selenium concentration in serum below 45 μg/l, while in the present study nobody had such a low concentration [47]. This change is a consequence of selenite supplementation of livestock and artificial fertilizers. Thus Finnish elderly people do not need to increase their selenium intake by selenium-containing supplements.

References

18. Grandjean AN, Korth LL, Kara GC, Smith JL, Schafer AE. Nutritional status of elderly participants in a