Changes in Food Patterns and Health in Europeans in their 8th decade

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Proefschrift

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Propositions

I

Assessment of food patterns and nutrient intake are equally important in the evaluation of nutritional status in the elderly (this thesis).

II

A common European food composition database is of paramount importance for the identification of cross-cultural variation in food sources of specific nutrients (this thesis).

III

When food handling and preparation are not taken into account in the evaluation of food composition data in the elderly, this may lead to misinterpretation of the results of a dietary survey (this thesis).

IV

Cluster analyses in international studies have lead to misleading results, because inadequate dimension criteria were selected.

V

Elderly people are not more reluctant to change of food patterns than younger (Horwath, 1992).

VI

Dietary recommendations are often not adequately targeted to specific food patterns (Trichopoulou, 1990).

VII

The quality of 'dietary quality indices' has to be considered.

VIII

When only quality of the diet is studied and not quantity, then a 'high quality diet' may not mediate an adequate nutrient intake.

IX

By standardisation for energy intake in epidemiologic research, it becomes impossible to focus on the importance of energy intake.

X

It is a foolish omission of one's own mortality to postpone healthy decisions to old age (Seneca, †, 65 A. D.).

Propositions belong to the thesis of Kirsten Schroll Bjørnsbo entitled "Changes in food patterns and health in Europeans in their 8th decade" Wageningen, the Netherlands, 18 November 1997.

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Abstract

Changes in Food Patterns and Health in Europeans in their 8th decade.

PhD Thesis by Kirsten Schroll Bjørnsbo, Division of Human Nutrition and Epidemiology, Wageningen Agricultural University, The Netherlands.

Knowledge of specific food patterns of elderly people is important for relating diet to nutritional status and disease and for the identification of groups at risk of under- or over-consumption of specific nutrients. The standardised methodology employed in the SENECA surveys (Survey in Europe on Nutrition and the Elderly a Concerted Action) provided a unique opportunity to study cross-cultural differences in nutritional issues and lifestyle factors affecting health and performance of elderly people in Europe.

This thesis explores food patterns in elderly Europeans and their impact on health. For the evaluation of the nutrient quality and the healthfulness of food patterns in elderly Europeans two approaches were applied: The Nutrient Adequacy Ratio, and a diet score, based on eight dietary components with a likely protective function for a number of chronic diseases. For a better insight in food patterns in addition to a conventional description, cluster analysis was employed

Food intake data from 1221 dietary histories recoded by the Eurocode system was used to identify specific food patterns within each of the SENECA towns. On the pooled level food patterns across centres emerged. Food patterns varied between and within European settings and the two types of variation appeared to be of the same magnitude.

Food patterns were stable with age in 245 women from the Danish, Dutch, Swiss and Spanish SENECA towns. Minor changes attributable to period were, however, found. Also, foods contributing to the intake of specific nutrients were found to vary between SENECA towns.

In addition to food choice, food handling affected the actual nutrient intake, and should, therefore, be considered in the nutritional evaluation of elderly people.

Weight loss showed to be an indicator of poor health in Danish (n=115) and Dutch (n= 121) elderly people, but energy intake as an intermediary factor could not be proven in this study. Nevertheless,

a further analysis of the Danish data showed that, both quantity and quality of food intake matter in the prevention of disability in 115 elderly Danes.

In conclusion, this thesis underlines the importance of food patterns of elderly people today for their ability to perform activities of daily living tomorrow. Inadequate nutrient intake appeared to result from a combination of low energy intake and unfavourable food patterns. Vulnerable groups of elderly people may gain from stimulation of physical activity and recommendations on nutritious foods.

1

General Introduction

General Introduction

Food patterns in elderly Europeans

Comparability of data on food patterns

Ageing, food patterns and disability

Aim of the thesis

Outline of the thesis

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Food patterns in elderly Europeans

Food patterns incorporate many dimensions of food culture; the foods available for consumption, the customs of preserving and processing foods, the meal pattern and the social context in which they are consumed. Food patterns vary between cultures.

Traditionally, associations between food patterns and health have been studied using single nutrients or components of the food intake. Conclusions about the effect of consumption level of a single nutrient, food, or dietary constituent on a specific health outcome may be uncertain, as human diets are complex and the intake of some nutrients correlate with the intake of others. Many nutrient to nutrient interactions in function and metabolism occur in the body. Food patterns accumulate the effects on health of every known and unknown dietary component. They are presumed to be a stronger determinant in health promotion, than any single nutrient. For these reasons it is useful to examine global indexes of food and nutrient intake that express several related aspects of dietary intake simultaneously[1,2].

Furthermore, people do not consume single foods but combinations of several foods that contain both nutrient and non-nutrient substances[1,3]. Dietary guidelines must, therefore, be based on a sound knowledge of food patterns and take social and traditional values into account. A clear idea of what different groups of people actually consume is essential[4].

Elderly Europeans are a vulnerable group with regard to adequate food intake, as a consequence of lower energy demand on the one hand, but unaltered requirements of most nutrients on the other hand[5-9].

Present knowledge of the food pattern and nutrient intake of different communities in Europe is based on a number of individual studies made for a variety of reasons[4]. Until recently, no standardised studies on elderly peoples food consumption throughout Europe existed, which could be used to produce comparable data on food and nutrient intake.

In 1988, this was one of the reasons for the initiation of an international mixed longitudinal study, named SENECA (Survey in Europe on Nutrition and the Elderly a Concerted Action). The aim of SENECA is to study cross-cultural differences in nutritional issues and lifestyle factors affecting health and performance of elderly people in Europe. In the baseline survey (1988/89), 2.586 men and women - born between 1913 and 1918 - were studied in 19 towns across Europe[10]. In 1993 nine towns participated in the follow-up study and a total of 1221 subjects were reexamined[11]. In both surveys, data regarding food and nutrient intake, diet habits, diet awareness, nutritional status, health and life style factors were collected using standardised methodology in all SENECA towns[12]. An important rationale for SENECA lies in the variation in the shopping basket and the traditional cuisine among European communities, which may influence life expectancy, morbidity and mortality. Thus, the follow-up study provided an unique opportunity to analyse the role of food patterns with respect to disease prevalence and incidence in elderly Europeans.

Comparability of data on food patterns

Arab (1985) [13]demonstrated the difficulties involved in making international comparisons of food and nutrient intake as a result of variations in nomenclature and the composition of foods. In SENECA, the same diet history technique was used in all sites but foods were converted into energy and nutrients with use of local food composition tables because there is not one European table. The Eurocode system[14], however, was developed to classify foods eaten in Europe according to the same food codes. In this study, Eurocode is employed for the analysis of cross-cultural variations and changes in intake of food groups in elderly Europeans. In addition the applicability of the Eurocode for European multi-centre studies has been evaluated.

Many methods have been developed to measure the quality and healthfulness of the diet. Because of the nature of food intake, one measure alone can not tell everything about the food pattern and its health associations. Applications of several instruments is therefore useful for the evaluation of the nutritional quality of the diet, for the identification of more or less favourable food patterns and for the study of associations between food patterns and disability.
For the evaluation of the nutrient quality and healthfulness of food patterns in elderly Europeans two approaches were applied.:

The Nutrient Adequacy Ratio (NAR)[15] is calculated by dividing the intake of a nutrient by its age- and sex-specific recommended dietary allowance. The NAR is the traditional way to evaluate whether the study population meets the requirements for a specific nutrient.

In this thesis a diet score was developed to predict disability, based on the intake of foods with a very likely protective function for a number of chronic diseases.

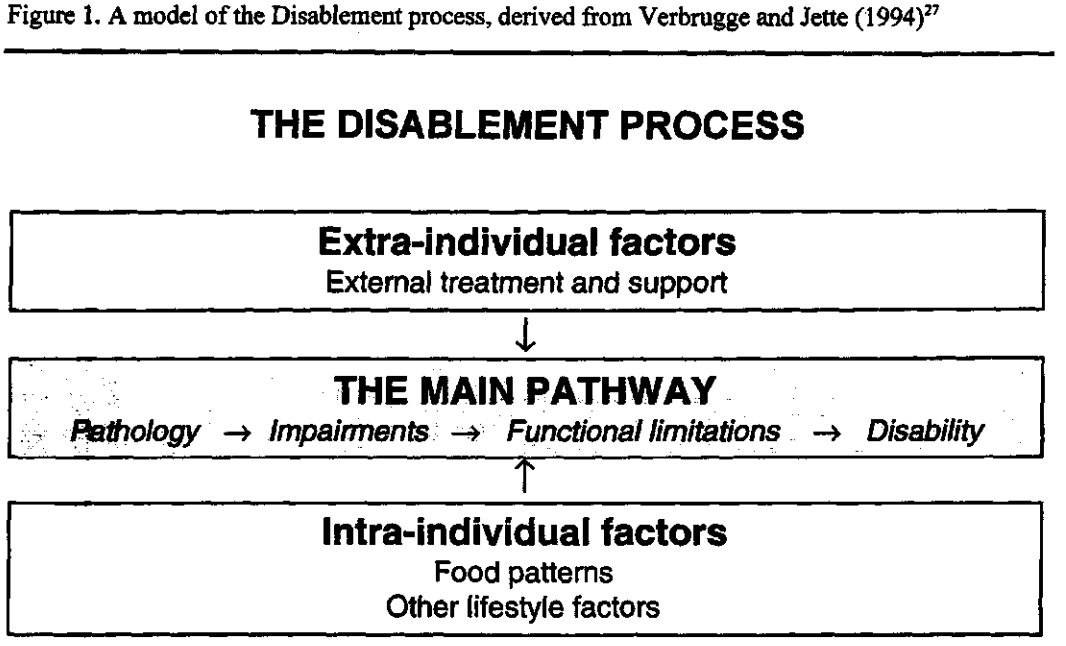
For a better insight in food patterns in addition to a conventional description, cluster analysis was employed:

Cluster analysis was used to identify segments of the elderly population at risk of inadequate micronutrient intake. Cluster analysis aggregates individuals into groups on the basis of their nutrient intake in such a way that the degree of similarity in micronutrient intake is higher within a group, than between groups[16]. The identified clusters are then to be characterised by food intake.

Ageing, food patterns and disability

Because food and, therefore, energy and nutrient intake decrease with age[4-8], and the requirements for most nutrients do not change with age[17], it becomes more difficult to compose a diet of the required nutrient content[9]. If the food pattern is not changed in favour of nutritious foods, the diet may be lacking some nutrients, thus leaving the elderly at nutritional risk. There are several possible mechanisms by which food patterns can influence disease incidence as well as the severity of the functional consequences of disease[18-26] A model called 'The Disablement Process' developed by Verbrugge and Jette (1994)[27]describes how chronic and acute conditions affect functioning in specific body systems, fundamental physical and mental actions, and activities of daily life (see figure 1). It is used here to describe how personal and environmental factors may speed or slow disablement

Figure 1. A model of the Disablement process, derived from Verbrugge and Jette (1994)[27]



'Pathology' refers to change at cell and tissue level, including biochemical and physiological abnormalities that are detected and medically labelled.

'Impairments' are changes at organ and body system level, resulting in symptoms and signs of acute and chronic degenerative conditions, which can be diagnosed.

'Functional limitations' are changes at person level, experience of restrictions in performing fundamental physical and mental actions used in daily life.

'Disability' is loss of ability to perform more complicated activities of daily life due to a health or physical problem. Disability occurs for a given activity, when there is a *gap* between personal capability and the activity's demand. Disability can be alleviated at either side, by increasing capability or by reducing demand.

Given old age and disease, a population of elderly people will be distributed along the main pathway to disability. The 'high risk agers' will already have reached disability, whereas 'successful agers' have just entered the pathway, where pathology is latent or not even present. 'Usual agers' will be distributed somewhere in-between these extremes[28]

It is presumed, that the effect of an unfavourable food pattern on a certain level of the disablement process may not be enough to cross diagnostic thresholds. However, the accumulated effect of many different influences on cell, organ and person level is expected to result in manifest, experienced disability.

Interventions to reduce disability serve as *'buffers'*.

Food pattern can serve as such an intervention factor (buffer). An elderly person can select more favourable foods in order to improve nutrient density. This may slow down the disablement process.

Family or the society may diminish the disability gap by (external) treatment and support. For instance motivate for cooking lessons for widowers, arrange help for partly disabled women to adapt cooking techniques, organise help with heavy shopping, ensure that every old person or couple has an emergency food store, arrange for meals on wheels.

This study has applied epidemiology of disability, which is the study of disease consequences rather than disease aetiology. General agreement exists on the disablement model to study exposure variables, here food patterns, in relation to different levels of disability. A European setting is ideal for such an analysis of food patterns and disability, because of the large variation in food patterns and possibly in biological age, as measured by different health outcomes, at a given chronological age.

Aim of the thesis

The purpose of the present thesis is to identify food patterns in elderly Europeans and explore their effect at different levels of the disablement process. Because of the complexity of food patterns it is not possible to cover all dimensions of food patterns in one thesis. In this monograph emphasis is given to the food consumption and food handling. Associations will be studied with 'health

problems' (chronic disease, self-perceived health), 'impairments' (self-reported problems with vision, hearing, chewing, mobility) , 'functional limitations' (tests of simple functions) and 'disability' (ADL) correcting for other life style factors, such as education, physical activity and smoking.

Outline of the thesis

In *chapters 2 and 3* the cross-cultural variation in food patterns in elderly Europeans are described. It is determined whether food patterns are stable or change with increasing age and whether any changes in intakes observed would be culture specific. In addition food patterns are identified which mediate favourable or unfavourable nutrient intakes.

Because substantial losses in the micronutrient content of foods occur during processing, the proportion of SENECA participants at risk of too low micronutrient intake, may be underestimated. Some elderly people may be especially at risk for nutrient losses, due to unfavourable food selection, long storage of foods, reheating of leftovers and use of meals on wheels. As an example, vitamin C losses due to the handling of foods were estimated and a classification system was developed to quantify the actual level of vitamin C intake in elderly people. This is described in *chapter 4*.

A negative energy balance results in weight loss, and especially involuntary weight loss is associated with morbidity and mortality[19,30]. In *chapter 5* changes in energy balance, body composition, health and performance are described for Danish and Dutch SENECA participants, to test the hypothesis that poor health promotes weight loss via a decrease in energy intake.

Chapter 6 describes the quality and healthfulness of food patterns of elderly Danes by the 3 approaches described above: The Nutrient Adequacy Ratio, cluster analysis and the use of a diet score to predict disability.

Finally in *chapter 7* the results are summarised, methodological problems are discussed, general conclusions are drawn and implications for health policy are discussed.

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2

Food patterns of elderly Europeans

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Eur. J. Clin. Nutr. 1996, 50 (suppl. 2), S86-S100

Abstract

Objective: To compare actual food intake of elderly people in Europe and further identify food patterns, which mediate favourable or unfavourable nutrient intakes from cluster analysis of pooled data.

Design: Cross-sectional analysis of food patterns of participants of the SENECA follow-up study (1993).

Setting: Twelve traditional European towns.

Subjects: Men (n = 647) and women (n = 710) aged 74-79 y in 1993.

Methods: Food intake data were assessed using the same validated dietary history technique in all SENECA towns. Cluster analysis was used to classify subjects into groups based on similarities in dietary variables.

Results: A northern and southern European eating pattern emerged. The southern food pattern appeared to be the most healthful being rich in grain, vegetables, fruit, lean meat and olive oil. The north south gradient did, however, not systematically segregate into the same clusters. All dietary profiles were represented in all sites. The four dietary profiles, identified by cluster analysis, were: 'Lean and green eaters': high carbohydrate and vitamin C intake, 'gourmands': high intake of energy and nutrients, 'milk drinkers': high intake of calcium and vitamin B_2 and 'small eaters': marginal energy and nutrient consumption.

Marital status, education, smoking, health status and physical activity level differed between clusters.

Conclusions: A north south gradient of food patterns was identified. The southern diet agreed better with guidelines for healthy eating. A sufficient energy intake seemed, however, to be necessary for an adequate nutrient intake, beside a good choice of food types.

Descriptors: aging, food group intake, nutrition

Introduction

Both cross-sectional and longitudinal studies in the elderly show a decline in energy intake with age (Horwath, 1989; James, 1989; Durnin, 1985; Moreiras-Varela *et al,* 1996). The requirements for most nutrients are, however, unchanged with age. With a decline in energy intake it becomes more difficult to compose a diet of the required nutrient content. If the food pattern is not changed in favour of nutritious foods, the diet might be lacking some nutrients, thus leaving the elderly at

nutritional risk (Voorrips, 1992). An advanced longitudinal analysis of the cross-cultural variation in food group intake in female participants from the Danish, Dutch, Swiss and Spanish SENECA towns revealed no changes in food patterns with age (Schroll *et al*, 1996). Also cross-sectional studies published earlier showed no difference in food patterns between groups differing in chronological age or health status (Kromhout *et al*, 1990; Levnedsmiddelstyrelsen, 1988; van der Wielen *et al*, 1995).

Knowledge of specific food patterns of elderly people is important for relating diet to nutritional status and disease and for the identification of groups at risk of under- or overconsumption of specific nutrients (Tucker, Dallal & Rush, 1992). Despite this fact only few studies have provided data on food patterns of representative samples of elderly people.

The Euronut SENECA baseline study (de Groot, van Staveren & Hautvast, 1991) was conducted in 1988/ 1989 providing information on nutritional status, health and socioeconomic background in 70-75 year old Europeans. Nutrient intake and serum levels of vitamins were described in 1991 (Amorim Cruz *et al*, 1991; Haller *et al*, 1991). Inadequate intakes of vitamin B_1, B_2, B_6, C, calcium and iron were widespread in the SENECA population. It was not possible, at SENECA baseline, to identify which foods were mediating the nutrient supply, as there was no common European food code enabling a comparison of actual food intake at that time. The development of the EUROCODE food coding system made it possible to include a description of actual food intake at the SENECA follow-up study in 1993.

The present paper reports on the quantification and comparison of food intake data obtained from men and women who participated in SENECA's second round in 1993. Cluster analysis of pooled data is used to classify elderly people into groups, on the basis of their dietary profile. People in different dietary groups will further be characterized by their food pattern, health, life-style and socio-economic background.

Methodology

The presented cross-sectional results include data from the SENECA follow-up study. All methods were highly standardized, using a detailed manual of operations (de Groot & van Staveren, 1988) and central training of fieldwork coordinators. Questionnaires developed in English were translated into the local language and translated back into English in order to check them for inconsistencies.

Subjects

The study population consisted of 1357 men and women, 74-79 years of age, from Hamme/Belgium (H/B), Roskilde/Denmark (R/DK), Haguenau/France (H/F), Romans/France (R/F), Padua/Italy (P/I), Culemborg/the Netherlands (C/NL), Coimbra/Portugal (C/P), Vila Franca de Xira/Portugal (V/P), Betanzos/Spain (B/E), Yverdon/Switzerland (Y/CH), Marki/Poland (M/PL) and Ballymoney-Limavady-Portstewart/Northern Ireland (BLP/NI/UK). Participants from Mansfield/Connecticut/USA (M/CT/USA) were not reported on, due to missing data on actual food intake.

Dietary methods

Data on dietary intake were obtained, during the first half-year of 1993, by a personal interview using a modified version of the dietary history method (Cameron & van Staveren, 1988; Nes *et al*, 1991) consisting of an estimated 3-day record and an interview on the subjects' usual food pattern, covering the previous month as the reference period. Portion sizes were recorded in household measures, whereby portion sizes of the foods most frequently used were weighed by the interviewer. Food consumption data were converted into energy and nutrients locally, with the use of country-specific food composition tables (Moreiras-Varela *et al*, 1996).

Food grouping scheme

Data on actual food intake at SENECA's follow-up were classified into main food groups by the EUROCODE system (Kohlmeier & Poortvliet, 1992). The EUROCODE was used to organize foods in groups and subgroups based either on their origin or on their composition and function in the diet.

Ten of the 13 main groups of the EUROCODE are included in the analyses:

milk and milk products (excluding butter);
eggs and egg products;
meat and meat products;
fish, mollusc, reptiles, crustaceans and products;
oils and fats and products (including butter);
grains and grain products;

vegetables and products;
fruits and products;
sugar, sugar products, chocolate products and confectionery and beverages (non milk).

Consumption from the groups including pulses, seeds and kernels and products, miscellaneous, soups, sauces and products or foods for special nutritional use was rare. Therefore, these groups are not included here.

Background variables

From a general interview, information on marital status and length of education was obtained. For a detailed description, see the manual of operations (de Groot & van Staveren, 1988).

Standing height of the participants was measured to the nearest 0.1 cm using a wall-mounted measuring tape. (The subject was standing without shoes with heels together and the Frankfurt plane horizontal). Body weight was measured in the morning after breakfast. Weight was measured to the nearest 0.5 kg, with the subject clothed only in light undergarment. A calibrated weighing scale was used for the measurement. From height and weight, the body mass index (BMI kg/m^2) was calculated.

Health status was assessed from questions on the presence of chronic disease, self-perceived health and Activities of Daily Living (ADL) (Schroll *et al*, 1991; Osler, de Groot & Enzi, 1991). ADL were assessed by 17 questions and for each of them the level of competence was measured on a four-point scale. A total ability score (ranging from 17 to 68) was calculated as the sum-score over all. The lower the rating the better the score. Similarly mobility scores (4-16) and self-care ability scores (7-28) were calculated as the sum-score over all mobility items and self-care items. respectively.
Physical activity level was based on Baecke's work activity questionnaire (Baecke, Burema & Frijters, 1982) and Voorrips' questionnaire on housework, leisure time activity and sports in the elderly (Voorrips *et al*, 1991) (the higher the score the more physically active).

Statistical analysis

One-way analysis of variance was conducted to test the cross-cultural variation in food group intake across SENECA towns, at follow-up. Analyses were carried out separately for men and women. Not normally distributed variables were log-transformed before this analysis. To analyse the cross-cultural variation further, Tukey's multiple comparison test was used. Differences in food group intake were regarded as significant when the P-value was <0.05.

Cluster analysis was used to classify individuals into a limited number of groups on the basis of their intake of vitamin B_1, B_2, B_6, C, calcium and iron and their serum levels of folic acid and vitamin B_{12} . A considerable number of SENECA participants had inadequate intakes of these nutrients at SENECA baseline (Amorim Cruz *et al*, 1991). The prevalences of folic acid and vitamin B_{12} deficiency were neglectable at SENECA baseline (Haller *et al*, 1991), but serum levels of folic acid and vitamin B_{12} were included, because of their potential impact on the health of elderly people. Due to small sample sizes and problems in the collection of some data, participants from C/P, M/PL and BLP/NI/UK were not included in the cluster analysis. The criteria dimensions chosen were standardized to mean zero and variance one, whereby the SAS procedure 'FASTCLUS' was run. FASTCLUS finds disjoint clusters of observations using a k-means method applied to coordinate data. ANOVA's followed by Tukey's multiple comparison test were used to characterize the food patterns of the identified clusters. The socio-economic, health and life-style variables were compared between clusters. Chi-square tests were used for the testing of nominal variables and ordered classifications were tested by Kendall's Tau c.

All analyses were carried out using the programs provided by SAS (SAS Institute Inc., Cary NC).

Results

In general men had higher mean intakes of various food groups than women (Figures 1a and b). Participants from the Spanish, Polish and Northern Irish towns, women from Culemborg/NL and men from Coimbra/P had the highest absolute food intake (mean intake men: 1512-1926 g/day, women: 1312-1740 g/day). Participants from Roskilde/DK, Padua/I, Vila Franca de Xira/P and Yverdon/CH had the lowest intake (men: 1089-1319 g/day, women: 969-1094 g/day).

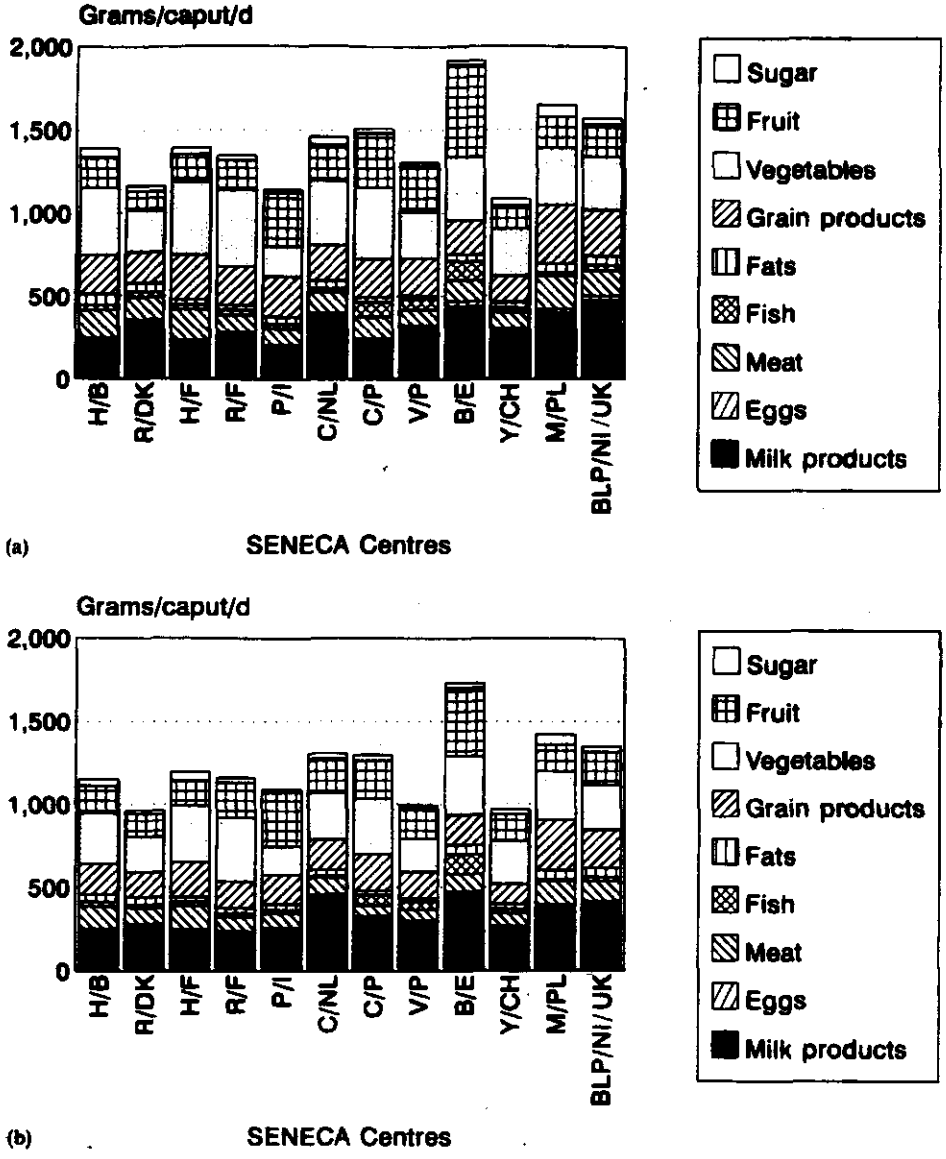


Figure 1 (a) Contribution of main food groups to the average (g/d) food intake in men from the SENECA follow-up study (1993). (See section for abbreviations for SENECA centres). (b) Contribution of main food groups to the average (g/d) food intake in women fr SENECA follow-up study (1993). (See method section for abbreviations for SENECA centres).

Cross-cultural variations in food (group) intake across SENECA sites

All participants reported to consume grain products and vegetables. Almost all participants consumed milk, meat, fats and fruit, whereas fewer participants were having eggs, fish and sugar (Tables la and b). The variation between the sites was in the amounts consumed of the main food groups and in the types of products within these groups. These differences between sites are discussed here per food group.

The variation in intake of *milk and milk products* was mainly explained by the higher consumption of milk and yoghurt by participants from the Dutch, Spanish, Polish and Northern Irish towns and by women from Coimbra/P (Figures 2a and b). Cream was mainly consumed by the more northern sites (R/DK, H/F, R/F, Y/CH, M/PL). Hard cheese consumption was reported in all but the Portuguese and Spanish sites. Soft cheese was mainly consumed in the southern towns (H/F, R/F, C/P, V/P, B/E and Y/CH). Intake of fresh cheese was highest in the Belgian, French, Spanish, Polish and Northern Irish participants. Ice cream was only consumed in Padua/I and BLP/NI/UK.

Men and women from Hamme/B, Padua/I, Vila Franca de Xira/P and Yverdon/CH had the lowest consumption of *eggs* with median intakes equal to 1 egg a week or less. Men from Roskilde/DK, Betanzos/E, Marki/PL, BLP/NI/UK and women from Marki/PL had the highest consumption of eggs with daily median intakes equal to 18 g or more.

The daily median intake of *meat and products* was about 100 g at all sites. Low consumption of meat (median intake < 75 g/d) was however reported by women from the Portuguese and Swiss towns and high consumption of meat (median intake > 150 g/d) was reported by men from Hamme/B, Haguenau/F and Marki/PL.

Table 1a Food group intake (g/caput/d) at SENECA follow-up (1993) of 647 European men, all born between 1913 and 1918

	Town											
	H/B	*R/DK*	*H/F*	*R/F*	*P/I*	*C/NL*	*C/P*	*V/P*	*B/E*	*Y/CH*	*M/PL*	*BLP/NI/UK*[1]
n	68	57	56	70	69	52	13	77	35	71	47	32
Milk products												
Mean	236^{cd}	334^{abcd}	219^{d}	264^{bcd}	198^{d}	390^{abc}	232^{bcd}	311^{abcd}	439^{a}	293^{abcd}	398^{ab}	471^{a}
P10	36	53	53	87	34	102	2	17	100	85	78	199
P50	181	191	157	225	175	371	100	285	477	239	334	376
P90	580	668	442	475	395	654	422	606	790	599	796	715
Eggs[2]												
Mean	11^{abc}	21^{abc}	16^{abc}	16^{abc}	8^{c}	11^{bcd}	12^{abcde}	10de	28^{a}	12^{abc}	22^{ab}	29^{ab}
P10	0	2	6	3	0	0	0	0	0	1	6	7
P50	8	18	14	15	5	10	14	7	26	8	22	21
P90	21	50	31	32	20	22	22	20	69	22	38	50
Meat												
Mean	167^{abc}	136^{cde}	184^{ab}	102^{e}	98^{f}	126de	129^{bcd}	94^{ef}	130^{cdef}	99^{f}	202^{a}	153^{bcd}
P10	92	85	108	65	49	76	23	31	32	60	101	77
P50	156	137	154	99	94	117	143	84	104	95	178	117
P90	237	208	327	144	142	187	174	167	243	138	346	201
Fish[2]												
Mean	29^{a}	32^{a}	29^{ab}	33^{ab}	28^{ab}	22^{ab}	89^{ab}	66^{b}	113^{a}	23^{ab}	20^{b}	33^{ab}
P10	0	0	9	9	7	0	37	24	36	5	0	12
P50	26	31	23	27	21	17	87	58	88	21	12	29
P90	57	72	45	63	60	42	140	121	234	42	42	54
Fats												
Mean	66^{a}	55^{ab}	32^{ef}	28^{def}	42^{bcd}	46^{bc}	30^{cdef}	19^{f}	42^{bcde}	37^{cde}	53^{ab}	55^{ab}
P10	35	28	19	19	20	22	7	8	16	21	20	33
P50	65	51	29	26	41	40	27	18	34	32	43	50
P90	105	86	48	39	76	77	61	32	71	64	112	82
Grain												
Mean	236^{ab}	186^{cd}	270^{a}	234^{bc}	245^{bc}	216^{bcd}	236^{bcd}	227^{bc}	203^{bcd}	160^{d}	354^{a}	280^{ab}
P10	123	95	173	148	143	115	137	116	64	96	202	175
P50	218	185	234	227	243	216	194	197	151	146	336	262
P90	370	290	364	336	328	339	264	380	367	245	521	407
Vegetables												
Mean	410^{abc}	251^{ef}	441^{ab}	461^{a}	183^{f}	387^{abc}	431^{abcd}	282de	386^{abcd}	281de	341^{bcde}	319^{cde}
P10	254	155	257	265	72	216	186	133	126	178	144	218
P50	389	237	386	447	155	364	355	255	413	285	322	292
P90	613	387	753	575	319	577	783	499	720	365	541	449
Fruit												
Mean	184^{abc}	120^{c}	165^{abc}	179^{abc}	320^{bcd}	214^{bcde}	324^{bcd}	278^{bcd}	549^{a}	143^{c}	186^{abc}	193^{bcde}
P10	21	0	71	87	120	48	43	87	43	42	28	48
P50	140	120	141	171	317	194	303	221	525	124	161	145
P90	493	240	298	269	498	349	615	490	900	275	373	285
Sugars[2]												
Mean	54^{ab}	31^{cd}	40^{abc}	29^{cd}	21^{d}	47^{abc}	28^{bcd}	20^{d}	27^{bcd}	41^{bc}	73^{a}	37^{abc}
P10	5	2	10	0	0	15	8	0	0	17	13	10
P50	43	25	37	26	17	43	20	16	15	32	63	37
P90	114	80	78	63	53	93	48	49	64	82	163	64

[1] For explanation see methodology section.
[2] ANOVA based on log-transformed variables.
Means within rows with different letter superscripts (a, b, c, d, e, f, g) are significantly different, $P < 0.05$.

Table 1b Food group intake (g/caput/d) at SENECA follow-up (1993) of 710 European women, all born between 1913 and 1918

	Town											
	H/B	*R/DK*	*H/F*	*R/F*	*P/I*	*C/NL*	*C/P*	*V/P*	*B/E*	*Y/CH*	*M/PL*	*BLP/NI/UK*[1]
n	61	58	53	72	66	69	14	80	47	79	73	38
Milk products												
Mean	246[be]	263[be]	233[e]	225[e]	252[be]	447[a]	314[abe]	292[be]	458[a]	259[be]	376[ab]	400[ab]
P10	32	45	74	84	40	137	9	15	100	67	86	195
P50	197	204	183	178	232	400	281	271	425	207	299	358
P90	529	609	435	459	459	823	1000	618	827	484	869	658
Eggs[2]												
Mean	8[bcd]	16[abc]	14[abcd]	14[abcd]	6[e]	12[abcd]	13[abcd]	9[de]	16[ab]	10[cd]	20[a]	17[abc]
P10	0	3	3	1	0	0	0	0	0	0	5	0
P50	7	15	12	11	3	12	9	7	12	8	19	13
P90	18	34	26	17	14	26	26	21	34	21	32	43
Meat												
Mean	132[ab]	97[cd]	143[a]	86[de]	87[de]	99[cd]	65[de]	66[e]	104[bcd]	77[de]	140[a]	122[abc]
P10	66	51	94	50	28	44	8	20	28	38	68	55
P50	129	96	127	90	80	86	52	62	95	72	131	115
P90	184	157	222	115	132	165	162	114	183	119	219	198
Fish[2]												
Mean	29[bcd]	21[cde]	25[cde]	22[def]	20[efg]	13[g]	60[abc]	47[b]	117[a]	22[def]	14[fg]	25[cde]
P10	0	0	11	4	2	0	19	19	25	5	0	0
P50	28	18	19	18	18	8	62	47	100	20	9	24
P90	59	39	43	43	42	30	100	80	198	44	41	46
Fats												
Mean	46[ab]	45[abc]	28[de]	31[d]	35[b]	37[bd]	27[bcde]	18[e]	59[a]	33[cd]	53[a]	54[a]
P10	23	19	17	20	15	11	5	8	21	16	19	29
P50	44	42	27	28	31	37	28	16	48	29	50	51
P90	70	76	39	39	60	63	46	30	117	56	92	80
Grain												
Mean	183[bc]	151[cd]	209[b]	159[cd]	176[bc]	180[bc]	218[bc]	161[c]	182[bc]	119[d]	301[a]	227[b]
P10	103	89	145	87	83	94	138	95	51	55	153	135
P50	195	145	204	152	167	182	202	152	148	115	268	217
P90	251	207	276	244	290	249	367	232	324	194	470	326
Vegetables												
Mean	304[bc]	214[def]	342[ab]	383[a]	171[f]	280[bcd]	334[abcd]	200[ef]	354[ab]	261[cd]	297[bc]	275[bcde]
P10	153	111	211	219	80	144	147	98	172	144	124	147
P50	280	196	326	368	162	255	337	179	296	250	291	243
P90	478	334	483	549	292	432	465	328	665	420	434	362
Fruit												
Mean	164[c]	135[c]	151[c]	212[c]	323[ab]	206[c]	231[bc]	184[c]	412[a]	158[c]	162[c]	198[c]
P10	21	24	83	101	99	32	14	59	43	38	32	58
P50	147	122	124	181	311	191	258	176	316	128	110	199
P90	298	264	255	352	472	373	414	355	950	318	408	349
Sugars[2]												
Mean	39[ab]	22[cd]	54[ab]	29[bcd]	21[d]	34[bcd]	35[abcd]	17[cd]	31[ab]	30[bc]	61[a]	34[abcd]
P10	7	2	5	3	1	5	2	0	0	9	10	2
P50	37	13	43	25	15	26	21	15	25	25	47	31
P90	76	61	114	56	50	74	70	41	68	64	129	78

[1] For explanation see methodology section.
[2] ANOVA based on log-transformed variables.
Means within rows with different letter superscripts (a, b, c, d, e, f, g) are significantly different, $P < 0.05$.

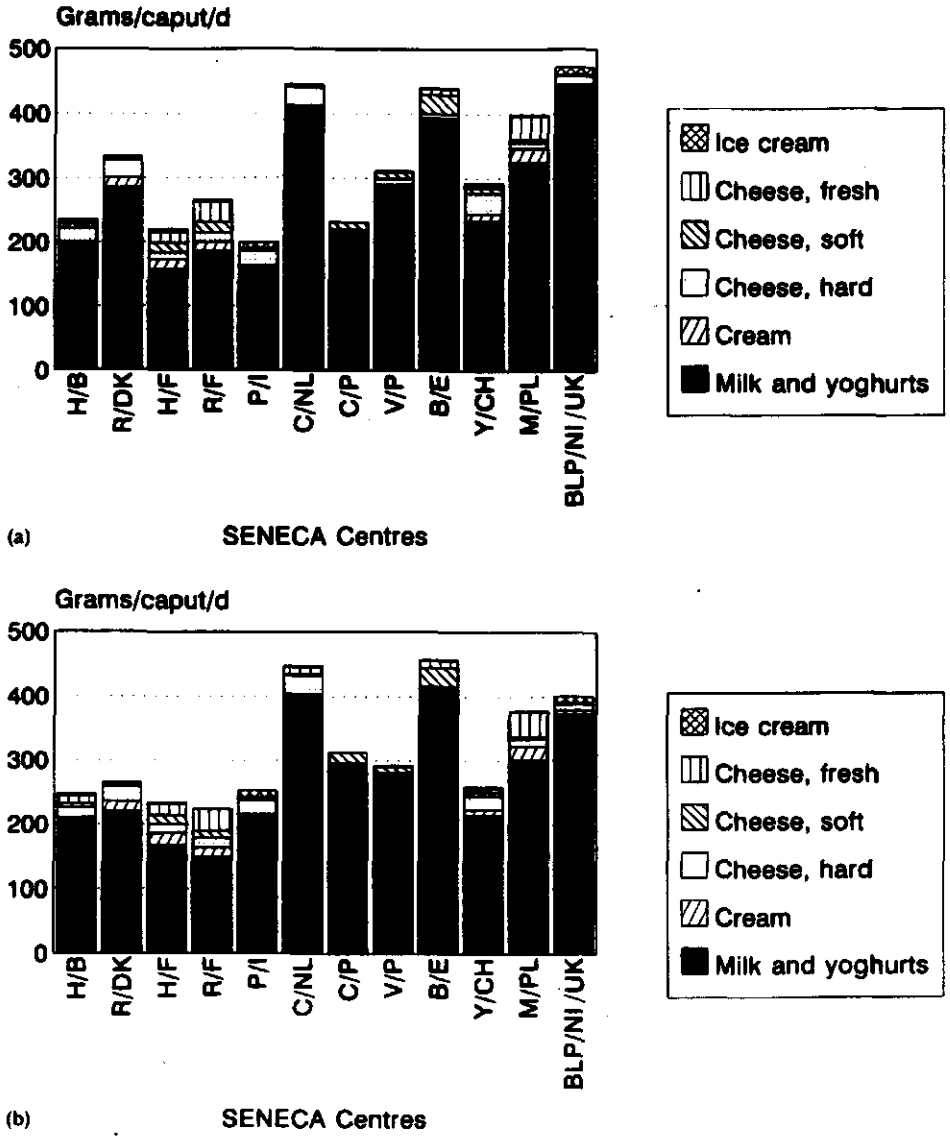


Figure 2 (a) Contribution of milk and milk products to the average (g/d) milk intake in men from the SENECA follow-up study (1993). (S method section for abbreviations for SENECA centres). (b) Contribution of milk and milk products to the average (g/d) milk intake in wom from the SENECA follow-up study (1993). (See method section for abbreviations for SENECA centres).

From Figures 3a and b it can be seen that mean intakes of the different meat types varied considerably across SENECA towns. Beef was consumed in all towns, but beef intake was especially high in the Northern Irish town. Veal was mainly consumed in the French, Spanish and Swiss sites. The Danish meat intake was dominated by pork, while only few grams of pork were consumed in the Italian and Spanish towns and by women from Vila Franca de Xira/P. Italian men and women had the highest poultry consumption.

High intakes of meat products were reported by participants from the Belgian and Dutch towns and especially by participants from Marki/PL. In all towns consumption of offal was almost equal to 0 g per day.

Fish consumption was highest in the Portuguese and Spanish towns with daily median intakes ranging from 47 to 100 g. Median fish consumption ranged from 8 to 31 g/d in the other sites. Fish of a low fat content (< 3 %) was the main contributor to total fish intake in the Portuguese and Spanish towns, while fish of a higher fat content was the main fish contributor in most of the other sites.

A high daily mean intake of *fats and oils* (> 40 g/d) was reported by participants from Hamme/B, Roskilde/ DK, Betanzos/E, Marki/PL, BLP/NI/UK and by men from the Italian and Dutch sites (Figures 4a and b). The mean intake varied from 18 to 37 g/d in the other towns. In the Danish and French sites at least 50% of the participants used butter. Margarine, on the other hand, was mainly consumed in the Belgian, Danish, Dutch, Polish and Northern Irish towns.
Vegetable oils (excluding olive oil) were mainly consumed in the French, Swiss, Polish and Northern Irish towns, while olive oil was consumed in the Italian, Portuguese and Spanish towns.

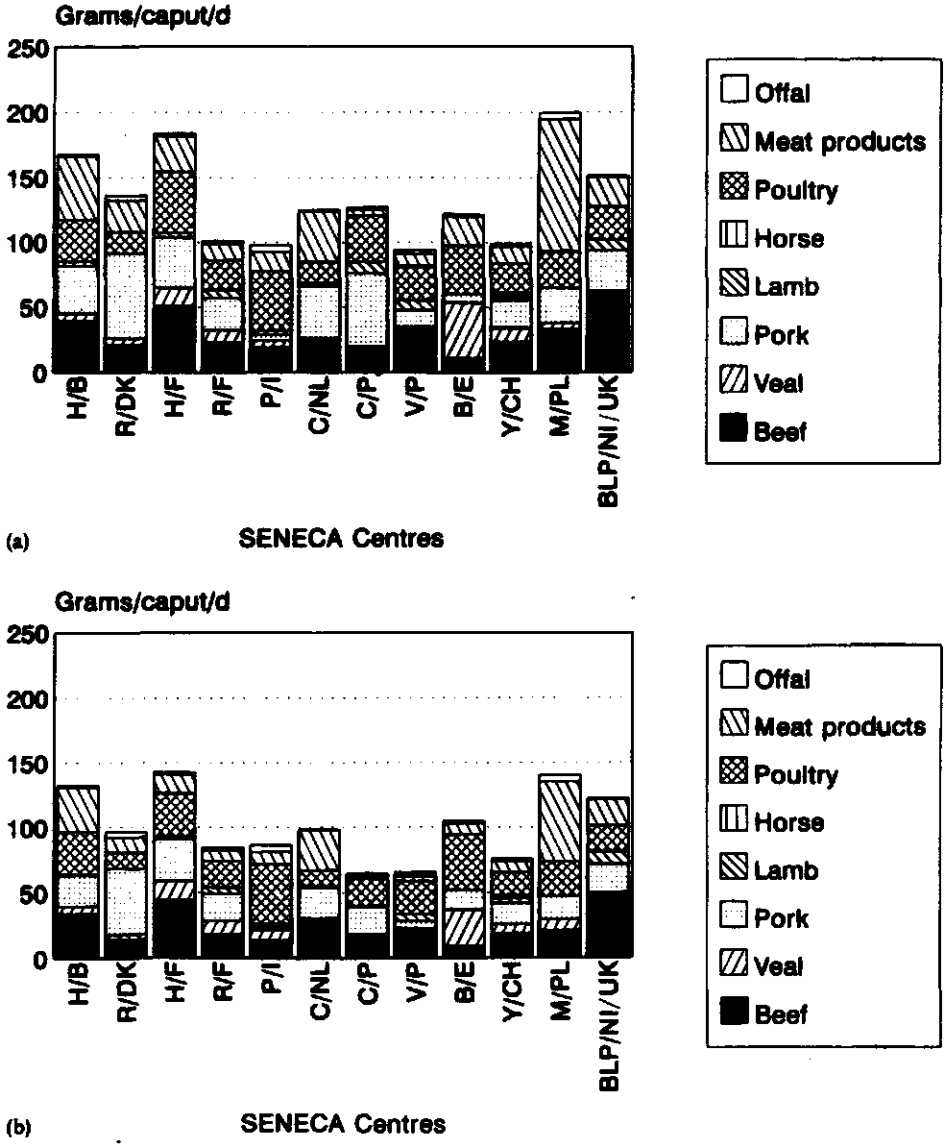
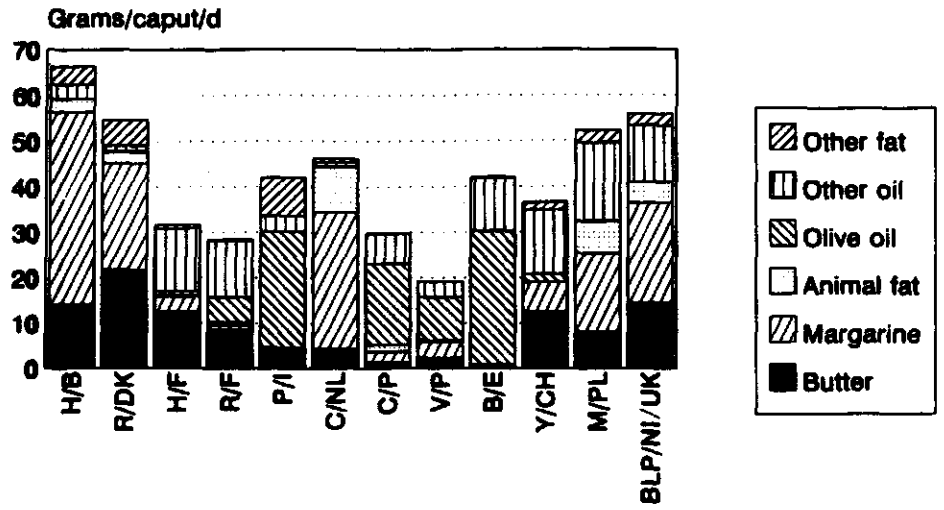


Figure 3 (a) Contribution of various meat types to the average (g/d) intake of meat and meat products in men from the SENECA follow-up stu (1993). (See method section for abbreviations for SENECA centres). (b) Contribution of various meat types to the average (g/d) intake of meat a meat products in women from the SENECA follow-up study (1993). (See method section for abbreviations for SENECA centres).



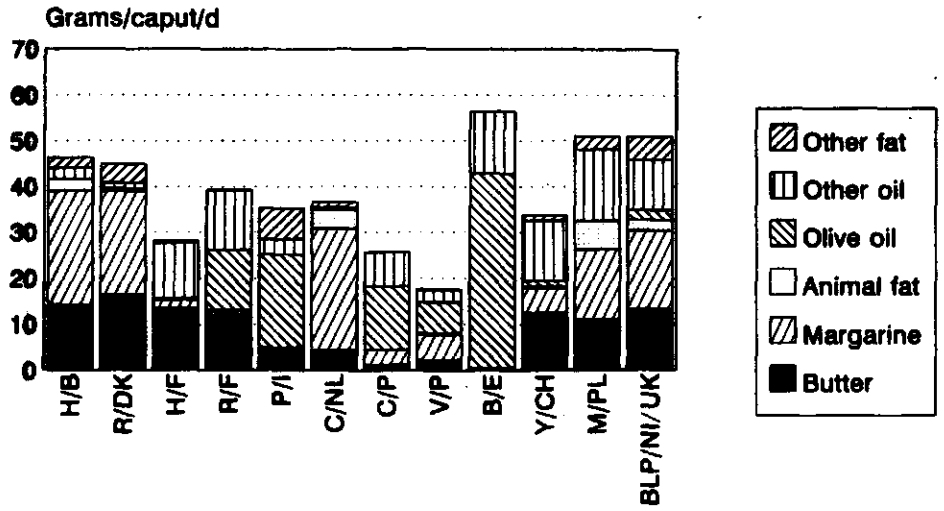


Figure 4 (a) Contribution of various types of fat to the average (g/d) intake of fats and oils in men from the SENECA follow-up study (1993). (See method section for abbreviations for SENECA centres). (b) Contribution of various types of fat to the average (g/d) intake of fats and oils in women from the SENECA follow-up study (1993). (See method section for abbreviations for SENECA centres).

The mean consumption of *grain products* was about 200 g/day among men and 150 g among women, with higher values in participants from Haguenau/F, Marki/ PL and BLP/NI/UK, among men from Padua/I and among women from Coimbra/P. Participants from Yverdon/CH and men from Roskilde/DK and Culemborg/NL had a lower mean grain consumption.

Wheat bread (Figures 5a and b) was the main grain product consumed in all towns, except for the Danish site, where rye bread was the main grain product eaten.

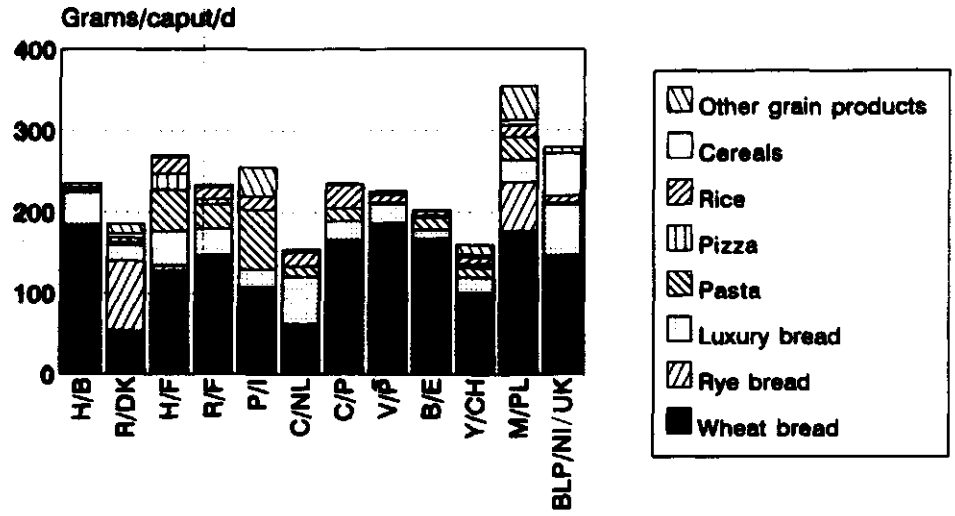
Rye bread was also an important contributor to grain intake in the Polish town.

Cookies, cakes and luxury breads were mainly consumed in the Belgian, Dutch and Northern Irish sites. Pasta was an important contributor to total grain intake in the French and Italian sites with daily mean pasta intakes equal to one portion every second or every day.

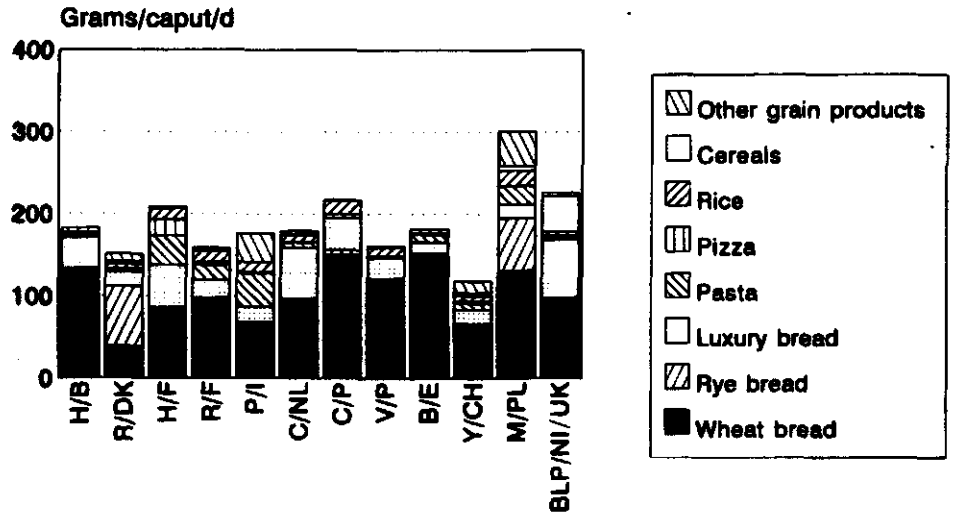
Participants from Haguenau/F, were the only ones consuming pizza, with mean intakes of about 20 g equivalent to one portion per week.

Participants from the French, Italian, Portuguese, Polish towns and Dutch men had a daily mean rice intake of 15-20 g equivalent to two portions a week. Participants from the Belgian, Danish, Spanish, Swiss, Northern Irish towns and women from Culemborg/NL ate rice less than once a week.

Participants from BLP/NI/UK were the only ones consuming an appreciable amount of breakfast cereals (mean intake = 45 g/d).



(a) SENECA Centres



(b) SENECA Centres

Figure 5 (a) Contribution of various grain products to the average (g/d) intake of grain and grain products in men from the SENECA follow-up study (1993). (See method section for abbreviations for SENECA centres). (b) Contribution of various grain products to the average (g/d) intake of grain and grain products in women from the SENECA follow-up study (1993). (See method section for abbreviations for SENECA centres).

Mean intakes of *vegetables* were about 300 g/day for men and 250 g for women, equivalent to five servings of 50 g each day. A lower vegetable intake was found among participants from Roskilde/DK and Padua/I and among women from Vila Franca de Xira where the daily mean intake of vegetables varied from 171 to 251 g. Leafy vegetables were the main source of vegetables in the French, Italian and Swiss towns, while potatoes were the main vegetable source elsewhere (Figures 6a and b).

Median *fruit* intake amounted to 200 g or more per day, equivalent to two pieces of fruit a day, in most towns. Meanwhile, daily median fruit intake was lower than 150 g in participants from Hamme/B, Roskilde/DK, Haguenau/F, Yverdon/CH and in men from BLP/ NI/UK and in women from Marki/PL.

Consumption of *sugar and confectionery* was equal to a median intake of about 20 g per day in most towns. The sugar intake in Hamme/B, Haguenau/F, Marki/PL and BLP/NI/UK and in Dutch men was twice this amount. Sugar, honey and syrup were the main contributors to total sugar intake in participants from the Polish and men from the Dutch sites. Sweets and jam were the most important sugar sources in the Belgian, French, Swiss and Northern Irish sites. Almost no sweets or jams were consumed in the Italian, Portuguese of Spanish towns.

The food patterns described above could be grouped in a northern and a southern dietary profile. The food pattern in the northern towns (H/B, R/DK, C/NL, M/PL, BLP/NI/UK) was characterized by high consumption of hard fats, luxury breads and sugar products. The diet of the southern towns (P/I, B/E, C/P, V/P), could be regarded as Mediterranean with high consumption of fish, liquid fats, vegetables and fruits.

The food pattern of the French and Swiss towns (H/F, R/F, Y/CH) was positioned between the more northern and southern regions.

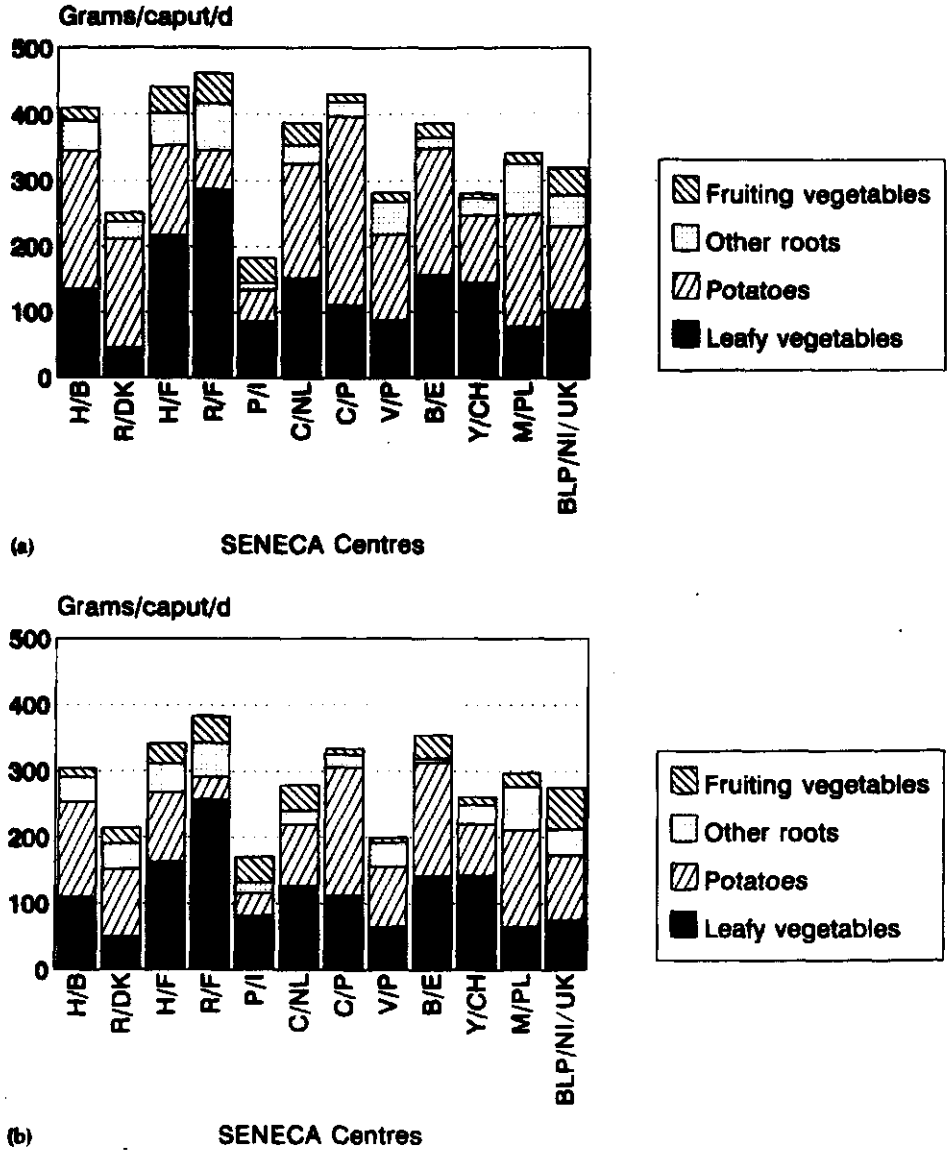


Figure 6 (a) Contribution of various vegetable types to the average (g/d) intake of vegetables in men from the SENECA follow-up study (1993). (See method section for abbreviations for SENECA centres). (b) Contribution of various vegetable types to the average (g/d) intake of vegetables in women from the SENECA follow-up study (1993). (See method section for abbreviations for SENECA centres).

Cluster analysis

Cluster analysis was used to group individuals into two to 10 clusters for each gender on the basis of similarities in the eight standardized variables (six dietary and two biochemical). The solution using eight clusters was selected, as the nutritional composition of these clusters were most clearly understandable. Clusters with a sample size below ten were regarded as outliers and excluded from further analysis. In men, four clusters were excluded (14 men in total) and in women three clusters were excluded (15 women in total).

Tables 2a and b present the daily intakes and serum levels of nutrients used for the clustering and Tables 3a and b present the food group intake patterns in the different clusters.

Men

In men, four clusters including 471 subjects remained: A, B, C, D. Based on their intake of nutrients and food groups they are named 'lean and green eaters', 'gourmands', 'milk drinkers' and 'small eaters'. Intake of vitamin B_6 and the folate serum level did not differ between the four clusters. Consumption of poultry, offal, margarine, roots other than potatoes, fruiting vegetables, sugar and non-alcoholic beverages was comparable across the four SENECA clusters.

In *Cluster A ('lean and green eaters')* men from Vila Franca de Xira/P and Yverdon/CH were highly represented. For this cluster, the highest vitamin C intake and a high consumption of veal, fish, oil, fruit and vegetables and the lowest consumption of grain products emerged.

Cluster B ('gourmands') was dominated by men from Hamme/B, Haguenau/F, Vila Franca de Xira/P and Yverdon/CH. The highest intake of energy, protein, fat, carbohydrate, alcohol, iron and vitamin B_1 was found in this cluster. The dietary pattern of the 'gourmands' was characterized by a high consumption of foods of animal origin, grain products, leafy vegetables, potatoes and alcoholic beverages.

Cluster C ('milk drinkers') was characterized by many males from the Danish and Portuguese SENECA towns. A high intake of fat coincided with the highest intake of calcium, vitamin B_2 and the lowest serum level of vitamin B_{12}. 'Milk drinkers' had a significantly higher intake of milk and milk products and a significantly lower consumption of alcoholic beverages than the other clusters.

Cluster D ('small eaters') was the largest cluster and was dominated by a high number of men from Hamme/B, Romans/F and Padua/I. Marginal intake of energy, protein, fat, carbohydrate, iron, vitamin B_1, B_2 and vitamin C appeared in this cluster together with the lowest consumption of milk products, vegetables and fruits.

Women

In women, five clusters including 502 subjects remained: A, B, C, D and E. Like in men, they are named 'lean and green eaters', 'gourmands', 'milk drinkers' and 'small eaters'. A group of 'modest eating women' was, however, also identified.

Intake of alcohol, vitamin B_6 and the serum level of vitamin B_{12} were comparable across the five clusters. No difference between clusters was found for oil and sugar consumption.

Cluster A ('lean and green eaters') was characterized by a higher number of women from the Belgian, Danish, Dutch, Portuguese and Swiss SENECA towns. For this cluster the highest vitamin C intake, a high milk, margarine and vegetable consumption and the highest consumption of fish and fruit emerged.

Only women from the Spanish towns were not represented in *Cluster B ('gourmands')*. This cluster was characterized by the highest intake of energy, macronutrients, iron, vitamin B_1, and a high consumption of all food groups. Intake of eggs, meat, grain, vegetables and alcoholic beverages was significantly higher in 'gourmands' than in the other clusters.

Cluster C ('milk drinkers') had a fairly equal contribution of women from each of the nine SENECA towns, women from Vila Franca de Xira/P were, however, not represented. Milk drinking women had the highest intake of calcium and vitamin B_2, which was also reflected in the highest consumption of milk and milk products.

Cluster D ('small eaters') was characterized by a high number of women from Yverdon/CH. Small eating women had marginal intake of energy and most nutrients. Surprisingly the serum folate level

and the energy percentage derived from fat were highest in this cluster. The consumption of foods, except for the intake of non-alcoholic beverages, was significantly lower than that in the other clusters.

Cluster E ('modest eaters') was the largest cluster and women from all SENECA towns were represented in this cluster. 'Modest eating women' had the lowest intake of vitamin C, and the intake of energy and most nutrients was marginal. The level of consumption of all the food groups was modest.

Table 2a Daily intake (mean and s.d.) of micronutrients and serum concentration of folate and vitamin B_{12} according to four clusters including 471 *men* from the SENECA follow-up study

	Cluster[1]			
	A	*B*	*C*	*D*
	Men (n)			
	32	*81*	*77*	*281*
Calcium (mg/d)	836.2 (244.8)[b]	969.2 (308.7)[b]	1388.1 (340.7)[a]	639.1 (219.4)[c]
Iron (mg/d)	12.6 (2.9)[b]	17.5 (3.7)[a]	11.9 (2.7)[b]	10.1 (2.8)[c]
Vitamin B_1 (mg/d)	1.2 (0.3)[b]	1.4 (0.4)[a]	1.2 (0.3)[b]	0.8 (0.2)[c]
Vitamin B_2 (mg/d)	1.6 (0.4)[b]	2.0 (0.6)[a]	2.2 (0.6)[a]	1.2 (0.3)[c]
Vitamin B_6 (mg/d)	2.1 (1.8)	2.6 (2.1)	1.7 (1.5)	2.5 (3.0)
Vitamin C (mg/d)	219.6 (61.4)[a]	114.6 (54.0)[b]	87.7 (44.2)[c]	64.3 (33.8)[d]
Folate (nmol/l)	5.8 (1.6)	6.8 (2.6)	6.6 (2.1)	6.9 (2.4)
Vitamin B_{12} (pmol/l)	372.9 (120.7)[ab]	465.3 (295.1)[a]	327.3 (138.8)[b]	411.5 (306.7)[ab]

[1] A = 'lean and green eaters', B = 'gourmands', C = 'milk drinkers' and D = 'small eaters'.
Means within rows with different letter superscripts (a, b, c, d) are significantly different, $P < 0.05$.

Table 2b Daily intake (mean and s.d.) of micronutrients and serum concentration of folate and vitamin B_{12} according to five clusters including 502 *women* from the SENECA follow-up study

	Cluster[1]				
	A	*B*	*C*	*D*	*E*
	Women (n)				
	103	*24*	*16*	*19*	*340*
Calcium (mg/d)	1115.6 (343.5)[a]	991.6 (403.5)[a]	1271.7 (494.1)[a]	643.2 (170.7)[b]	695.6 (266.4)[b]
Iron (mg/d)	13.6 (2.9)[b]	22.2 (4.7)[a]	12.8 (3.2)[b]	9.6 (1.6)[c]	10.2 (3.2)[c]
Vitamin B_1 (mg/d)	1.2 (0.3)[a]	1.8 (0.4)[a]	1.5 (0.4)[b a]	0.7 (0.1)[d]	0.8 (0.2)[d]
Vitamin B_2 (mg/d)	1.8 (0.4)[a]	2.2 (0.9)[a]	4.1 (1.6)[a]	1.2 (0.3)[d]	1.3 (0.4)[d]
Vitamin B_6 (mg/d)	1.8 (1.3)	2.3 (1.5)	1.7 (0.4)	1.4 (1.8)	2.6 (3.0)
Vitamin C (mg/d)	165.0 (69.7)[a]	105.3 (55.2)[b]	72.4 (29.1)[bc]	72.5 (41.2)[bc]	66.9 (33.6)[c]
Folate (nmol/l)	6.3 (2.3)[b]	6.4 (1.9)[b]	7.9 (3.9)[b]	46.8 (4.3)[a]	7.0 (2.6)[b]
Vitamin B_{12} (pmol/l)	439.6 (312.0)	371.0 (309.1)	380.0 (167.0)	357.8 (160.0)	458.1 (346.5)

[1] A = 'lean and green eaters', B = 'gourmands', C = 'milk drinkers', D = 'small eaters' and E = 'modest eaters'.
Means within rows with different letter superscripts (a, b, c, d) are significantly different, $P < 0.05$.

Table 3a Daily intake (mean and s.d.) of energy, macronutrients and main food groups according to four clusters including 471 *men* from the SENECA follow-up study

	Cluster[1]			
	A	*B*	*C*	*D*
	Men (n)			
	32	*81*	*77*	*281*
Energy (MJ/d)	8.7 (2.1)[b]	10.9 (2.9)[a]	9.2 (2.3)[b]	7.2 (1.8)[c]
Energy (kcal/d)	2088.3 (493.2)[b]	2597.8 (686.6)[a]	2197.3 (546.9)[b]	1719.9 (430.8)[c]
Protein (g/d)	77.3 (15.0)[b]	95.2 (23.7)[a]	80.2 (14.9)[b]	60.5 (14.4)[c]
Fat (g/d)	83.6 (39.3)[ab]	98.6 (37.3)[a]	92.5 (28.1)[a]	66.4 (27.8)[b]
Carbohydrate (g/d)	243.0 (75.0)[b]	292.7 (103.6)[a]	238.9 (67.3)[b]	193.7 (51.8)[c]
Alcohol (g/d)	11.1 (13.2)[ab]	22.9 (28.1)[a]	10.1 (24.5)[b]	12.2 (19.3)[b]
Milk products (g/d)	288 (196)[bc]	309 (203)[b]	579 (304)[a]	205 (147)[c]
Eggs (g/d)	13 (12)[ab]	18 (18)[a]	14 (14)[ab]	11 (12)[b]
Meat (g/d)	111 (52)[b]	164 (77)[a]	111 (57)[b]	101 (52)[b]
Fish (g/d)	74 (47)[a]	60 (65)[a]	28 (30)[b]	31 (29)[b]
Fats (g/d)	43 (32)	42 (28)	42 (23)	35 (22)
Grain (g/d)	174 (98)[b]	279 (129)[a]	205 (72)[b]	184 (68)[b]
Vegetables (g/d)	419 (198)[a]	436 (171)[a]	281 (126)[b]	267 (129)[b]
Fruit (g/d)	481 (294)[a]	272 (188)[b]	214 (173)[bc]	183 (126)[c]
Sugar (g/d)	30 (29)	33 (27)	36 (33)	28 (27)
Non-alcoholic beverages (g/d)	642 (653)	864 (695)	1085 (633)	865 (617)
Alcoholic beverages (g/d)	132 (164)[ab]	265 (331)[a]	138 (416)[b]	146 (235)[ab]

[1] A = 'lean and green eaters', B = 'gourmands', C = 'milk drinkers' and D = 'small eaters'.
Means within rows with different letter superscripts (a, b, c) are significantly different, $P < 0.05$.

Table 3b Daily intake (mean and s.d.) of energy, macronutrients and main food groups according to five clusters including 502 *women* from the SENECA follow-up study

	Cluster[1]				
	A	*B*	*C*	*D*	*E*
	Women (n)				
	103	*24*	*16*	*19*	*340*
Energy (MJ/d)	9.5 (2.2)[b]	12.5 (3.3)[a]	8.8 (1.9)[b]	5.8 (1.2)[c]	7.2 (1.9)[c]
Energy (kcal/d)	2257.7 (522.6)[b]	2977.2 (799.5)[a]	2111.2 (445.8)[b]	1388.4 (279.2)[c]	1721.6 (460.3)[c]
Protein (g/d)	81.4 (17.9)[b]	105.6 (28.8)[a]	80.1 (12.0)[b]	49.1 (10.4)[d]	61.8 (14.9)[c]
Fat (g/d)	94.0 (38.6)[b]	121.0 (60.6)[a]	75.7 (26.4)[bc]	64.6 (25.4)[c]	65.2 (26.8)[c]
Carbohydrate (g/d)	256.0 (62.8)[b]	327.2 (119.4)[a]	247.4 (83.5)[bc]	139.6 (33.3)[d]	198.2 (63.5)[c]
Alcohol (g/d)	11.9 (32.2)[b]	24.8 (34.2)[a]	16.2 (25.0)[b]	5.7 (8.1)[c]	11.8 (18.0)[b]
Milk products (g/d)	401 (226)[ab]	276 (252)[bc]	485 (340)[a]	177 (91)[c]	229 (172)[c]
Eggs (g/d)	15 (15)[ab]	30 (31)[a]	11 (7)[bc]	9 (10)[c]	11 (11)[c]
Meat (g/d)	118 (56)[b]	245 (132)[a]	111 (49)[b]	91 (32)[b]	100 (51)[b]
Fish (g/d)	60 (78)[a]	49 (45)[ab]	29 (18)[ab]	22 (12)[b]	32 (30)[b]
Fats (g/d)	46 (27)[a]	49 (38)[ab]	31 (15)[b]	36 (20)[ab]	34 (21)[ab]
Grain (g/d)	207 (84)[b]	350 (134)[a]	229 (121)[b]	116 (49)[c]	186 (80)[b]
Vegetables (g/d)	418 (208)[b]	541 (336)[a]	308 (182)[bc]	257 (82)[c]	265 (133)[c]
Fruit (g/d)	345 (240)[a]	325 (472)[a]	166 (115)[b]	144 (89)[b]	193 (123)[b]
Sugar (g/d)	35 (36)	30 (29)	34 (26)	28 (24)	27 (25)
Non-alcoholic beverages (g/d)	920 (674)	848 (769)	1106 (605)	1124 (482)	826 (585)
Alcoholic beverages (g/d)	89 (141)[c]	289 (367)[a]	238 (492)[ab]	63 (93)[c]	133 (201)[b]

[1] A = 'lean and green eaters', B = 'gourmands', C = 'milk drinkers', D = 'small eaters' and E = 'modest eaters'.
Means within rows with different letter subscripts (a, b, c, d) are significantly different, $P < 0.05$.

Comparison of background variables across clusters

Socio-economic, health and lifestyle variables of the identified clusters were compared, to find out whether other characteristics were associated with different dietary profiles (Tables 4a and b).

Men

Male 'lean and green eaters' and 'gourmands' were significantly more likely to be married or living with a partner than 'small eating' and 'milk drinking men'.

'Milk drinking men' had the highest level of education and 'lean and green eating men' had the lowest level of education.

The prevalence of chronic diseases was about 82% in 'small eating men', while it ranged between 65 and 73% in the other clusters.
Significantly more 'gourmands' and 'milk drinkers', than 'lean and green' and 'small eaters', were perceiving their health as good.

Overall, no difference in ability to manage activities of daily living was found across the four clusters. Male 'gourmands' were, however, best able to manage mobility activities of daily living.
'Gourmands' had the lowest prevalence of never smokers and the highest prevalence of former smokers. 'Lean and green eaters' had the lowest prevalence of current smokers.

About half of the 'milk drinking men' used vitamin supplements. The use of vitamin supplements ranged from 11 to 24% in the other men.

The body mass index and the physical activity level did not vary significantly across the four clusters.

Women

Marital status did not vary significantly across the five clusters of women.
The 'milk drinking women' had a lower level of education than other women.

In contrast to men the lowest prevalence of chronic diseases was found among 'small eating women' (53%) and female 'gourmands' (59%) and the highest prevalence was found in women with a modest food intake (83%).
The highest prevalence of 'non smokers' was found among 'small eating women' (84%). The highest prevalence of current smokers was found in female 'milk drinkers' (29%) and 'gourmands'(28%).

Almost two thirds of the 'small eating women' used vitamin supplements. The prevalence of vitamin use ranged from 7 to 47% in the other women.

No significant differences in self-perceived health, ability to manage activities of daily living, BMI or in the level of physical activity were found between the five clusters. However, female 'gourmands' had a significantly higher work activity level, than women from the other clusters. 'Small eating women' had the highest house work and leisure time activity level.

Table 4a Comparison of socio-economic, health and activity variables between four clusters including 471 men from the SENECA follow-up study

	Cluster[1]			
	A	B	C	D
	Men (n)			
	32	81	77	281
Marital status				*
Single (%)	3.0	8.4	9.5	9.9
Living with partner (%)	72.7	67.5	53.6	44.3
Widowed/divorced (%)	24.2	24.1	36.9	45.7
Education				*
Illiterate (%)	12.9	8.1	3.7	12.1
Primary (%)	67.7	52.7	43.2	55.4
Secondary (%)	12.9	27.2	45.7	26.0
Higher (%)	6.5	12.2	7.4	6.5
Chronic disease				*
(%)	72.7	67.1	65.1	81.8
Self-perceived health				*
Poor (%)	15.2	6.0	13.3	15.0
Fair (%)	30.3	26.5	21.7	33.9
Good (%)	54.6	67.5	65.1	51.1
Ability to manage ADL activities				
All ADL activities (%)	27.3	36.1	38.8	26.2
All mobility items (%)	42.4	62.7	47.1	40.4
All self-care items (%)	48.5	63.9	56.5	57.1
Smoking status				*
Never (%)	54.5	36.1	50.0	59.9
Former (%)	42.4	50.6	33.3	27.3
Current (%)	3.0	13.3	16.7	12.8
Use of supplements				*
(%)	18.8	11.0	46.3	24.2
BMI kg/m^2	27.3 (4.9)	27.1 (3.2)	26.5 (3.1)	26.4 (4.4)
Physical activity	3.9 (5.7)	6.7 (3.2)	7.6 (7.5)	5.2 (6.3)
Work activity	0.2 (0.7)	0.1 (0.5)	0.1 (0.5)	0.1 (0.5)
House work activity	1.4 (0.9)	1.5 (0.9)	1.6 (0.9)	1.6 (1.6)
Sport	0.7 (1.8)	0.6 (1.3)	0.7 (1.5)	0.3 (1.0)
Leisure time activity	1.6 (5.1)	4.5 (6.6)	5.2 (6.7)	3.3 (5.9)

[1] A = 'teas and green eaters', B = 'gourmands', C = 'milk drinkers' and D = 'small eaters'.
* Indicates significant difference between clusters ($P < 0.05$).

Table 4b Comparison of socio-economic, health and activity variables between five clusters including 502 women from the SENECA follow-up study

	Cluster[1]				
	A	B	C	D	E
	Women (n)				
	103	24	16	19	340
Marital status					
Single (%)	5.6	6.9	5.9	5.3	8.2
Living with partner (%)	57.0	69.0	58.8	42.1	59.1
Widowed/divorced (%)	37.4	24.1	35.3	52.6	32.7
Education					*
Illiterate (%)	4.9	8.0	5.9	0.0	12.3
Primary (%)	52.4	48.0	64.7	61.1	51.8
Secondary (%)	27.2	40.0	23.5	27.8	29.0
Higher (%)	15.5	4.0	5.9	11.1	6.9
Chronic disease					*
(%)	73.8	58.6	70.6	52.6	83.5
Self-perceived health					
Poor (%)	8.6	10.3	5.9	5.3	13.3
Fair (%)	24.8	37.9	41.2	21.1	36.0
Good (%)	66.7	51.7	52.9	73.7	50.7
Ability to manage ADL activities					
All ADL activities (%)	32.7	31.0	47.1	42.1	26.8
All mobility items (%)	50.5	55.2	64.7	52.6	44.7
All self-care items (%)	64.5	82.8	64.7	68.4	52.9
Smoking status					*
Never (%)	54.2	41.4	41.2	84.2	60.3
Former (%)	34.6	31.0	29.4	10.5	28.8
Current (%)	11.2	27.6	29.4	5.3	10.9
Use of supplements					*
(%)	32.4	7.1	47.1	63.2	22.3
BMI					
(kg/m^2)	25.8 (3.8)	26.4 (4.6)	28.2 (5.4)	25.1 (5.0)	27.0 (4.2)
Physical activity	6.9 (6.6)	6.6 (8.1)	5.9 (8.0)	7.7 (5.4)	5.0 (5.4)
Work activity	0.2 (0.7)[a]	0.6 (1.1)[a]	0.0 (—)[a]	0.0 (—)[a]	0.1 (0.6)[a]
House work activity	1.5 (0.9)[a]	1.1 (0.9)[a]	1.7 (0.9)[a]	2.4 (0.7)[a]	1.6 (0.9)[a]
Sport	0.7 (1.7)	4.5 (7.4)	0.3 (0.7)	0.4 (0.8)	0.3 (1.0)
Leisure time activity	4.5 (6.5)	5.2 (6.7)	3.8 (7.1)	5.0 (4.6)	2.9 (5.0)

[1] A = 'lean and green eaters', B = 'gourmands', C = 'milk drinkers', D = 'small eaters' and E = 'modest eaters'.
* Indicates significant difference between clusters ($P < 0.05$).
Means within rows with different letter superscripts (a, b) are significantly different, $P < 0.05$.

Discussion

The identification of patterns of food consumption is essential to target attention toward improving diet and nutritional status. In this analysis of food group intake across SENECA towns, earlier findings of a northern and southern European type of eating pattern were confirmed. Though men consumed more (g) from all food groups than women, the food pattern was the same for men and women within the twelve SENECA towns.

Nevertheless, people from the north or south did not systematically segregate into the same dietary profiles, which were identified by cluster analysis. Marital status, education, smoking status, health and physical activity differed between clusters.

In considering the results some limitations regarding subjects and methods should be taken into account. First, the elderly people studied are not representative of the general European elderly population, but they are representative of elderly people living independently in small European towns. However, non-response was large and comparison with the participants who dropped out between the SENECA baseline and follow-up surveys, showed that the SENECA participants who were followed up, had a lower prevalence of chronic diseases and were more physically active at baseline, than those who dropped out (van't Hof & Burema, 1996).
The food pattern may, however, give a realistic description of the cross-cultural variation in food patterns of independently living, relatively healthy elderly people across Europe.

Secondly, the same dietary history technique was used in all twelve SENECA towns, thus enabling a valid comparison of habitual food consumption between these towns. This technique was validated against a 3-day weighed record and shown to be able to adequately characterize the intake of energy, selected nutrients and foods of the research population (Nes *et al*, 1991). However, the second evaluation showed problems with the towns participating for the first time (van Staveren *et al*, 1996). The Eurocode was used to compare food group patterns between SENECA towns. The code proved to be adequate for the presented types of analyses. Difficulties regarding classification of meat cuts were solved by ranking of meat types on the basis of fat content.

The food pattern in the northern towns resembled that of younger and older adults in industrialized countries, with adequate intakes of vegetables and fruits, but with a relatively high consumption of animal products leading to a high fat content of the diet (Ferro-Luzzi *et al*, 1994; Maisey *et al*, 1995; Huijbregts *et al*, 1995). The southern diet resembled the modern Mediterranean diet described by Ferro-Luzzi & Sette (1989). Cluster analyses over the pooled data set showed, that the diet of the 'lean and green eaters' resembled that of a southern diet and the 'milk drinkers' and 'gourmands' resembled a northern European food pattern. The northern and southern towns did not systematically segregate in the same clusters. 'Lean and green eaters' were not dominated by Italian and Spanish participants. 'Gourmands' were not made up by Frenchmen, and 'milk drinkers' were not a group of Danish and Dutch participants. All dietary profiles were represented in all sites. This is in agreement with the Seven Countries Study, which longitudinally showed that participants from five cohorts in Finland, the Netherlands and Italy approach each others diet (Huijbregts *et al*, 1995).

Results of elderly Americans support some of our observations with regard to eating patterns and their characteristics. Among others, Akin *et al* (1986) also identified a cluster of light eaters, a cluster of heavy eaters, a cluster of fruit and vegetable consumers and a cluster of high-fat milk consumers. The light eaters appeared to consume sub-optimal intakes of energy, calcium, magnesium and vitamin B_6. Tucker, Dallal & Rush (1992) identified a group of consumers with high intakes of milk, fruits and cereals, who were characterized by significantly higher education level and higher mean intake of vitamin A, C, B2, B6 folate and calcium.

If the diet reported reflects the dietary pattern of a long life in a population of healthy agers, each of the SENECA diets reported could, by definition, be interpreted as a healthful diet.
Participants from the southern French, Italian, Portuguese and Spanish towns seemed, however, to fulfill better the demands of a healthful diet (Nestle, 1995; Kennedy *et al*, 1995), as they consumed more grain products, vegetables and fruits, and less meat, saturated fats and luxury breads. This is suggested by the Mediterranean diet pyramid, which is now accepted as a cultural model for healthy eating (Willett *et al*, 1995). This model is also true for healthy eating in old age. Trichopoulou *et al* (1995) found that a diet meeting the characteristics of a traditional Mediterranean diet favourably affects life expectancy among elderly people. Similarly, Osler & Schroll (1996) found that a

Mediterranean dietary pattern was associated with improved survival in the Danish SENECA population.

In our comparison of health status across clusters, total energy intake, rather than food pattern seemed to be important for preservation of health and ability to manage activities of daily living in old age. 'Small eating' men and 'modest eating' women, had the lowest energy and nutrient intake and poorest health status. 'Gourmands' had the highest intake of energy and most nutrients and a good health status. The 'small eating' women had the lowest prevalence of chronic diseases. The fact, that they had the highest use of vitamins and minerals, may reflect dietary awareness and healthy lifestyle in general.

It should, however, be kept in mind that cluster analysis is dependent on the statistical analysis system used and dimension criteria chosen, and, therefore, is not a conclusive method. It is a hypothesis generating method which is useful in the analysis of large data sets, where it can be difficult to visualize associations. There is, thus, a call for further analyses of the full data set for confirmations of the associations found between energy intake, food pattern and health.

In conclusion, more or less healthy dietary profiles were represented in all SENECA sites. The cluster analysis suggested that adequate nutrient intake was found in individuals with high energy intakes. The majority of individuals were 'small eaters'. They had low energy intakes associated with less favourable health and life-style characteristics. A good choice of food types might not suffice for them to reach adequate nutrient intake, if energy intake is not increased.

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3

Cross-cultural variations and changes in food group intake among elderly women in Europe: Results from the Survey in Europe on Nutrition and the Elderly a Concerted Action

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Abstract

To study cross-cultural variations and changes in intake of food groups in elderly Europeans, longitudinal data on food-group intake from Danish (n = 55), Dutch, (n = 65), Swiss (n = 79), and Spanish (n = 46) female participants in the Survey in Europe on Nutrition and the Elderly a Concerted Action (SENECA) were compared. Participants were born between 1913 and 1918. Information on food intake was obtained with use of the same diet-history method at all sites and in both 1988-1989 and 1993. Actual food intake was coded according to the Eurocode system, the applicability of which for European multicenter studies was evaluated in this study. All participants, regardless of site, reported consumption of milk, grain products, and vegetables, and almost all ate meat, fats, and fruit. Fewer women ate eggs, fish, and sugar. The variations between the sites were in the food groups consumed and the types of foods within the groups. Spanish women appeared to have the most healthy food-intake pattern. They also had more changes in their dietary pattern than did women in the other countries. The Eurocode was adequate for describing the actual food intake of elderly women in four European towns. The coding for meat, however, was ambiguous and should be revised.

Key Words: Eurocode, food groups, elderly, women, Europe, Mediterranean diet, dietary pattern, Survey in Europe on Nutrition and the Elderly a Concerted Action, SENECA

Introduction

Both cross-sectional and longitudinal dietary studies in elderly subjects have shown that energy intake decreases with age (1-3), giving rise to the question of whether the decline is caused by a decreased intake of specific foods or is equally distributed over all foods. In the latter situation, there would be no change in dietary pattern with age. Cross-sectional studies in Netherlands and Denmark have not found a difference in older and younger adults (4, 5). A study in Netherlands in four groups of elderly people with differences in health status and performance showed a large variation in energy intake but few differences in food patterns (6). Information on changes in food intake with aging, along with data on changes in intake of energy and nutrients, is important for improving the diets of elderly people. In addition, some diseases are related to the intake of foods rather than specific nutrients (7-10).

The SENECA (Survey in Europe on Nutrition and the Elderly a Concerted Action) project, which included an initial survey in 1988-1989 and a follow-up survey in 1993, provided an opportunity to examine cross-cultural variations and changes in the intakes of food groups in elderly Europeans born between 1913 and 1918 (11). Arab (12), however, demonstrated the difficulties involved in making international comparisons as a result of variations in nomenclature and the composition of foods. One of SENECA's tasks, therefore, was to develop a dietary assessment method for comparing diets in different cultures. The same diet-history method was used in all sites but foods were converted into energy and nutrients with use of local food-composition tables because there is not one European table. The Eurocode system, however, was developed to classify foods eaten in Europe according to the same food codes. One of the objectives of the present study was to evaluate the applicability of this food-classification system.

We reviewed data from elderly women living, in towns in Denmark, Netherlands, Switzerland, and Spain to describe cross-cultural variations in food-group intake between the SENECA centers in those towns and to determine whether there were changes in intakes of specific foods and if any changes in intakes observed were culture-specific.

Methods

The SENECA study had a mixed longitudinal design (13). All procedures were highly standardized and used a detailed manual of operations (14) and centralized training of fieldwork coordinators. Questionnaires developed in English were translated into local languages for field use and then translated back into English to check them for inconsistencies.

The study population consisted of 55 Danish, 65 Dutch, 79 Swiss, and 46 Spanish women (total: 245) who participated in both SENECA studies and were 70-75 y old in the first study (1988-1989) and 74-79 y old in the follow-up study (1993). The women lived in Roskilde, Denmark; Culemborg, Netherlands; Yverdon, Switzerland; and Betanzos, Spain. The participation rates at the baseline of SENECA were 46%, 37%, 49%, and 58%, respectively, for the Danish, Dutch, Swiss, and Spanish sites. Fifty-five percent of the Danish women who were studied at baseline also participated in SENECA's second round. Participation rates in the second round for the Dutch,

Swiss, and Spanish centers were 52%, 63%, and 39%, respectively. The survey was approved by Danish, Dutch, Swiss, and Spanish ethical committees.

Data on dietary intake were obtained during a personal interview that used a modified version of the diet-history method (15) and included an estimated 3-d food record and an interview about usual food-intake pattern in which the previous month served as the reference period. Portion sizes were recorded in household measures. Portion sizes of the foods most frequently consumed were weighed by the interviewer. Food-consumption data were converted into energy and nutrient intake values locally with use of country-specific food-consumption tables (16-18).

Baseline and follow-up data on actual intake by the subjects were recorded according to the Eurocode system (19). This coding system was used to organize foods into groups and subgroups on the basis of either their origin, their compostion, or their function in the diet. We analyzed data on the following food groups: milk and milk products (excluding butter); eggs and egg products; meat and meat products; fish, mollusks, reptiles, and crustaceans and their products; oils and fats and their products (including butter); grains and grain products; vegetables and their products, fruit and fruit products; and sugar, sugar products, chocolate products, and confectionery. We did not study the groups: pulses, seeds, kernels and their products; miscellaneous soups and sauces and their products; products for special nutritional use; or nonmilk beverages because many participants did not consume them at all or because differences existed in the coding of amounts consumed.

Student's paired t test was used to analyze changes in food-group intake within each center between the first and second survey. One-way analysis of variance was used to test for cross-cultural variations in food-group intake among the SENECA centers in both the baseline and follow-up surveys. Tukey's multiple comparison test was used for further characterization of cross-cultural variations observed. Differences in food-group intake were considered significant when $p < 0.05$. All analyses were done with SAS software (SAS institute, Inc, Cary, NC).

Results

Characteristics of the study population during both the baseline and follow-up surveys are shown in **Table 1.** As expected in women of this age, most participants had only a primaryschool education (they had gone to school for $\geq$7 y). Only in the Spanish town were there nonliterate participants

(11%). The proportions of women with a secondary or higher level of education were larger in the Danish and Dutch centers than in the Swiss and Spanish centers. Average body mass index (BMI, in kg/m^2) ranged from 25 to 30; thus, the subjects were slightly overweight. The SD was ≈4, indicating that only a few of the women were underweight (BMI < 20) but that an appreciable proportion were obese.

Mean energy intake at baseline was highest in the Spanish participants (10.1 MJ/d) and lowest in the Swiss participants (6.3 MJ/d). The values at the 10th percentile of energy intake were remarkable low (< 5.4 MJ/d in 1993) at all four sites. Mean energy intake declined during the 4 y between the baseline and follow-up surveys in the Danish and Spanish women but there was little or no change in the Dutch or Swiss participants.

Variations in food-group intake and changes in intake in the four SENECA sites are shown in **Table 2.** All women reported consuming milk, grain products, and vegetables, and almost all said they currently ate meat, fats, and fruit. Fewer women consumed eggs, fish, and sugar. The sites varied with respect to the amounts of the main food groups consumed and the items in these groups **(Figures 1-4).** The changes in food-group consumption over time also varied according to SENECA site.

TABLE 1

Educational level, body weight, height, BMI, and energy intake in female SENECA participants at four sites during the baseline (1988–1989) and follow-up (1993) surveys[1]

	Roskilde, Denmark (n = 55)	Culemborg, Netherlands (n = 65)	Yverdon, Switzerland (n = 79)	Betanzos, Spain (n = 46)
Education level (% of subjects)				
Primary	48	44	71	85
Secondary	40	49	20	2
Higher	10	7	9	2
Nonliterate	0	0	0	11
Body weight (kg)				
1988–1989	63.7 ± 11.0[2]	71.3 ± 11.0[3]	62.8 ± 11.8[4]	65.8 ± 10.6[4]
1993	62.0 ± 12.0	70.9 ± 11.1[3]	62.0 ± 12.1[4]	62.4 ± 10.8[5]
Height (m)				
1988–1989	1.60 ± 0.06[3]	1.61 ± 0.06[3]	1.57 ± 0.06[4]	1.52 ± 0.07[5]
1993	1.58 ± 0.06[3]	1.59 ± 0.06[3]	1.56 ± 0.06[4]	1.51 ± 0.07[5]
BMI (kg/m^2)				
1988–1989	24.3 ± 3.9[3]	27.6 ± 4.0[3]	25.6 ± 4.2[4]	28.6 ± 4.4[5]
1993	25.1 ± 4.9[3]	28.1 ± 4.2[3]	25.6 ± 4.4[4]	27.0 ± 4.2[5]
Energy (MJ/d)				
1988–1989	7.8 ± 1.8[3]	7.7 ± 2.1	6.3 ± 1.5	10.1 ± 3.3
1993	7.2 ± 1.7[3]	7.6 ± 2.4	6.3 ± 1.7	9.1 ± 3.3

[1] SENECA, Survey in Europe on Nutrition and the Elderly a Concerted Action.

[2] $\bar{x}$ ± SD.

[3] Missing values equal to 1–3.

[4] Sample including 61 subjects.

[5] Sample including 40 subjects.

TABLE 2
Overall mean food-group intake and mean intake at the 10th and 90th percentiles (P) for elderly women at four SENECA *sites* during the baseline (1988–1989) and follow-up (1993) surveys[1]

	Roskilde, Denmark (n = 55)		Culemborg, Netherlands (n = 65)		Yverdon, Switzerland (n = 79)		Betanzos, Spain (n = 46)	
	1988–1989	1993	1988–1989	1993	1988–1989	1993	1988–1989	1993
	g · d^{-1} · capita^{-1}							
Milk								
Mean	314^{ab}	246^{A,2}	366^{a}	447^{B}	145^{b}	259^{A,2}	254^{c}	460^{B,2}
10 P	95	40	91	137	30	67	25	100
90 P	641	609	600	823	361	484	551	827
Eggs								
Mean	21^{b}	16^{A}	17^{a}	13^{A}	14^{b}	10^{B}	24^{a}	15^{A}
10 P	2	3	1	0	0	0	0	0
90 P	40	34	27	26	26	21	44	34
Meat								
Mean	101^{ac}	95^{AB}	114^{a}	99^{A,2}	79^{b}	77^{B}	94^{bc}	100^{A}
10 P	80	51	66	44	57	61	95	28
90 P	153	157	185	165	145	139	254	180
Fish								
Mean	17^{a}	21^{A}	13^{a}	12^{A}	21^{a}	22^{A}	66^{b}	119^{B,2}
10 P	2	0	0	0	4	5	12	25
90 P	36	39	36	30	36	44	128	198
Fats								
Mean	42^{a}	45^{A}	36^{a}	38^{A}	36^{a}	33^{A}	58^{b}	60^{B}
10 P	22	19	12	11	14	16	30	21
90 P	63	76	61	63	62	56	114	117
Grain								
Mean	160^{a}	150^{AB}	178^{a}	181^{A}	187^{a}	119^{B,2}	271^{b}	186^{A}
10 P	107	89	115	94	91	55	100	51
90 P	207	207	241	249	324	194	524	324
Vegetables								
Mean	239^{a}	214^{A,2}	293^{a}	279^{B}	248^{a}	262^{AB}	382^{b}	354^{C}
10 P	129	111	162	144	160	145	81	172
90 P	394	334	493	432	374	420	731	665
Fruit								
Mean	175^{a}	133^{A,2}	216^{a}	208^{A}	194^{a}	158^{A,2}	305^{b}	420^{B,2}
10 P	50	34	75	32	64	38	77	43
90 P	316	264	376	373	370	318	501	950
Sugar								
Mean	29^{a}	22^{A,2}	37^{a}	34^{A}	30^{a}	30^{A}	26^{a}	30^{A}
10 P	6	2	6	5	5	9	0	0
90 P	64	61	71	74	53	64	57	68

[1] n = 245. SENECA, Survey in Europe on Nutrition and the Elderly a Concerted Action. Values within rows with different lowercase superscript letters (a, b, and c) were significantly different at SENECA baseline ($P < 0.05$); values within rows with different uppercase superscript letters (A, B, and C) were significantly different at SENECA follow-up ($P < 0.05$).
[2] Significantly different from baseline, $P < 0.05$.

Variations in the intake of milk and milk products were due mainly to the higher consumption of yogurt and milk in the Dutch and Spanish sites, where the daily median intake in 1993 was ≈400 g, or two big glasses. Only about half this amount (200 g) was consumed by women in the Swiss and Danish sites. An increase in milk intake between the baseline and follow-up surveys was observed in the Swiss, Dutch, and Spanish participants, whereas intake decreased in the Danish subjects.

The consumption of eggs was comparable between the sites and did not change substantially. The median intake of 10-15 g, indicated that about one egg was consumed every 5 d.
In 1993 the median daily intake of meat at all four sites was ≈100 g, which was generally less than had been observed in the baseline study. The type of meat consumed, however, varied according to site: participants in Demark, for example, ate less beef but twice as much pork as did women in other countries. The Spanish women consumed significantly more poultry than did those in the other three sites (Figure 1).

Fish consumption was low in Denmark, Netherlands, and Switzerland and did not change much over 4 y. In contrast, in 1993 the median consumption of fish by the Spanish women was 111 g/d, an amount that represented twice that eaten in 1988-1989.
The Spanish participants also had the highest intake of fat, with a median daily intake of 53 g (1993). In comparison, the Danish, Dutch, and Swiss participants consumed median amounts of 41, 37, and 29 g fat/d, respectively. The consumption of fat did not change much over time at any of the four sites. Butter, margarine, and animal fats were the main contributors to total fat intake in Danish, Dutch, and Swiss subjects (1988-1989), whereas olive oil and other vegetable oils were the main sources of fat in the diet of Spanish participants (Figure 2).

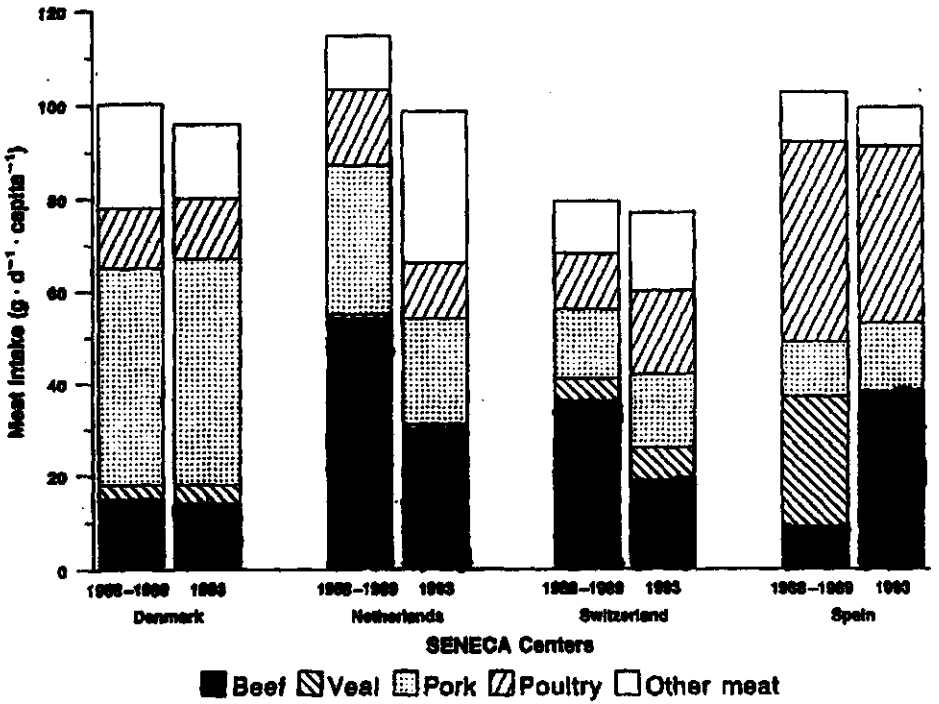

FIGURE 1. Contribution of various types of meat to the average intake of meat and meat products in women at the Danish, Dutch, Swiss, and Spanish SENECA (Survey in Europe on Nutrition and the Elderly a Concerted Action) sites during the baseline (1988–1989) and follow-up (1993) surveys.

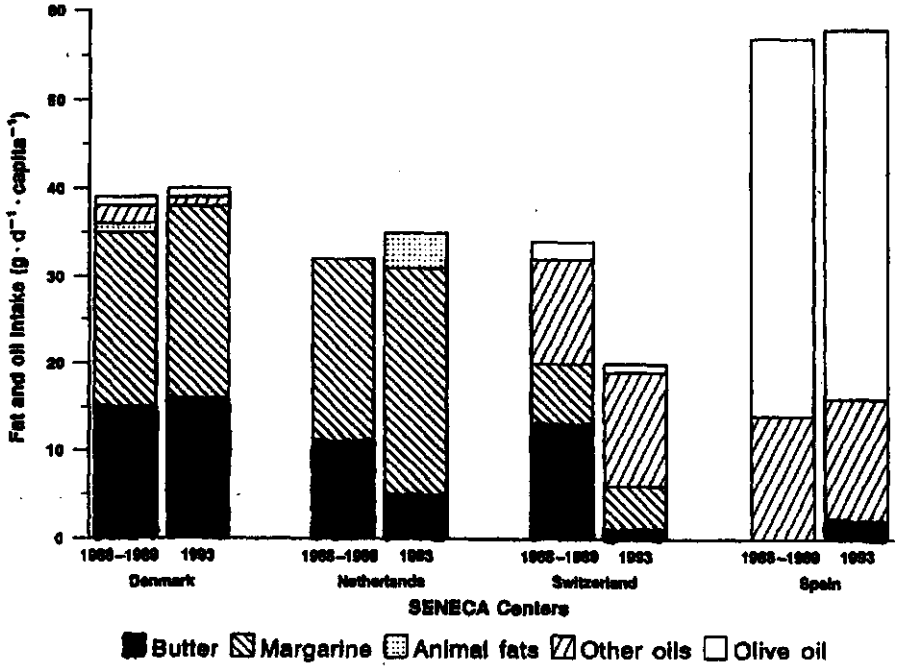

FIGURE 2. Contribution of various types of fat to the average intake of fats and oils in women at the Danish, Dutch, Swiss, and Spanish SENECA (Survey in Europe on Nutrition and the Elderly a Concerted Action) sites during the baseline (1988–1989) and follow-up (1993) surveys.

In 1993 the median daily intake of grain products ranged from 115 g for participants in Switzerland to 184 g for those in Netherlands. Spanish participants had the highest level of wheat-bread consumption (Figure 3). In Denmark, rye bread was consumed most often. Dutch participants had the highest consumption of cookies. The total intake of grain products declined significantly over 4 y in both the Swiss and Spanish centers.

The median daily intake of vegetables ranged from 193 g in Danish women to 298 g in Spanish women. Potatoes represented more than one-half of the amount of vegetables eaten by the Danish and Spanish participants and about one-third of total vegetable consumption by Swiss and Dutch subjects. In Switzerland and Netherlands, leafy vegetables were the principal items eaten in the vegetable food group. The Danish center was the only one in which vegetable consumption decreased significantly from baseline to follow-up (Figure 4). In 1993 participants in Spain had the highest consumption of fruit, with their median daily intake of 352 g indicating that they ate at least three servings of fruit a day. Moreover, their consumption of fruit increased since 1988-1989. In the other centers, consumption tended to decrease and daily median intakes in 1993 did not exceed 200 g.

In 1993 the median intake of sugar, including honey and jam, ranged from 13 g in the Danish subjects to 27 g in the Dutch participants. The amount consumed by the Danish participants had decreased slightly but no important changes were observed in the other centers.

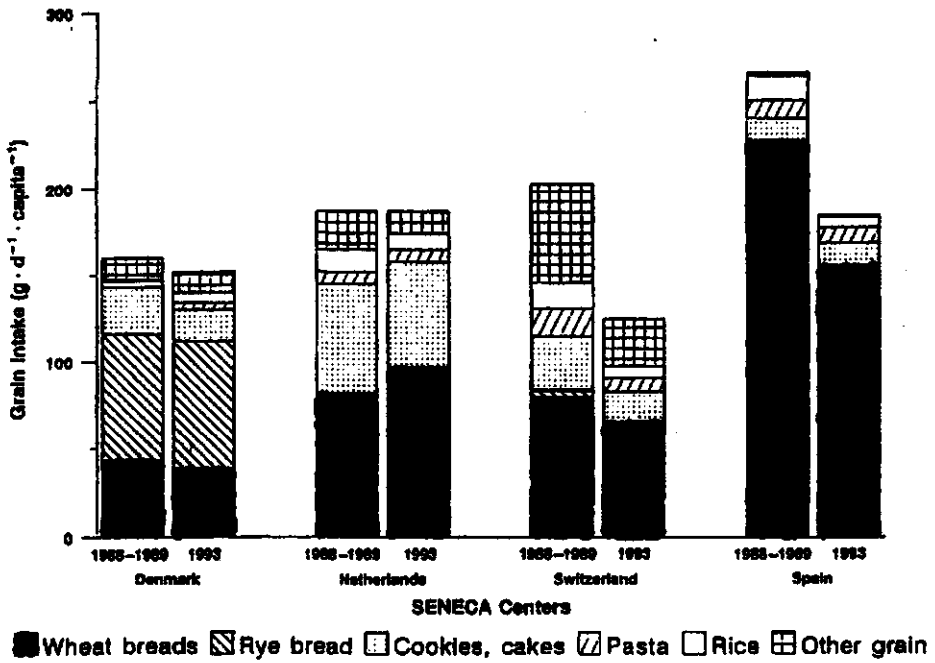

FIGURE 3. Contribution of various grain products to the average intake of grain and grain products in women at the Danish, Dutch, Swiss, and Spanish SENECA (*Survey in Europe on Nutrition and the Elderly a Concerted Action*) sites during the baseline (1988–1989) and follow-up (1993) surveys.

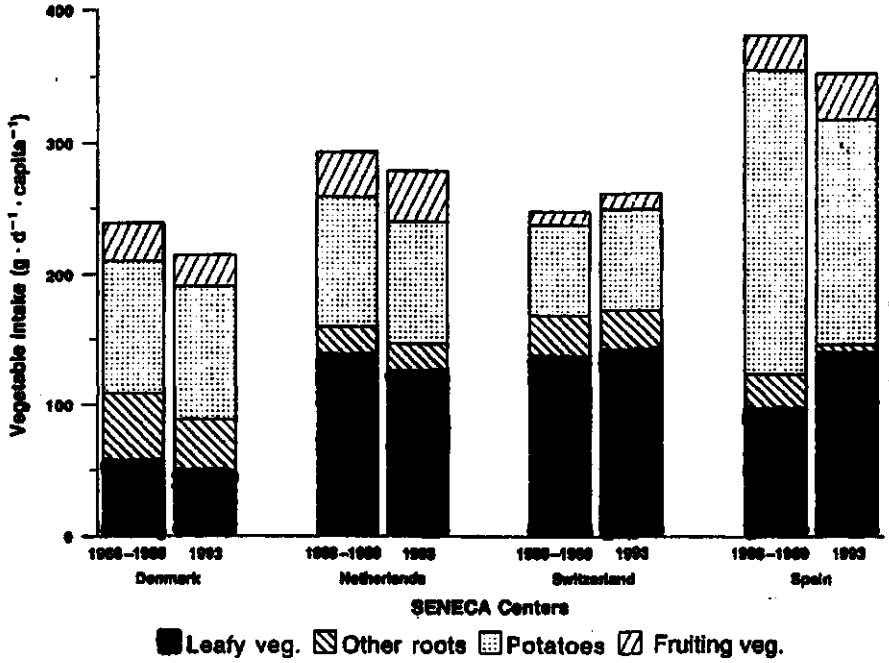

FIGURE 4. Contribution of various types of vegetables to the average intake of vegetables in women at the Danish, Dutch, Swiss, and Spanish SENECA (Survey in Europe on Nutrition and the Elderly a Concerted Action) sites during the baseline (1988–1989) and follow-up (1993) surveys. veg., vegetables.

Discussion

This study on the food-group intake of elderly people in four European SENECA centers revealed that the food pattern of women in Spain was different from that of women in Netherlands, Switzerland, and Denmark in that Spanish women consumed more fish, olive oil, wheat bread, vegetables, and fruit. In addition, changes in intake from 1988-1989 to 1993 were different in the Spanish SENECA site compared with the other three sites. These differences in food patterns have several health implications, although our results may also have been partly affected by some factors that must be considered in interpreting them.

For example, nonresponse analyses indicated that subjects who participated in both the baseline and follow-up studies were more healthy than a representative sample of nonparticipants of the same age from the same four sites (13). Data on health and activity patterns have also suggested that healthier, "successful aging people" participated (11, 20, 21). The mean energy intake in the Danish and Dutch participants and the fact that they had only a slight decrease in body weight between the surveys suggest that those subjects were still quite mobile in 1993. Among the Spanish women, a decrease in mean energy intake coincided with a mean decrease in body weight, but energy intake was still relatively high. Mean energy intake in Swiss subjects was low in 1993 but it had not changed in 4 y. Thus, the participants in this study were probably among the more healthy elderly persons in the four European towns that served as SENECA sites.

The adequacy of the method used to assess food consumption might be questioned. However, the same modified dietary history was used in all four sites and this instrument has been validated in a subsample from all centers against a 3-d weighed-food record and shown to provide sufficient characterization of the intake of energy, selected nutrients, and foods in the research population (11). In the evaluation of the dietary assessment method used, actual energy intake was compared with the physical activity index (PAI), which is equal to the energy intake divided by the basal metabolic rate (BMR). BMR was estimated from formulas developed by the Food and Agriculture Organization, World Health Organization, and United Nations University (22). PAI expresses energy requirements as a multiple of BMR for persons involved in different levels of activity: restricted = 1.27 X BMR, sedentary = 1.40 x BMR, light = 1.55 x BMR, and moderate = 1.8 x BMR).

The mean PAI of the participants at baseline (Danish 1.5 x BMR, Dutch = 1.4 x BMR, Swiss = 1.2 x BMR, and Spanish = 1.9 x BMR) and at follow-up (Danish = 1.4 x BMR, Dutch = 1.4 x BMR, Swiss = 1.1 x BMR, and Spanish = 1.7 x BMR) suggested that the method used to determine energy intake probably underestimated habitual intake below physiologic needs for the Swiss women (23). The energy intake in the Danish and Dutch women (1.4 x BMR), however, would cover only the energy cost of relative inactivity (2). Therefore, some underreporting of energy intake apparently occurred in the northern European centers because the household and leisure-time activities reported by most of the subjects had an energy cost equal to light activity (11; M Schroll, K Bjørnsbo, M Ferry, B Livingstone, unpublished observations, 1994). There was better agreement between energy intake and activity level for Spanish women.

In a separate study of elderly Dutch women, energy intake was measured with the same assessment method and tested by comparisons with values for total energy expenditure measured for 3 d in a metabolic laboratory. The method underestimated energy intake by an average of 12% (24). We are not sure whether this bias is indeed constant because validity has not been tested in each center separately. Because the women studied were similar in body size and physical activity, there may have been some cultural differences in the reporting of diet history.

The effect of differences in the European nutrient databases on the conversion of foods into energy and nutrients was examined in a sample of food-intake data from 21 elderly persons in three different countries. The intake data provided by the Hungarian, Norwegian, and Portuguese participants were converted into energy and macronutrients with use of local (25-27) as well as Dutch (17) food-composition tables. The differences observed were < 10% of the reference value (11). Arab (12) found the differences in European food-composition tables to be 10% for energy and 7-17% for macronutrients. Therefore, the energy difference may be due not only to variations in food-composition tables but also to a methodologic bias in the diet-history assessment that has not been overcome. The bias presumably affects estimates of energy and nutrient intakes in the northern European centers so that the risks of inadequate intakes are likely to be exaggerated. The food-intake pattern and changes in food intake described here, however, may be assumed to be unaffected by this error because a checklist of foods was elaborated for each center and included in

the dietary assessment (14). In addition, food patterns observed in this study agreed with those in nationwide surveys (5, 28, 29).

To overcome the limitations associated with the lack of one European food-composition table, we also used the Eurocode system, which was developed to allow comparisons of food patterns within Europe. This study is one of the first multi-center investigations to use this code. We found the code to be adequate for the analyses we performed. A drawback of the code, however, related to its classification of meat, which is cut in a variety of ways in Europe. A classification system based on the fat content of various types of meat would be more unambiguous than the current coding, which includes only a few cuts of meat. Moreover, the differences in veal consumption in the Spanish site between 1988-1989 and 1993 suggest a change in coding rather than a real change in the types of meat consumed.

A healthy diet is based mainly on consumption of grains, fruit, and vegetables, with meat and dairy foods eaten in lower quantities. When meat and dairy products make up the dominant part of the diet, the meat should be lean and the dairy foods low in fat (30). The food pattern we observed in Spanish women clearly fulfills these criteria better than the pattern in the Danish, Dutch, and Swiss participants. That food pattern observed - among selected, successful aging women in Spain - is in accordance with the Mediterranean diet pyramid, which has been suggested as a cultural model for healthy eating (31). In contrast with expectations regarding the food pattern of aging women, intakes of dairy products, fish, and fruit increased in the Spanish SENECA center from 1988-1989 to 1993. It was unlikely that this was due to an assessment artifact because it reflected the predominant food pattern in the Spanish population (32).

Food patterns in the other three centers resembled those of younger adults in industrialized countries; intakes of fruit and vegetables were adequate but there was a relatively high consumption of animal products that resulted in a diet with a high saturated fat content (33, 34). The minimal change in food intake observed in the 4 y between the baseline and follow-up surveys is in accordance with the results of a study by Maisey et al (35), who found little variation in food intake between young elderly (68-73 y) and older elderly (74-90 y) people.

Because of the higher energy intake in the women in Spain, their intakes of most nutrients were also higher than those of women in the other sites. The nutrient densities of riboflavin, calcium, and iron, however, were lower and the vitamin C density higher in the Spanish center than in the other centers (11; JA Amorim Cruz, O Moreiras, A Brzozowska, unpublished observations, 1994). This reflects the relatively higher consumption of milk in the northern European sites and the higher intake of fruit in Spain. The increase in consumption of fruit and milk in the Spanish site was also reflected in an increase in the nutrient density of vitamin C and calcium during the study period.

In summary, the overall food pattern of the female SENECA participants described in this paper was that of a successful aging group. The dietary assessment method used to study these women tended to underestimate energy intake in the northern European centers. In the Spanish center, the reported energy intake and the level of physical activity were in better agreement than at the other sites. The bias presumably resulted from differences in the reporting of portion sizes of food items consumed. Although the presence of omissions in the reporting of food consumed cannot be excluded, we believe that the food-pattern characteristics were unaffected. The Eurocode system was found to be applicable in this comparison of actual food intake in various European countries. The coding for meat, however, should be revised.

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4

Quantification of the dietary intake of vitamin C in Danish and Dutch elderly people, correcting for storage and cooking losses

Submitted as:

Kirsten Schroll Bjørnsbo, Lisette C.P.G.M. de Groot, Anders Møller, Janneke Verloop and Wija A. van Staveren. Quantification of the dietary intake of vitamin C in Danish and Dutch elderly people, correcting for storage and cooking losses

Abstract

Because of a low food intake in elderly people, a precise quantification of micronutrient intake may be especially important in this population group. Estimation of micronutrient intake from food composition tables is prone to errors due to the high biological variation in micronutrient composition of foods and the number of ways micronutrients can be lost during processing. Particularly vitamin C is liable to losses during storage and cooking.

In this study vitamin C losses due to the handling of foods were estimated. A classification system was developed to quantify the vitamin C content of foods after storage and cooking. From this system correction factors were derived to estimate the actual vitamin C intake according to 236 dietary histories of 75-79 year old participants from the Danish and Dutch SENECA follow-up surveys.

The median uncorrected vitamin C intake was 97 mg/d in men and 89 mg/d in women, meanwhile the median corrected values were 40 mg/d and 44 mg/d respectively.

After correction for cooking and storage losses one third of the participants were at risk of inadequate vitamin C intake. Participants with a low vitamin C intake were characterised by an unfavourable food pattern, having potatoes and cabbages as the major vitamin C source. Furthermore, they were more dependent on home delivered meals, and they reheated meals more frequently.

It is, therefore, important in the evaluation of vitamin C intake in the elderly, that food sources, storage and losses in preparation are examined.

Introduction

Low vitamin C intake is one of the factors related to health problems like retarded wound healing (Ringsdorf & Cheraskin, 1982), senile cataract (Jacques *et al,* 1988; Jacques & Chylack, 1991), cancer (Burr *et al.* 1987; Block & Menkes, 1989) and deteriorated cholesterol metabolism (Jialal *et al.* 1990; Frei, 1991; Niki, 1991).

In general, food consumption surveys, using food composition tables, produce reliable results about the mean macronutrient intake of a population. The assessment of intakes of micronutrients based on food composition data is more prone to random errors, due to the high biological variation in micronutrient composition of foods. An example of such a nutrient is vitamin C, as this vitamin is labile and prone to destruction during storage, processing and cooking (Southgate, 1993). As other water-soluble vitamins, vitamin C is also lost by leaching into the cooking water.

The lowest European recommended dietary intake for vitamin C is 30 mg/d. This figure is based on the body's ability both to avoid scurvy and to maintain a body pool of 1 g of ascorbate (Hodges *et al.* 1971).

Since body stores of vitamin C are considered low, covering daily needs of this vitamin is very important. Fresh fruit, fruit juices and green leafy vegetables are good sources of vitamin C. Potatoes are not a rich source, but as large amounts may be eaten they are the major source of vitamin C in some countries (MAFF, 1989; Nordisk Ministerråd, 1996).

Consumption of foods with a high vitamin C content, may be especially important in the elderly population , as a consequence of lower energy demand on the one hand, but unaltered requirements of most nutrients on the other hand. Some elderly people may be especially at risk for nutrient losses, due to unfavourable food selection, long storage of foods, reheating of left-overs and use of meals on wheels (Horwath, 1989).

Van der Wielen *et al.* (1994) concluded in their review on water-soluble vitamins, that the dietary intake of vitamin C in apparently healthy, free-living elderly in Western societies on a group level seemed to be sufficient.

However, substantial losses in the vitamin C content of foods may occur during storage and cooking, and though the vitamin C intake calculated from food composition tables may appear to be above the safe intake threshold, the actual intake for a proportion of the elderly people, may be below an acceptable threshold.

The purpose of this paper is to estimate the vitamin C losses due to the handling of foods, to assess the actual level of vitamin C intake and associated prevalence of inadequacies. Furthermore we want to examine whether an unfavourable food selection enhances the problem of inadequate vitamin C intake in elderly people.

For this purpose we used data from the SENECA follow-up study (Survey in Europe on Nutrition and the Elderly a Concerted Action). To study the relationship between nutrition, health and performance in elderly Europeans SENECA was conducted in 19 centres in Europe in 1988/89 and repeated in 9 centres in 1993 (de Groot *et al.* 1991). Longitudinal changes in intake of energy and nutrients were reported in 1996 (de Groot *et al.* 1996).

Methodology

For the presented study, data have been used from the Danish and Dutch SENECA follow-up studies, because computerised food composition databases to link foods to nutrients , for these two SENECA towns, were available. These data sets could be combined, because all methods were highly standardised, by the use of a detailed manual of operations (de Groot & van Staveren, 1988) and central training of fieldwork co-ordinators.

Subjects

The study population consisted of 57 men and 58 women from Roskilde/Denmark (R/DK) and 52 men and 69 women from Culemborg/the Netherlands (C/NL), who all completed the dietary history interview. The participants were 74-79 years of age, free-living and generally in good health (Schroll *et al.* 1996).

Dietary assessment

Data on dietary intake were obtained, during the winter season, using a personal interview by trained investigators. The modified version of the dietary history method employed (Cameron & van Staveren, 1988; Nes *et al.* 1991; van Staveren *et al.* 1996) consisted of an estimated 3-day

record and an interview on the subjects' usual food intake pattern, covering the previous month as the reference period. Portion sizes were recorded in household measures, whereby portion sizes of the foods most frequently used were checked by weighing by the interviewer. Food consumption data were coded as the raw ingredient and converted into energy and nutrients locally, by the use of Danish and Dutch food composition tables (Møller, 1985; NEVO, 1986). The 1996 release of Danish and Dutch food data bases were used for the calculation of food sources of vitamin C (Møller & Saxholt, 1996; NEVO, 1996).

Foods contributing to vitamin C intake were classified into main food groups by the EUROCODE system (Kohlmeier & Poortvliet, 1992). The food sources of vitamin C were described by the EUROCODE subgroups of *fruits* (citrus, other fruits), *vegetables* (leafy vegetables, cabbages, leek, potatoes, roots and tubers, fruiting vegetables), *beverages* (juices) and a group combining all the other main groups of the EUROCODE (milk, eggs, meat, fish, pulses, miscellaneous) into an *other group*.

A classification system was developed to divide foods by their liability to losses of vitamin C during storage or cooking. The following classes A through F were distinguished with class A containing the most reliable vitamin C sources:

A) *The class of fresh, raw eaten foods* included foods with minimum storage and cooking losses, such as berries, citrus fruits and fruit juices.

B) *The class of stored, raw eaten foods* contained fruits and vegetables, such as apple, banana and salad vegetables, which vitamin C content is readily oxidised during peeling and cutting.

C) *The class of foods with low storage and low cooking losses of vitamin C* included vegetables, which are consumed after a short storage period and cooked without water for a short time, such as paprika and courgette.

D) *The class of foods with low storage losses and high cooking losses of vitamin C* consisted of vegetables which can endure refrigerated storage for a long time, but are vulnerable to losses during cooking, such as cabbages, leek, onion and carrots.

E) *The class of foods with high storage losses and high cooking losses of vitamin C* consisted of potatoes, beans, peas and spinach, which have high vitamin C losses during storage and further are exposed to vitamin C losses during peeling, soaking and cooking.

F) *The class of foods with very high storage and cooking losses of vitamin C* included processed foods, because of the heat damage during processing, high storage losses after preparation and cooking losses during re-heating of the product before consumption.

A correction factor for storage losses and one for cooking losses was applied to each of the 6 classes on the basis of studies of vitamin C losses in raw vegetables and fruits during storage and cooking (see table 1).

In appendix I the foods consumed and respective correction factors are summarised.
The effective correction factor was calculated as the ratio between the corrected and the uncorrected value for the total vitamin C intake.

General interview

From an interview on background variables, including questions on supplement use, cooking abilities, use of home delivered meals and reheating of dishes, information about food handling and supplementation was obtained (Van't Hof *et al.* 1991). This information was used to characterise elderly people with different levels of vitamin C intake.

Data analysis

The percentile distributions of vitamin C intake from different food groups were calculated to identify the main sources of vitamin C in the diets of Danish and Dutch elderly men and women. Then participants from Roskilde/DK and Culemborg/NL were pooled and the percentile distributions for uncorrected and corrected vitamin C were calculated for men and women to describe the amount consumed from the six classes of vitamin C containing foods and to illustrate the effect of correction.
To estimate the prevalence of participants at risk of a low corrected vitamin C intake men and women were defined into a group with corrected vitamin C values below 30 mg/d and a group with corrected vitamin C values equal to or above 30 mg/d. Energy intake, food choice, supplement use, cooking abilities and food handling were compared between the two groups of corrected vitamin C intake, to find possible reasons for a low corrected vitamin C intake.

Continuous variables were tested by the non-paired t-test. Chi-square was used for the testing of nominal variables. Differences between values were regarded as significant when the p-value was < 0.05.

All analyses were carried out using the statistical analysing system SAS version 6.07 (SAS institute INC., Cary NC).

Table 1. Examples of food sources of vitamin C, in the classification system based on average cooking and storage losses of vitamin C after a storage time of 1 week at 4°C (1-10).

	Cooking losses				
	Raw foods	Cooked foods			
Storage losses	0%	25%	50%	75%	100%
25%	A Citrus fruits Juices	C Cauliflower, carrots, cooked without salt	D Raw vegetables		
50%	B Other fruits Salad vegetables		E Raw potatoes Raw peas, beans, spinach	F Curly kale Chicory	F Vegetables in ready made foods

1) Belliot et. al., 1983
2) Blauw , 1976
3) Lombardi-Boccia, 1986
4) van der Meer, 1982
5) Nagy, 1980
6) Sprenger Instituut Wageningen, 1974, 1980-1988
7) Weichmann, 1987
8) Weits & Lassche, 1965
9) Wills et. al. 1984
10) Woolfe, 1987

Results

The total median intake of vitamin C was lower in men (89 mg/d) and women (75 mg/d) from Roskilde/DK, than in men (110 mg/d) and women (111 mg/d) from Culemborg/NL. The food groups mediating these vitamin C intakes are shown in table 2.

Potatoes are the most important contributor to vitamin C intake in the Danish participants, while cabbages in addition to potatoes make up the main sources of vitamin C in the Dutch participants. Fruits and juices are also important sources of vitamin C, but are not consumed by all participants. Since the food pattern contributing to vitamin C is fairly similar for the two SENECA towns, we found it acceptable to combine the Danish and Dutch data sets for further analyses.

The uncorrected total median intakes of vitamin C were 107 mg/d and 98 mg/d in men and women respectively, as appeared from the pooled data set. The corresponding corrected values were 50 mg/d in men and 55 mg/d in women. That is, the corrected vitamin C intake was about half the value estimated from food composition tables. The effective correction factor was *0.44* in men and *0.46* in women.

In table 3 the foods contributing to vitamin C intake in men and women are shown for the six classes (A through F). Foods from group A (fresh fruits, raw eaten) were the main contributors to vitamin C intake. These foods were, however, not consumed by all participants. Women consumed more vitamin C from class A (fresh fruits, raw eaten) than men, while men consumed more vitamin C from class E (high storage losses, high cooking losses) than women.

When the food composition table values were used, 8 (7 %) men and 14 (11 %) women had a mean vitamin C intake *below 30 mg/d.* When the corrected values for vitamin C intake were used 40 (37 %) men and 47 (37 %) women had mean vitamin C intakes below the lowest European recommended dietary intake.

A little more Danish (42%) than Dutch (32%) participants had low corrected intakes of vitamin C. This difference was, however, not significant.

Table 2. Percentile distribution of uncorrected vitamin C intake (mg/d) from different food groups in 74-79 year old men and women from the Danish and Dutch SENECA centres, at SENECA follow-up (1993).

	Men						Women					
	R/DK n=57			C/NL n=52			R/DK n=58			C/NL n=69		
	P10	P50	P90	P10	P50	P90	P10	P50	P90	P10	P50	P90
Potatoes	13	28	49	5	11	19	8	15	34	3	7	14
Roots and tubers	0	2	6	0	0	6	0	2	6	0	1	5
Leafy vegetables	0	0	1	0	3	11	0	0	2	1	4	14
Cabbages	0	7	21	8	28	67	0	7	34	1	18	52
Leek, onion, sprouts	0	2	6	0	1	7	0	1	7	0	1	6
Fruiting vegetables	0	2	8	1	5	16	0	3	13	0	4	17
Citrus fruits	0	0	64	0	7	59	0	7	54	0	28	69
Other fruits	0	4	17	3	8	16	0	7	25	1	8	33
Juices	0	3	53	0	0	36	0	3	34	0	2	35
Other foods	1	4	10	3	6	13	0	3	8	2	6	22

Table 3. Percentile distribution of uncorrected and corrected values of vitamin C intake (mg/d) from 6 food classes in pooled data of 74-79 year old Danish and Dutch SENECA participants (1993).

	Men (n=109)		*Women (n=127)*	
	Uncorrected	*Corrected*	*Uncorrected*	*Corrected*
Fresh foods, raw eaten				
P50	24	18	35	26
(P10, P90)	(0,88)	(0,66)	(0,96)	(0,72)
B Stored foods, raw eaten				
P50	7	3	6	3
(P10, P90)	(0,16)	(0, 8)	(0,18)	(0, 9)
C Low storage losses, low cooking losses				
P50	0	0	1	1
(P10, P90)	(0,10)	(0, 5)	(0, 7)	(0, 4)
D Low storage losses, high cooking losses				
P50	16	6	15	6
(P10, P90)	(3,61)	(1,23)	(1,55)	(0,21)
E High storage losses, high cooking losses				
P50	17	4	8	2
(P10, P90)	(1,45)	(0,11)	(0,30)	(0, 8)
F Very high storage losses, high cooking losses				
P50	3	0	2	0
(P10, P90)	(0,18)	(0, 2)	(0, 10)	(0, 1)

On the basis of the corrected vitamin C intake men and women were defined into a group below and a group above the lowest recommended dietary intake of vitamin C (30 mg/d). The mean corrected vitamin C intake was 17.8±8.7mg/d in men and 15.8±8.9 mg/d in women with a low corrected intake. The corresponding values were 68.7±39.1mg/d and 69.1±28.6 mg/d respectively for men and women with a high corrected vitamin C intake. The effective correction factor was 0.36 in the low vitamin C consumers and about 0.50 in the high vitamin C consumers.
A low vitamin C intake could be expected to result from a low energy intake. However, no significant differences in energy intake existed between the groups of vitamin C intake (men, low = 9.2±2.1 MJ/d, high = 9.3±1.6 MJ/d; women, low = 7.0±1.6 MJ/d, high = 7.7±2.2 MJ/d).

The lower vitamin C intake appeared to result from an unfavourable food selection. In consumers with a low corrected vitamin C intake, potatoes and cabbages contributed to more than 50% of the total vitamin C intake, with limited intakes of the more reliable vitamin C sources, such as fruits and juices, which on the other hand were important sources of vitamin C in the group of high vitamin C consumers (see figure 1).

Factors which affect the actual vitamin C intake in elderly participants from the Danish and Dutch SENECA towns are outlined in table 4. No significant differences were found between the two groups of corrected vitamin C intake. In both the group with a low corrected vitamin C intake and the group with a high corrected vitamin C intake about sixty percent of the Danish and seventeen percent of the Dutch participants used vitamin C supplements. So the actual group of elderly people at risk of too low vitamin C intake was including 21 men and 23 women.
The majority of the participants had a cooked meal everyday. About half of the participants received home delivered meals every day. However, in women with a high vitamin C intake, the proportion receiving a home delivered cooked meal every day was only 38%.
About 80% of all women reported to prepare their own meals, while 42% of the men with a low vitamin C intake and 28% of the men with a high vitamin C intake always cooked for themselves. Two thirds of the men with a low vitamin C intake always reheated their left-overs, as compared to only half of the rest of the participants.

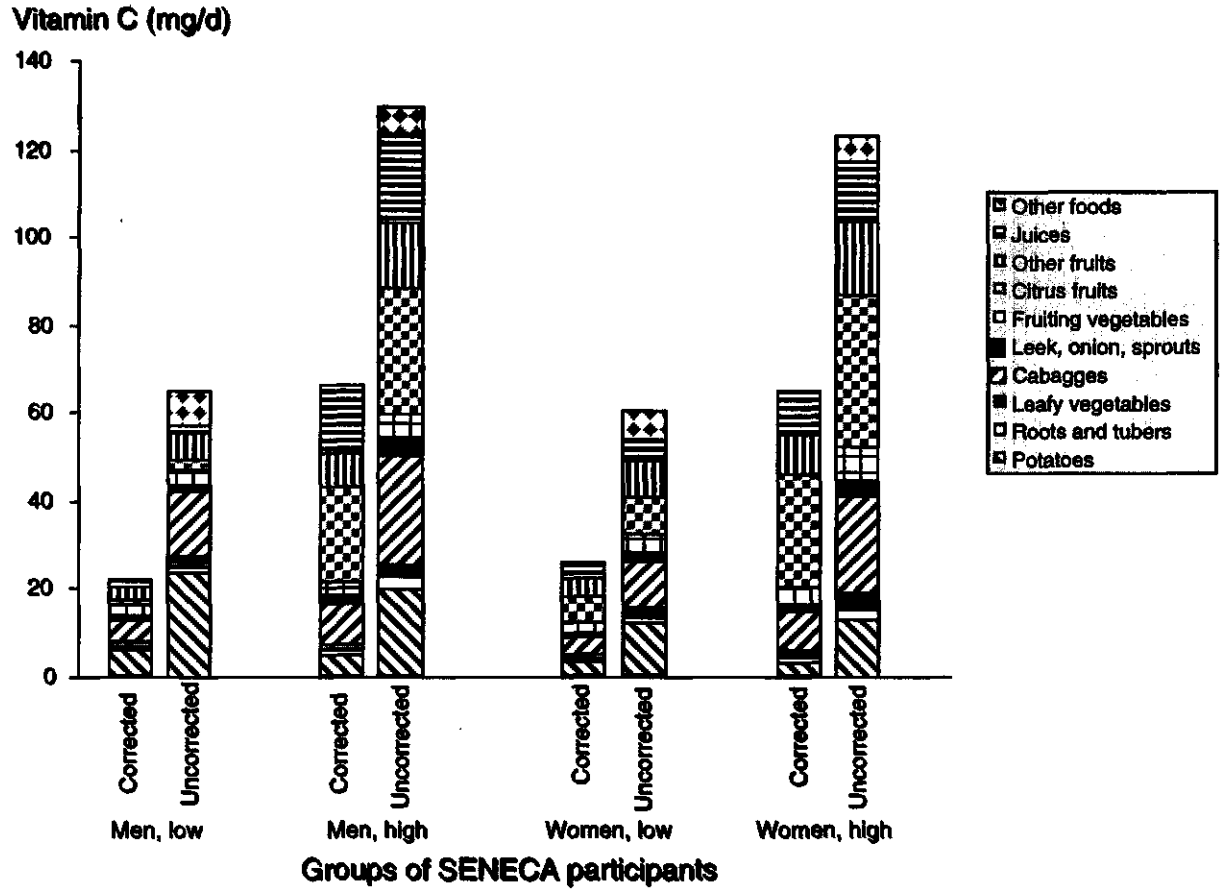

Figure 1. Foods contributing to vitamin C intake (*corrected* and *uncorrected*) in Danish and Dutch SENECA participants classified into groups of a low (< 30 mg/d) and a high (≥ 30 mg/d) *corrected* vitamin C intake.

Table 4. Supplement use and food handling in 236 SENECA participants classified into groups of a low (<30mg/d) and a high (≥30mg/d) *corrected* vitamin C intake.

	Men		Women	
	Low	High	Low	High
	40	69	47	80
Use of vitamin C supplement	49%	54%	52%	52%
How often do you eat a cooked meal				
Every day	86%	96%	90%	90%
Regularly	14%	3%	10%	10%
Occasionally	0%	0%	0%	0%
What do you do with leftovers				
Throw away	9%	21%	27%	19%
Reheat aways	67%	47%	50%	45%
Reheat sometimes	14%	16%	15%	18%
Reheat never	0%	3%	0%	8%
Do not know	9%	13%	8%	9%

Discussion

This study showed that when vitamin C intake in the diet of elderly participants from the northern SENECA towns was calculated from raw values in food composition tables, the median vitamin C intake was more than twice as high as compared to intakes with values corrected for losses during food handling.

After correction for storage and cooking losses, the proportion of participants with vitamin C intakes below the lowest European recommended dietary intake (< 30mg/d) increased from one tenth to one third.

In the interpretation of these results the following points should be taken into account: Correction factors, food composition tables and population.

Correction factors

The classification system developed to correct for vitamin C losses is based on laboratory studies of retention times of vitamin C after 1 weeks storage at 4°C and use of generalised cooking methods. A direct analysis of the foods contributing to vitamin C intake would be appropriate to test the validity of the developed classification system. However, a marked basket analysis was impossible in the context of the SENECA surveys. Löwik *et al* (1993) measured vitamin C retention by direct analyses of different food samples taken after preparation and distribution of meals in a nursing home. The vitamin C losses were comparable to our findings.

Because food intake in SENECA is coded as the raw ingredient, the classification system corrects for losses of the raw coded, cooked eaten food. Classification of a cooked coded food can be derived from the 'raw coded' variant. The cooked variant is hereby classified into one class higher (lower loss) than the raw variant. For example 'raw coded' potatoes are defined into class E, meanwhile 'cooked coded' potatoes are defined into class D.

The classification system used to correct for cooking and storage losses was developed on the basis of the stability of the vitamin C content of different food items. Since any food can be classified into this system, it may also be applied to other food cultures. The food patterns in the different SENECA towns will, however, affect the magnitude of the correction factor. The diet of the southern SENECA towns (Schroll *et al.* 1996) with a high content of fresh fruits and vegetables is expected to have a much lower correction factor, than those found in the northern SENECA towns.

The classification system did not take vitamin C losses due to heat retention in home delivered meals or losses due to re-heating of left-overs into account. Cooking losses of vitamin C vary from 0 to 100% dependent on treatment (Southgate & Johnson, 1993). Given long storage time, long warm holding and re-heating of foods it is shown, that the vitamin C content of these meals is virtually equal to zero (Holland *et al.* 1991). The proportion of elderly people at risk of too low vitamin C intake may therefore be larger than calculated on the basis of this correction factor. On the other hand, when energy intake as measured by a similar modified dietary history method was compared with energy expenditure measured in metabolic rooms, energy intake appeared to be underestimated by the diet history method by about 12% compared to energy expenditure (Visser *et al.* 1995). This means that the number of people with marginal vitamin C intakes might be overestimated from this study.

Besides, about fifty percent of the participants used vitamin C supplementation, which improve vitamin C status in participants with a low consumption of vitamin C containing foods.

Food composition tables

For technical reasons the newest Danish and Dutch food composition tables have been used in this study. The use of the old (NEVO, 1986) and the new (NEVO, 1996) version of the Dutch tables resulted in comparable values for vitamin C intake in participants from Culemborg/NL. Meanwhile, the use of the new Danish tables (Møller & Saxholt, 1996) as compared to the old ones (Møller, 1985) resulted in systematically higher values for vitamin C intake. Comparisons between vitamin C intake presented in this study and the results presented in former SENECA publications are therefore not sound.

For some foods, for instance cabbage, spinach and peas, the Danish table values for vitamin C were substantially higher than the Dutch . These results might reflect real differences in the vitamin C content, due to differences between Denmark and the Netherlands in variety, soil and cultivation methods. But the differences could also illustrate the difficulties in getting a precise measure of this very labile vitamin. This further underlines the importance of caution in the interpretation of results based on food composition tables alone.

Population

Analysis of socio-economic background, body composition and food pattern across SENECA towns have shown that the Danish and Dutch participants are comparable with regard to these factors (de Groot *et al.* 1996; Schroll *et al.* 1997). We found it therefore acceptable to pool the data for the characterisation of high and low vitamin C intakes in participants from the northern SENECA centres. Dietary histories from Roskilde/DK and Culemborg/NL are not representative for the dietary pattern in Europe (Schroll *et al.* 1996). This was, however, not needed for our purpose, i.e. illustrating how to estimate the vitamin C intake in elderly people.

The low vitamin C intake in participants with a corrected vitamin C intake lower than 30 mg/d appeared to result from an unfavourable food selection, since the major vitamin C sources were cabbages and potatoes, which are prone to cooking losses. The diet contributing to a high vitamin C intake was characterised by a variety of vegetables, citrus fruits and juices, the latter being less vulnerable for cooking losses.

The actual vitamin C status of elderly people is practically hard to evaluate in these types of field surveys, however, studies in Dutch nursing home residents indicates that at least one third has an inadequate vitamin C status as compared to less than 4% in independently-living elderly people (Löwik *et al.* 1993, van der Wielen *et al.* 1995).

In an analysis of socio-cultural patterns of eating behaviour across SENECA towns Schlettwein-Gsell and Barclay (1996) found highly significant differences in meal structure between northern and southern European towns. They suggested that these findings would have an important impact on the total nutrient intake. This study supports their hypothesis. Clearly the major food sources of vitamin C in the northern diets were potatoes and cabbages, which are characteristic ingredients in Danish and Dutch traditional winter dishes. Fruiting and leafy vegetables hardly contributed to vitamin C intake as salads are not a natural part in the northern winter meal pattern. In the Danish nation-wide dietary survey (Haraldsdóttir *et al.* 1988) it was found, that the cooked meal was the major mediator of vegetables in the Danish diet, and thereby an important mediator of vitamin C.

Conclusion

In conclusion, values of vitamin C intake estimated from data for unprocessed foods in food composition tables underestimate the number of people at risk of inadequate intake of vitamin C. Since food composition tables cannot include all storage and cooking methods of a food item to make up for this, it is the responsibility of the food composition table user to evaluate the reliability of the vitamin C sources consumed in the assessment of vitamin C status. Such an evaluation should also be considered for other labile vitamins like folic acid in the nutritional evaluation of the diet of elderly people.

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Appendix 1. Correction factors applied for foods consumed in the Northern SENECA towns

Apple	0.50
Apple, pie	0.56
Apple, stewed	0.56
Avocado	0.50
Banana	0.50
Beans, green	0.25
Beans, runner	0.25
Berries	0.75
Broccoli	0.38
Brussels sprouts	0.38
Cabbage, Chinese	0.50
Cabbage, red	0.38
Cabbage, Savoy	0.38
Cabbage, white	0.38
Carrots	0.38
Cauliflower	0.38
Cherries	0.75
Chervil	0.38
Chicory	0.13
Corn	0.38
Courgette	0.56
Cucumber	0.50
Curly kale	0.13
Endive	0
Fruit, (non-citrus)	0.50
Fruits, canned	0.50
Fruits, dried	0
Garlic	0.38
Grapefruit	0.75
Horseradish	0.38
Juice, berries	0.75
Juice, grapefruit	0.75
Juice, lemon	0.75
Juice, Orange	0.75
Juice, tomato	0.56
Kiwi	0.75
Kohlrabi	0.38
Leek	0.38
Liver	0
Mandarin	0.75
Mango	0.75
Melon	0.50
Milk, whole	0
Onion	0.38
Orange	0.75
Parsley	0.56
Peaches	0.75
Pear	0.50
Peas	0.25
Pepper, green	0.56
Pepper, red	0.56
Pineapple	0.75
Pizza	0
Plum	0.75
Potatoes	0.25
Pumpkin	0.56
Radish	0.50
Rhubarb	0.50
Salad	0.50
Sauerkraut	0.56
Spinach	0.25
Strawberry	0.75
Tomato	0.75
Tomato ketchup	0.56
Vegetables, mixed	0.38
Vegetables, raw	0.50
Vegetables, soup	0.38
Vegetables,winter	0.38

5

Longitudinal changes in weight, energy intake and physical activity over four years and associated health factors in Danish and Dutch elderly people

Submitted as:

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Longitudinal changes in weight, energy intake and physical activity over four years and associated health factors in Danish and Dutch elderly people.

Abstract

Changes in energy balance, body composition, health and performance were described for Danish and Dutch participants from the longitudinal Survey in Europe on Nutrition and the Elderly, a Concerted Action named SENECA, to test the hypothesis that poor health promotes weight loss via a decrease in energy intake. Of the 202 Danish and 238 Dutch men and women surveyed in 1988/89, 115 Danes and 132 Dutch people were re-examined in 1993.

Data on energy intake, anthropometry, health and physical activity were collected in a standardised way by trained investigators. Average body weight did not change significantly ranging from -0.3 kg to 0.5 kg, height declined significantly by 2.2 cm to 0.7 cm and energy intake declined significantly ranging from 1.0 MJ/d to 0.1MJ/d between the two SENECA surveys. Although disability increased from baseline to follow-up, most participants still perceived their health as good and were able to continue an independent life.

Overall no association was found between weight loss, energy intake, physical activity or smoking. The 33 weight losers (loss $\leq$ 3.5 kg) were characterised by disability at baseline, more chronic diseases at follow-up, and a greater decline in circumferences of the arm, waist and hip than the 124 weight stable participants.

In conclusion, the results confirm that weight loss as well as changes in waist, arm and hip circumferences were indicators of poor health. Disability precedes disease manifestation and weight loss, while decrease in energy intake as an intermediary factor could not be proven.

Introduction

Energy requirements decrease with age mainly because of a lower level of physical activity and changes in body composition [1-3]. Adaptations of energy intake to a lower energy requirement leave the elderly person at risk of improper energy balance [4-5]. Improper energy balance is associated with health risks [6].

A positive energy balance may result in overweight and obesity [1]. While obesity is a risk factor for a cluster of diseases in the elderly, the relationship between overweight and health is ambiguous in old age [7-10].

A negative energy balance results in weight loss, and especially involuntary weight loss is associated with morbidity and mortality [11-12]. Involuntary weight loss might be induced by poor health [13-14]. A low energy intake makes it more difficult to compose a nutrient dense diet, which together with weight loss renders the elderly person more susceptible to disease [15-16].

The Survey in Europe on Nutrition and the Elderly, a Concerted Action, (SENECA) was started in 1988/89 to study the role of nutrition on health and performance in ageing populations. This survey included 70-75 year old, mainly non-institutionalised people living in 19 European communities [17]. The longitudinal follow-up study was conducted in 9 of these communities in the first part of 1993.

Over the four years of follow-up the elderly people studied were expected to undergo changes in body composition, energy intake and physical activity, as a consequence of a combination of ageing, changes in lifestyle, living conditions and health.

This paper describes changes in energy balance, health and performance in participants from the SENECA centres Roskilde (R/DK) and Culemborg (C/NL) and further aims to compare a weight losing and a weight stable group over a four year period for changes in energy intake, health, physical activity and smoking.

It is hypothesised that poor health promotes weight loss via a decrease in energy intake. This relationship might be modified by smoking and physical activity.

Methodology

Study population

In 1988/89 as part of the SENECA study a randomised, non-proportional stratified sample of Danish and Dutch elderly men and women born in 1913-1918 was drawn from registration lists of the municipalities of Roskilde and Culemborg. Subjects living in psycho-geriatric nursing homes, not fluent in the country's language or not at all able to answer questions independently were excluded [17]. The response rate at SENECA baseline was 46% in the Danish centre and 37% in the Dutch centre. Most important reasons for non-response were "too tired", "too ill" and "lack of time" for Danish and Dutch elderly. It was demonstrated from data collected that main results regarding the background population were only slightly affected by differences between participants and non-participants [17]. The study was approved by Danish and Dutch ethic committees, and written consent was obtained from the participants.

Of the 202 elderly Danes studied in Roskilde at SENECA baseline, 115 (57%) were followed up in spring 1993. In Culemborg, 238 Dutch elderly were surveyed in 1988/89 and 132 (55%) of those participated in the follow-up study. Reasons for non-participation were death (16%, 16% in Roskilde and Culemborg respectively), disease (12%, 8%) lack of time (10%, 7%) and other reasons (4%, 13%).
Roskilde has 48,950 inhabitants and is situated on the island of Zealand. Culemborg is a suburban town with 20,604 inhabitants, situated in the centre of the Netherlands.

All data were collected in a standardised way by trained investigators following the instructions given in the SENECA manual of operations [18].

Dietary methods

Dietary intake data were collected by a modified version of the dietary history method [19-20] consisting of an estimated 3-day record and an interview on the subjects' usual food intake pattern, covering the previous month as the reference period. Portion sizes were recorded in household measures, whereby portion sizes of the foods most frequently used were weighed by the

interviewer. Food consumption data were converted into energy and nutrients locally, by the use of the Danish [21] and Dutch [22] food composition tables.

General standardised questionnaire

From a general standardised questionnaire data on education type, marital status, health and physical activity were obtained.

Health status was assessed from questions on presence of chronic disease, self-perceived health and Activities of Daily Living (ADL) [23-24]. ADL was assessed by 16 questions and for each of them the level of competence was measured on a 4-point scale. A total ability score was calculated as the sumscore over all items ranging from 16 to 64. The lower the rating the better the score.

At follow-up, the level of physical activity was based on Voorrips' activity questionnaire on housework, leisure time activity and sports [25]. Tertiles of Voorrips' activity score (range = 0-43.0) were used to characterise each participant's level of activity as sedentary, moderately active and physically active (the higher the score, the more physically active). Questions on relative activity level, and activity level at follow-up compared to four years earlier were also included in the description of activity level.

Anthropometric methods

The standing height was measured (to the nearest 0.1 cm) using a wall-mounted measuring tape. The subject was standing (without shoes) with heels together and the Frankfurt plane horizontal. Body weight was measured in the morning, after breakfast. Weight was measured to the nearest 0.5 kilo with the subject clothed only in light undergarment. A calibrated weighing scale was used for the measurement. On the basis of weight change, participants were classified as weight losing (loss $\leq$ 3.5 kg) or weight stable (change = +/- 2.0 kg). Other participants (weight loss (-3.5 < change < -2.0 kg) or weight gain (change > 2.0 kg)) were not included in the analysis of weight loss and health. From height and weight the body mass index (BMI kg/m^2) was calculated.

Mid-upper-arm, waist and hip circumferences were measured with the subject standing with the feet fairly close together and weight equally divided over both legs. Measurements were done in duplicate using a plastic tape measure (accurate to 1 mm). Measurement site was clearly indicated by drawings.

Data analysis

Means and standard deviations of continuous variables were calculated, as well as the change in variables. The paired t-test and Wilcoxon's signed rank test were used for tests of differences in parameters between baseline and follow-up. Chi-square was used for the testing of nominal variables. Ordered classifications were tested by Kendall's Tau c. Differences between values were regarded as significant when the p-value was < 0.05.

Socio-economic, health and lifestyle variables were compared between responders and non-responders at follow-up to find out how non-response affected the results.

Because of the low number of participants at follow-up, an analysis of factors associated with weight loss was not possible by centre. Baseline values for Danish and Dutch participants were compared by the non-paired t-test to check whether pooling was reasonable.

All analyses were carried out using the statistical analysing system SAS version 6.07 (SAS institute INC., Cary NC).

Results

Participation at follow-up

Due to selective participation the subjects studied at follow-up (n = 115, R/DK, n = 132, C/NL) were slightly different from those who were not able to, or not willing to participate a second time (n = 87, R/DK, n = 106, C/NL) (table 1a-b).

Differences in characteristics of participants compared to non-participants, as appeared from the baseline survey, were:

- -Higher level of education in participants from Roskilde/DK and in men from Culemborg/NL.
- -Less chronic disease, better self-perceived health, more physical activity and less smoking especially in elderly men from Roskilde/DK,
- -Better ability to perform all activities of daily living without difficulty in participants from both SENECA centres.

Table 1a. Socio-economic, health and activity characteristics at SENECA baseline (1988/89) and at SENECA follow-up (1993) in elderly Danish and Dutch men participating only at baseline and in men participating in both studies.

		R/DK			C/NL		
Measurement time		1988/89		1993	1988/89		1993
Participation		baseline only	baseline + follow-up	follow-up	baseline only	baseline + follow-up	follow-up
n		44	57	57	54	60	60
Characteristics							
Education			*			*	
primary	(%)	41	21		48	32	
secondary	(%)	50	62		48	57	
higher	(%)	9	17		4	12	
do not know	(%)	0	0		0	0	
Marital status							
single	(%)	5	7	7	6	3	4
partner	(%)	81	81	85	94	94	92
alone	(%)	14	12	7	0	3	4
Chronic disease							
	(%)	75	57	57	61	63	50
Selfperceived health			*				
poor	(%)	5	2	7	0	3	3
fair	(%)	34	19	19	28	12	20
good	(%)	61	79	74	72	85	76
Ability to manage all ADL items			*	†		*	†
	(%)	30	62	59	35	58	47
Relative activity			*			*	
less active	(%)	9	2	18	17	2	9
average active	(%)	48	30	18	36	28	25
more active	(%)	43	68	63	47	70	66
Current smoking			*		§		
	(%)	61	34	30	41	38	38

The chi-square test was used to test nominal variables and Kendall's Tau C to tests ordered classifications.

* Significant difference between subjects studied only at baseline and subjects studied both at baseline and follow-up ($p<0.05$)

† Significant difference within a group between values at baseline and follow-up

‡ Significant difference between genders ($p<0.05$)

§ Significant difference between centres within a gender group ($p<0.05$)

Table 1b. Socio-economic, health and activity characteristics at SENECA baseline (1988/89) and at SENECA follow-up (1993) in elderly Danish and Dutch women participating only at baseline and in women participating in both studies.

Measurement time		R/DK 1988/89		1993	C/NL 1988/89		1993
Participation		baseline only	baseline + follow-up	follow-up	baseline only	baseline + follow-up	follow-up
n		42	58	58	53	72	72
Characteristics							
Education			*				
primary	(%)	64	48		55	46	
secondary	(%)	33	38		43	46	
higher	(%)	0	10		2	7	
do not know	(%)	2	3		0	0	
Marital status							
single	(%)	2	9	9	2	11	12
partner	(%)	93	81	74	98	86	82
alone	(%)	5	10	17	0	3	6
Chronic disease						‡	†‡§
	(%)	81	81	75	77	70	58
Selfperceived health			*			‡	
poor	(%)	14	5	12	4	0	5
fair	(%)	29	14	9	33	23	25
good	(%)	57	81	79	62	77	71
Ability to manage all ADL items			*	†	‡	*‡§	†‡§
	(%)	24	56	40	21	38	18
Relative activity						‡	
less active	(%)	21	2	9	14	9	15
average active	(%)	46	52	28	37	31	24
more active	(%)	33	46	63	50	60	62
Current smoking					‡§	‡§	‡§
	(%)	44	28	22	6	4	3

The chi-square test was used to test nominal variables and Kendall's Tau C to tests ordered classifications.

* Significant difference between subjects studied only at baseline and subjects studied both at baseline and follow-up ($p<0.05$)

† Significant difference within a group between values at baseline and follow-up

‡ Significant difference between genders ($p<0.05$)

§ Significant difference between centres within a gender group ($p<0.05$)

Change in variables between baseline and follow-up

Comparison of longitudinal data reveals, surprisingly, that the prevalence of chronic disease was significantly lower at follow-up than at baseline in women from Culemborg/NL. More participants perceived their health as poor at follow-up than at baseline. This finding was, however, not significant. Significantly less men and women were able to manage all activities of daily living without difficulty at follow-up than at baseline. In 1993 more subjects than in 1988/89 perceived themselves as less active, than other people of the same age.

Differences between centres and genders

At both baseline and follow-up more women from Roskilde/DK were able to manage all ADL items and smoking was more prevalent in this group than women from Culemborg/NL (tables 1a-1b). Chronic disease was more prevalent in women from Roskilde/DK than in women from Culemborg/NL in both SENECA surveys. Significantly more elderly people from the Dutch centre (61% of the men and 72% of the women) than from the Danish centre (38% of the men and 47% of the women) perceived themselves as less active at follow-up than at baseline.
According to Voorrips' physical activity score elderly men and women from Roskilde/DK were significantly more active than men and women from Culemborg/NL (mean and standard deviations were 13.5±9.1 for Danish men and 11.6±7.5 for Danish women and 8.6±6.9 for Dutch men and 6.7±5.9 for Dutch women).

Chronic diseases were significantly more often reported in women than in men and fewer women than men were able to manage all ADL activities without difficulty at the follow-up study. Significantly fewer women than men were current smokers in 1988/89 and in 1993.

Energy intake and Anthropometry

In tables 2a and b energy intake and measures of body composition are presented.
On average energy intake decreased (-0.9 MJ/d) significantly among participants of both genders from Roskilde/DK and in men from Culemborg/NL over the four years of follow-up. The average energy intake in the women from Culemborg/NL did not change between baseline and follow-up.

The average body weight did not change (-0.1 kg) significantly over the period of follow-up. Averages of differences in height indicated a small but significant loss of height (-1.6 cm) in all participants. During follow-up values for BMI increased, but not significantly.
Average differences of circumference of the upper-arm indicated a significant decrease in arm circumference between baseline and follow-up in participants from the Danish SENECA centre, while no significant change was observed in Dutch participants. The hip circumference was significantly lower at follow-up in men from Roskilde/DK than at baseline. The waist circumference was significantly higher in men from Culemborg/NL at follow-up than at baseline. On average the waist to hip ratio (WHR) did not alter significantly over the four years of follow-up. Data on height, BMI and WHR are presented elsewhere [26].
Over all, the anthropometric measures at baseline and follow-up were lower in women from Roskilde/DK than in women from Culemborg/NL, and the decline in these measures tended to be greater in women from the Danish than in women from the Dutch SENECA centre.

Associations between weight loss, health and performance

A comparison of changes in energy intake and body composition variables between the weight losing and weight stable group is shown in table 3. No significant difference in change in energy intake or height were found between the two groups of weight change status.

Circumferences declined significantly more in the group of weight losers, than in the weight stable group. However, the WHR was not affected by the changes in circumferences.

Table 4 shows a comparison of health, smoking and activity parameters between groups of weight change status at SENECA baseline and follow-up.
The prevalence of chronic diseases was significantly higher ($p=0.01$) in subjects losing weight than in weight stable subjects. While the prevalence of chronic diseases increased between baseline and follow-up in the weight losing group, the opposite trend was seen in the weight stable group and in the overall analysis of Danish and Dutch subjects (table 1a-1b).

Table 2a. Changes in energy intake, body weight, height, BMI, circumferences of the upper arm, waist, hip and WHR in Danish and Dutch elderly men participating in both the SENECA baseline (1988/89) and follow-up (1993).

		R/DK						C/NL					
		1988/89		1993		Change		1988/89		1993		Change	
		Mean	sd	Mean	sd	Mean	sd	Mean	sd	Mean	sd	Mean	sd
Men													
n		57		57		57		60		60		60	
Energy	(MJ)	10.3	2.1[a]	9.4	1.7[a]	-0.9	2.1[a*]	10.1	2.2[c]	9.2	1.8[c]	-1.0	1.9[c*]
Weight	(kg)	76.2	10.1[c]	76.7	11.2[c]	0.5	3.7[c]	76.5	9.8[c]	76.3	10.3[c]	-0.2	2.9[c]
Upper arm	(cm)	30.4	2.3[d]	29.8	2.4[d]	-0.6	1.4[d*]	30.4	2.7[d]	30.4	2.6[d]	0.0	1.1[d]†
Waist	(cm)	99.9	9.2[d]	98.8	9.0[d]	-1.1	3.9[d]	97.5	8.1[d]	99.0	8.7[d]	1.5	3.7[d*]†
Hip	(cm)	107.3	6.1[d]	105.3	7.0[d]	-2.0	4.4[d*]	100.6	6.0[d]†	101.1	5.6[d]†	0.5	2.7[d]†

Students t-test was used to test normal distributed variables.
a = 1-3 missing values, b = 4-6 missing values, c = 7-9 missing values, d = 10-12 missing values, e = 13-15 missing values
Missing values on energy intake in 1993 resulted from various personal reasons.

Reasons for missing values on body composition were refusal, illness and oedema.

* Significant difference between baseline and follow-up values ($p<0.05$)
† Significant difference between centres within a gender group ($p<0.05$)

Table 2b Changes in energy intake, body weight, height, BMI, circumferences of the upper arm, waist, hip and WHR in Danish and Dutch elderly women participating in both the SENECA baseline (1988/89) and follow-up (1993).

		R/DK						C/NL					
		1988/89		1993		Change		1988/89		1993		Change	
		Mean	sd	Mean	sd	Mean	sd	Mean	sd	Mean	sd	Mean	sd
Women													
n		58		58		58		72		72		72	
Energy	(MJ)	7.9	1.8[a]	7.2	1.7[a]	-0.7	1.5[a*]	7.7	2.1[a]	7.6	2.4[a]	-0.1	2.2[a]
Weight	(kg)	62.4	11.2[b]	62.0	12.3[b]	-0.3	5.6[b]	71.2	10.9[c]†	70.9	11.1[c]†	-0.3	3.8[c]
Upper arm	(cm)	29.0	3.2[d]	28.0	3.1[d]	-1.0	1.6[d*]	30.9	3.3[d]†	31.1	3.1[d]†	0.2	1.7[d]†
Waist	(cm)	86.2	11.4[d]	84.6	11.7[d]	-1.6	8.0[d]	95.3	10.3[e]†	95.7	11.3[e]†	0.4	7.8[e]
Hip	(cm)	103.3	10.2[d]	101.6	9.6[d]	-1.7	5.9[d]	104.3	8.7[d]	104.5	8.7[d]	0.1	3.9[d]

Students t-test was used to test normal distributed variables.
a = 1-3 missing values, b = 4-6 missing values, c = 7-9 missing values, d = 10-12 missing values, e = 13-15 missing values
Missing values on energy intake in 1993 resulted from various personal reasons.

Reasons for missing values on body composition were refusal, illness and oedema.

* Significant difference between baseline and follow-up values ($p<0.05$)
† Significant difference between centres within a gender group ($p<0.05$)

Table 3. Analysis of changes between SENECA baseline (1988/89) and follow-up (1993) in energy intake and anthropometric measures in elderly Danish and Dutch men and women with a weight loss (change = -3.5 kg or more) or with a stable body weight (change = +/- 2.0 kg).

		Weight loosing group		Weight stable group	
Men:		15		58	
		Mean	sd	Mean	sd
Δ Energy	(MJ)	-1.3	1.9	-1.1	1.8
Δ Height	(cm)	-1.0	2.1	-1.4	1.8
Δ Arm circumference	(cm)	-1.2	0.8	-0.4	1.3*
Δ Waist circumference	(cm)	-2.8	2.6	-0.1	3.5*
Δ Hip circumference	(cm)	-3.2	3.6	-0.7	3.7*
Women:		18		64	
		Mean	sd	Mean	sd
Δ Energy	(MJ)	0.0	1.7	-0.2	2.1
Δ Height	(cm)	-2.3	2.8	-1.6	1.7
Δ Arm circumference	(cm)	-1.9	2.3	-0.4	1.5*
Δ Waist circumference	(cm)	-6.8	9.0	-0.1	6.9*
Δ Hip circumference	(cm)	-4.9	4.5	-0.9	3.8*

Students t-test was used to test normal distributed variables.

*significant difference between the weight loosing and the weight stable group ($p<0.05$)

In both groups of weight status more people at follow-up than at baseline perceived their health as poor and relative activity as low. Also the activity at follow-up compared to four years ago was perceived as lower. Based on Voorrips' activity score weight losing and weight stable participants were ranked into the same tertiles of activity (mean and standard deviations for activity scores for the weight losing and weight stable groups were 11.4 ± 10.6 for men and 10.3 ± 8.3 for women and 11.1 ± 7.4 for men and 9.4 ± 7.4 for women). Elderly people with weight loss were significantly more disabled at baseline (p=0.01) than the group of weight stable elderly.

There were relatively more smokers in the weight losing group than in the weight stable group, however, this difference was not significant.

Table 4. Comparison of health and activity variables at SENECA baseline (1988/89) and follow-up (1993) in elderly Danish and Dutch men and women with a weight loss (- 3.5 kg or more) and a stable body weight (change = ± 2.0 kg).

	Weight loosing group (n=33)				Weight stable group (n=124)			
	1988/89		1993		1988/89		1993	
	n	%	n	%	n	%	n	%
Chronic disease	24	73	29	88	83	67	70	56
Selfperceived health								
poor	0	0	1	3	5	4	9	7
fair	10	33	10	30	18	15	21	17
good	23	70	21	64	101	81	94	76
do not know	0	0	1	3	0	0	0	0
Relative activity								
less active	1	3	7	21	5	4	15	12
as active	14	42	8	24	48	39	26	21
more active	16	48	17	52	68	55	80	65
do not know	2	6	1	3	3	2	3	2
Activity compared to 4 years ago								
less active			22	66			66	53
as active			8	24			53	43
more active			3	9			5	4
Ability to manage all ADL items							*	
	11	33	10	30	73	59	55	45
Smoking status								
never			13	39			53	42
former			9	27			47	38
current			11	33			24	19

The chi-square test was used to test nominal variables and Kendall's Tau C to tests ordered classifications.
*Significant difference between weight status groups

Discussion

In this population of mainly healthy elderly people, only few changes occurred on average in energy balance, health and performance over the four years of follow-up. The hypothesis, that poor health promotes weight loss via a decrease in energy intake could not be confirmed. Weight losers were, however, characterised by more disability at baseline and an increased prevalence of chronic diseases at follow-up . Considering these results we have to realise that the data concerned those Danish and Dutch subjects who were willing to participate at both SENECA baseline and at SENECA follow-up. Comparisons of health and lifestyle characteristics at baseline between participants and non-responders showed that participants had a longer education, a better health, they were more physical active and they smoked less. These findings were in accordance with the assessment of selection bias in the total SENECA population [27].
If all participants had been re-examined it might be expected, that changes in energy balance, body composition and health parameters would be more pronounced and the association between weight loss and chronic diseases stronger.

We found it acceptable to pool the data for comparison of weight losers and weight stable of the two centres for two reasons:
1) Significant differences in most baseline values were not found between the two centres and
2) Both centres are situated in Northern Europe, therefore it was expected that weight status was a stronger determinant for health status than nationality.
Investigators from the Nordic study on Ageing assumed similarly, that cross-national differences were less important determinants than inter-individual differences for functional capacity of 75 year old Scandinavians [28].

The rationale for a study population ageing from 70-75 to 74-79 years was, that most elderly people are reasonably healthy when they enter the eighth decade, but at the same time vulnerable to changes in health and performance at the end of the same decade [29-30]. The participants' health and performance were therefore expected to decline over the four years of follow-up. These expectations were supported by poorer self-perceived health, lower activity level and more disability. However, participants from both SENECA centres reported fewer chronic diseases at the

re-examination. This may be explained by a longer time distance to morbid events at follow-up, to effective treatment of diseases between the two studies, or participants became less conscious of disease with age.

Energy intake declined by about 10% between baseline and follow-up. This was twice the decline assumed by the Danish Nutrition Council in their Recommendations for the elderly. The energy intake at both baseline and follow-up was, however, within the reference values recommended for healthy elderly people (> 75 years) by both the Danish and Dutch Nutrition councils [31-32].
In the evaluation of the dietary method used, the actual energy intake was compared with the physical activity index (PAI). PAI is equal to energy intake divided by the basal metabolic rate (BMR). BMR was estimated from FAO/WHO/UNU's formulas [33]. PAI expresses energy requirements as a multiple of BMR for persons involved in different levels of activity (restricted = 1.27xBMR, sedentary = 1.40xBMR, light = 1.55xBMR and moderate =1.8xBMR).
The mean PAI of the participants (men = 1.5xBMR, women = 1.4xBMR) indicated that the method used to determine energy intake, did not estimate habitual intake below physiological needs of this group [34]. An energy intake equal to 1.4xBMR, however, only covers the energy cost of relatively inactive persons [2]. Some underreporting of the energy intake seems, therefore, to be present, since most of the elderly studied reported that they were engaged in household and leisure time activities equal to an energy cost of light activity. Underestimation of energy intake has been found in most validation studies on energy intake including those conducted in elderly people [35-36].

On the basis of Danish and Swedish longitudinal studies we expected a decrease in weight of 2-3 kg per decade [37-38]. On average weight change was small and did not change significantly in our study population, but the comparison of data with the non-participants suggests, that participants belonged to a very healthy group, in which only minor changes in weight status were likely to occur. About 14% of the population lost weight, 53% were weight stable and 21% gained weight. The other participants had minor changes in weight, or data were missing. Deeg et al. reported similar changes in a Dutch longitudinal study on elderly ageing on average from 73-78 years of age (15% had a considerable weight loss, 50% changed weight by 0.5 -2.5 kg, 30% did not change weight and 4% gained weight) [12].

Most cross-sectional studies show differences in height by 5 to 7 cm between 30 year old people and 70 year old people [4, 39]. In our study height declined significantly by 1.6 cm. This is more than the loss of 1-2 cm per decade reported in groups of participants from the Baltimore population (68-78 years) [40] and the Gothenborg population (70-82 years) [38].

Data on circumferences of the arm, hip and waist were up to 5% higher, but within the same range of distribution as data on 65 year old Danes and 75 year old Americans [41-42]. While circumferences decreased with age in participants from Roskilde/DK, the opposite was found in participants from Culemborg/NL. Shimokata et al. showed higher circumferences with increasing age in a cross sectional study of 70-96 year old elderly from Baltimore [42]. Campbell and Borrie showed the opposite trend in mid-upper-arm circumference in a cross sectional study in New Zealand of 70-90+ year old men and women [43].

The lower anthropometric measures in women from Roskilde/DK than in women from Culemborg/NL might be explained by the fact, that Danish women were less disabled, they were more active and they smoked more than Dutch women. This relationship is also found in cross-sectional analyses of physical activity, functional ability and BMI in women participating in SENECA's baseline study[44].

In the analysis of variables associated with weight loss a pathway from poor health over decline in energy intake to weight loss could not be shown.
Possibly the method used to measure energy intake was not sufficiently precise to estimate the small difference in energy intake to account for the weight loss. Weight loss was, however, preceded by disability. Similarly Launer et. al. showed a twofold risk of disability in elderly women, participating in the NHANES I, and ageing from 66 to 79 years with a weight loss of 5% or more [45].
Lehmann and Bassey (1996) found no association between change in body weight, morbidity and mortality in a four year follow-up study of relatively healthy, non-institutionalised, British women (n=385) and men (n=244) aged 65 years and older. They suggested, that thinness is not an ominous sign, as long as old people are not severely dependent [46].

In conclusion the results of our study confirm, that weight loss is an indicator of poor health, and that circumference measures of the hip and waist indicate the same. Changes in energy intake, activity level or smoking habits could not be proven as intermediary factors in the relationship between poor health and weight loss.

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6

Importance of the diet in relation to disability in elderly Danes

Submitted as:

Kirsten Schroll, Merete Osler, Marianne Schroll, Lisette C.P.G.M. de Groot and Professor Wija A. van Staveren. Importance of the diet in relation to disability in elderly Danes

Abstract

Objectives: To characterise the diet of a group of elderly Danes and evaluate the healthfulness of the diet by different approaches.

Design: Longitudinal analysis of diet, health and performance in Danish SENECA participants.

Setting: Roskilde/ Denmark.

Subjects: 115 of the 202 Danes born between 1913-1918, who were examined at SENECA baseline (1988/89), were re-examined in 1993.

Main outcome measures: Nutrient adequacy was assessed by the ratio between the nutrient intake and the recommendations for that nutrient. A diet score, with eight dietary components with a likely protective function for a number of chronic diseases, was developed to predict disability in elderly people. Associations with health (chronic diseases, self-perceived health, self-reported impairments) and performance (tests of simple functions and self-reported ADL) were examined. Cluster analysis based on micronutrient intake was used to identify risk profiles.

Results: In a multivariate analysis the diet score, physical activity and disability at baseline significantly predicted disability four years later. On average the Danish diet met the requirements. Five dietary profiles were identified by cluster analysis: 'Danish core eaters' (n=90) with average intakes of energy and nutrients, 'Milk drinkers (n=20)'with high energy, calcium and riboflavin intakes. 'Small eaters' (n=50) with low energy and nutrient intakes, 'Male gourmands' (n=15) with high energy and nutrient intake and 'Green eating women' (n=8) having a low energy diet with a high nutrient content.

Conclusions: Dietary quality predicts functional ability in elderly Danes. Food profiles underlying more or less adequate nutrient intake can be identified, each of which need specific nutritional guidance in the prevention of disability.

Introduction

As life expectancy has increased the new health goal for elderly people is to enhance the quality of life with emphasis on autonomy. Good nutrition may be a factor in maintaining an independent life style (1,2). For elderly people this is not so easy, as energy intake decreases with increasing age, and the requirement for most nutrients do not change with age (3-7), it becomes more difficult to compose a diet of the required nutrient content.

Many different approaches have been used to evaluate the nutrient quality and the healthfulness of the diet. It is common practice to evaluate the dietary intake in populations by comparison with the recommended dietary allowances (8). Such a comparison can tell whether the study population meet the requirements for most nutrients.

To examine the healthfulness of the present diet of elderly people other instruments may be used, which are developed to predict different health outcomes (9). Recent prospective studies among the elderly in Greece and Italy have related specific diet scores, devised on the basis of characteristics of the Mediterranean diet, to overall survival (10,11). Osler analysed mortality data from the Danish part of SENECA baseline (Survey in Europe on Nutrition and the Elderly, a Concerted Action), and found that eating a Mediterranean type of diet also improves survival in a Northern European community (12).

Death is preceded by disability (13-17). It is therefore important to see whether a healthful diet may improve functional ability. A model called 'The disablement process' developed by Verbrugge and Jette describes how chronic and acute conditions affect functioning in specific body systems, physical and mental actions and activities of daily life and describes the personal and environmental factors that speed or slow disablement (health deterioration → impairments→ functional limitations→ disability) (18). This model is used here to indicate the different stages of the 'disablement process' in elderly Danes, where nutrition may have an important preventive role in maintaining a healthy active life.

Based on cluster analysis more or less favourable dietary profiles can be identified(19,20).

The purpose of this study is to characterise the diet of the Danish participants in the SENECA surveys, and evaluate the healthfulness of the diet by the different instruments described above.

Material and methods

SENECA is a mixed-longitudinal multi-centre survey on nutrition and health in elderly Europeans (21,22). The aim of SENECA is to study cross-cultural differences in nutritional issues and life-style factors affecting health and performance of elderly people in Europe. The SENECA baseline survey was conducted in 19 centres in Europe in 1988/89 and repeated in 9 centres in 1993 (21). The longitudinal findings were reported on in 1996 (22). All methods were highly standardised, using a detailed manual of operations (23) and central training of fieldwork co-ordinators.

Study population

In 1988/89 as part of the SENECA study a randomised, non-proportional stratified sample of Danish elderly men and women born in 1913-1918 was drawn from registration lists of the municipality of Roskilde. Roskilde has 48,950 inhabitants and is situated on the island of Zealand. Subjects living in psycho-geriatric nursing homes, not fluent in the country's language or not at all able to answer questions independently were excluded (24,25). The response rate at SENECA baseline was 46%. Of the 202 elderly Danes studied in Roskilde at SENECA baseline, 115 (57%) were followed up in spring 1993. Non-participation is described elsewhere (26-28). These data showed a tendency for healthy and active persons to have a higher participation rate than others. The study was in accordance with the Helsinki declaration II , approved by the Danish ethic committee, and written consent was obtained from the participants.

Dietary methods

Dietary intake data were collected by a modified version of the dietary history method (29-31) consisting of a 3-day record and an interview on the subject's usual food intake pattern, covering the previous month as the reference period. Portion sizes were recorded in household measures, whereby portion sizes of the foods most frequently used were weighed by the interviewer. Food consumption data were converted into energy and nutrients, using the Danish food composition table (32). Data on actual food intake were classified into main food groups by the EUROCODE system (33).

The Nordic Nutrient Allowances (NNA) were used to evaluate the nutrient adequacy of the diet, by dividing the individual daily dietary intake of a nutrient by age and sex specific NNA for that nutrient (the Nutrient Adequacy Ratio (NAR) (34-35).

A diet score was developed to predict disability in the elderly. The score was derived from the scores used by Trichopoulou (10) and Osler (12) and used to classify the diet of participants into categories of dietary quality. Based on a very likely protective function for a number of chronic diseases (36-42) the following eight dietary components each contributed with maximum points to the sum score , *i)* high consumption of cereals, *ii)* high consumption of fruits, *iii)* high consumption of vegetables (including potatoes and legumes), iv) moderate consumption of meat, v) moderate consumption of milk (excluding cream), vi) moderate intake of cheese, vii) high mono-unsaturated:saturated fat ratio and viii) moderate ethanol consumption. The quartile values specific for each sex was used as cut-off points. The potential score range was 0-24 points; the higher the score the better the supposed health effects of the diet (see table 1).

The diet score was modified in a number of ways: Quartile values were used as cut-off points for all the characteristics instead of medians. We did not adjust for energy intake, because recommendations on basis of an energy adjusted index are difficult to interpret, and the requirements of several nutrients are not related to energy intake. Instead, we corrected for energy intake in the regression analysis. We subdivided the group of dairy products into milk (excluding cream) and cheese. We introduced a high score for moderate intakes of alcohol, meat, milk and cheese, instead of a high score for the lowest intake. We had disability and not mortality as an outcome factor.

Table 1. Criteria, which were used to assign healthy diet values, largely based on the diet score described by Trichopoulou et. al. (10) and Osler et. al. (12).

Cereal	Lowest quartile=0, Median=1, Highest quartile=3
Fruit	Lowest quartile=0, Median=1, Highest quartile=3
Vegetable	Lowest quartile=0, Median=1, Highest quartile=3
Meat	Lowest quartile=0, Median=3, Highest quartile=0
Milk	Lowest quartile=0, Median=3, Highest quartile=0
Cheese	Lowest quartile=0, Median=3, Highest quartile=0
MUFA/SFA	Lowest quartile=0, Median=1, Highest quartile=3
Alcohol	Lowest quartile=0, Median=3, Highest quartile=0
Total score	Min = 0 Max = 24

General Standardised questionnaire

We used the model of the disablement process, as explained in the introduction, to derive indicators of the main pathway to disability.

Health

Health was self-reported, measured by questions on presence of chronic diseases and self-perceived health.

Impairment

Questions about problems with vision, hearing, mobility and chewing were asked to assess the level of impairment.

Functional limitations

The tests of simple function employed in the SENECA follow-up (43) add the chair stand and the tandem test from the NHANES (III) (44) to Reubens 7-item physical performance test (PPT) (45). Each test simulates a basic activity which is likely to be at the threshold for, what a 75-80 year old person is able to do. The subject performs an activity, while the examiner counts the seconds used or notice the stability and continuity whereby the task is performed. Seconds or stability are then transformed into a score from 1-4 according to a standardised scoring system. The higher the score the less seconds needed to perform a test. The sum-score of the 7-item PPT ranges from 7 to 28.

Disability

The capacity to perform activities of daily living (ADL) was assessed by 16 questions and for each of them the level of competence was measured on a 4-point scale. A total ability score was calculated as the sum-score over all items ranging from 16 to 64. The lower the rating the better the score. Mobility and self-care ability scores were calculated as the sum-score over all mobility and self-care items ranging from 4 to 16 and 7 to 28 respectively(46).

Other covariates

The participants age, sex, length of education, energy intake, current smoking, relative physical activity and supplement use were assessed to control for potential effects of confounding.

Data analysis

The percentile distribution of the nutrient adequacy ratio of micronutrient intake in elderly Danes was calculated from the NNA.

Elderly Danes were classified into quartiles of the diet score and the lower and the upper quartiles were compared by chi-square (nominal variables) and Kendall's Tau C (ordered variables) to health characteristics at SENECA baseline and follow-up. Differences between mean values were regarded as significant, when the p-value was < 0.05.

Multiple regression analysis was used to test the ability of the diet as a continuous variable at SENECA baseline to predict disability four years later, controlling for the above mentioned covariates and already existing disability at baseline.

Cluster analysis was used to classify individuals into a limited number of groups on the basis of similarity in nutrient adequacy. Subsequently, the consumption of food groups were characterised for the identified clusters. The nutrient adequacy ratios between the intake of vitamin B1, B2, B6, C, calcium and iron and the NNA for these nutrients were calculated and used as criteria for the cluster analysis. These criteria dimensions were chosen, because a considerable number of elderly Europeans had inadequate intakes of these nutrients both at SENECA baseline and follow-up (47,48). The criteria dimensions chosen were standardised to mean zero and variance one, whereby the SAS procedure 'FASTCLUS' was run. FASTCLUS finds disjoint clusters of observations using a k-means method applied to coordinate data. ANOVA followed by Tukey's multiple comparison test were used to characterise the food patterns of the identified clusters.

All analyses were carried out using the statistical program SAS system, version 6.07 (SAS institute INC., Cary NC).

Results

Subjects

Dietary histories were obtained from 96 men and 98 women, at SENECA baseline, 56 of the men and 58 of the women were re-examined in 1993. The average age was 73.2 years at SENECA baseline and 77.0 years at follow-up. The majority of men had at least secondary school, whereas in

women the majority had primary school. As compared to other people of the same age, participants were regarding themselves as average or more physical active (1989: men=96%, women=91%; 1993: men=81%, women=92%). About half of the men (45%) and one third of the women (35%) were smokers at baseline. This prevalence was reduced by 60% at follow-up.

Comparison with the Nordic Nutrient Allowances (NNA):

Comparison of the Danish diet with the NNA revealed that the mean intake of the Danish participants at SENECA baseline met the requirements for all nutrients (see figures 1a-d). The intake of fat (41 en%) was, however, much too high as compared to the guidelines of a maximum intake of 30 en% from fat. In line with this the carbohydrate intake (43 en%) was much lower than the guidelines recommending 55-60 en% from carbohydrate.

Energy intake decreased significantly over the 4 year follow-up period (1988/1989: men=10.1±1.9 MJ/d women=7.7±1.8 MJ/d; 1993: men=9.4±1.7 MJ/d women=7.2±1.7 MJ/d) and as a consequence of this intake of most nutrients also decreased significantly. Nevertheless, mean nutrient intake met the NNA at follow-up. An exception was, however, vitamin B1 in women. Fiftythree percent of the women, had a thiamin intake below 1.0 mg/d. The energy intake from fat was unchanged.

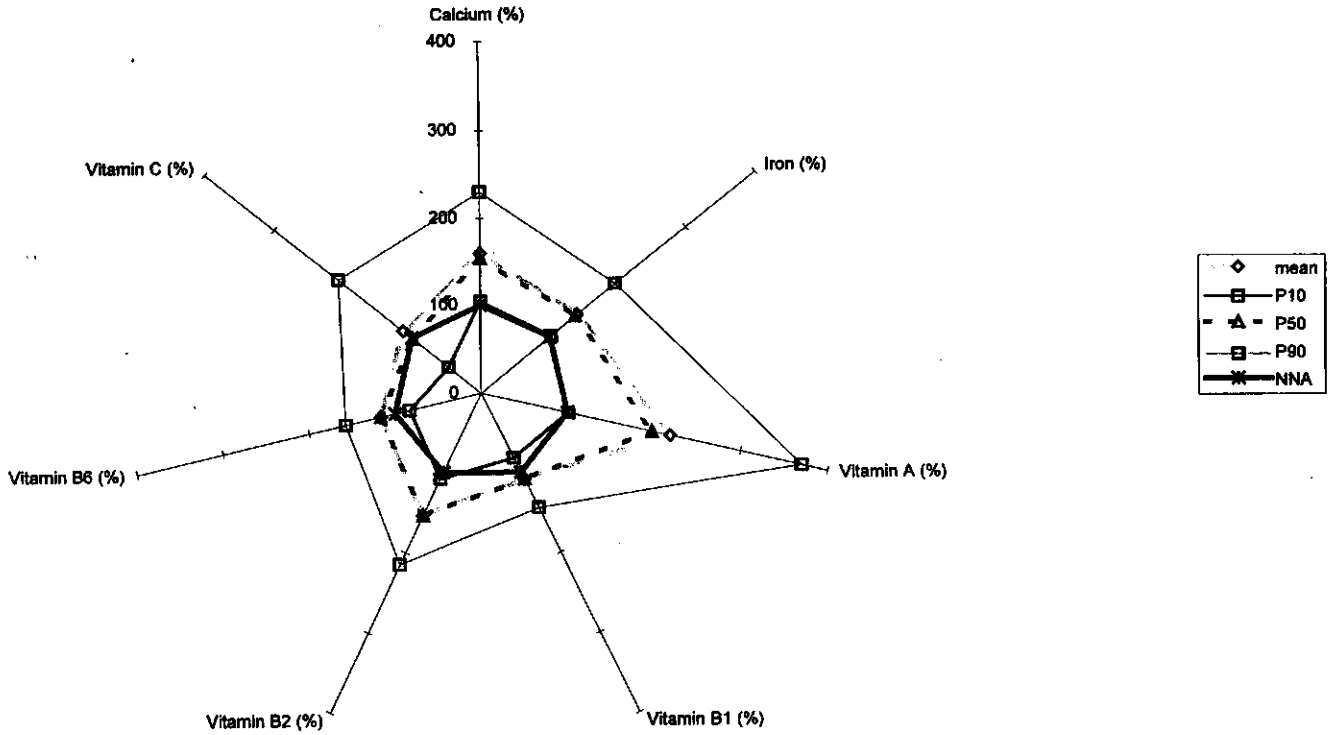

Figure 1a. Mean and percentile distribution of Nutrient Adequacy Ratios of micronutrient intake, in men at SENECA baseline.

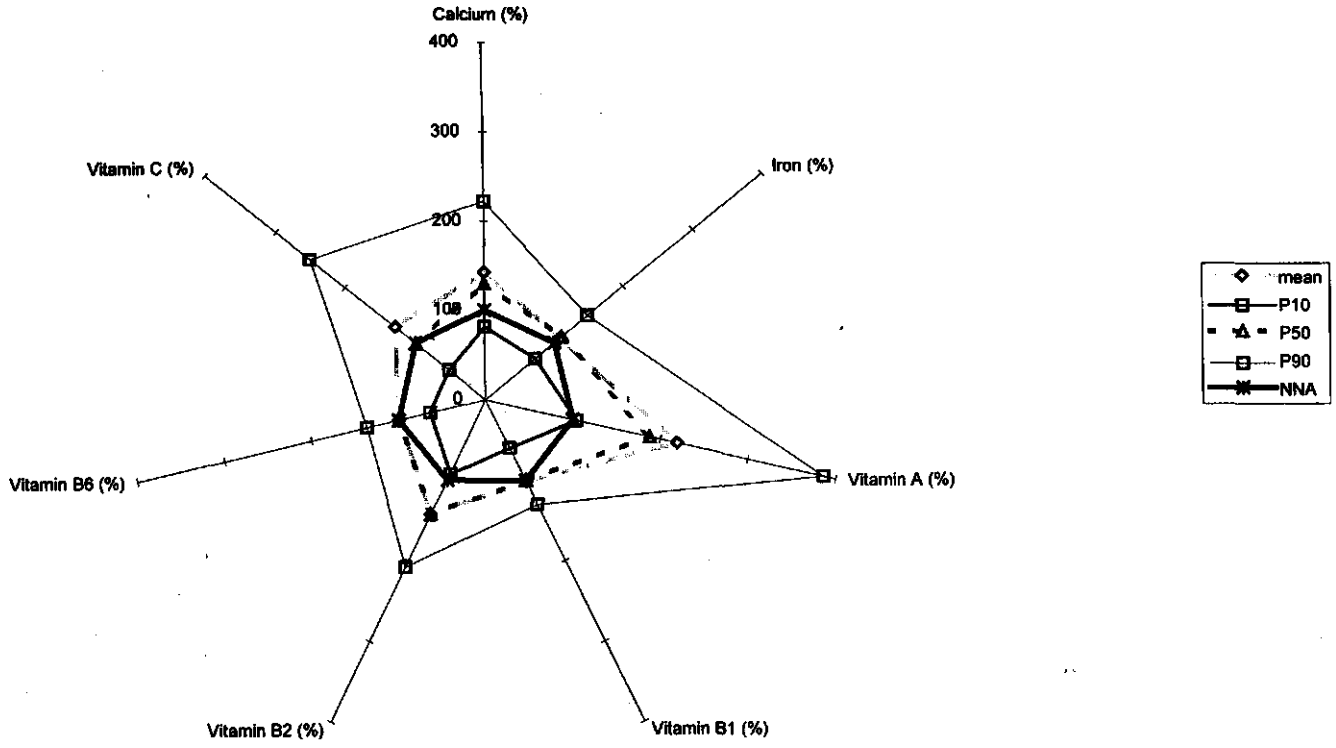

Figure 1b. Mean and percentile distribution of Nutrient Adequacy Ratios of micronutrient intake, in women at SENECA baseline.

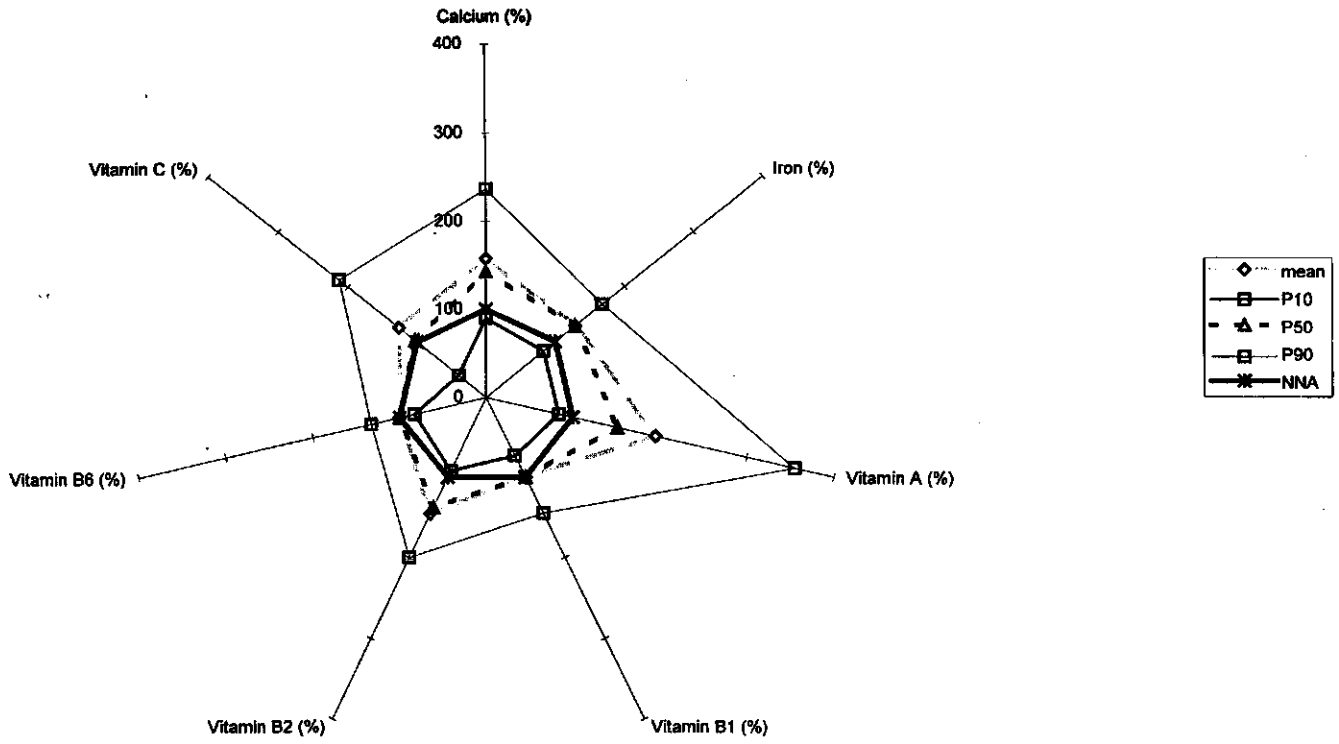

Figure 1c. Mean and percentile distribution of Nutrient Adequacy Ratios of micronutrient intake, in men at SENECA follow-up.

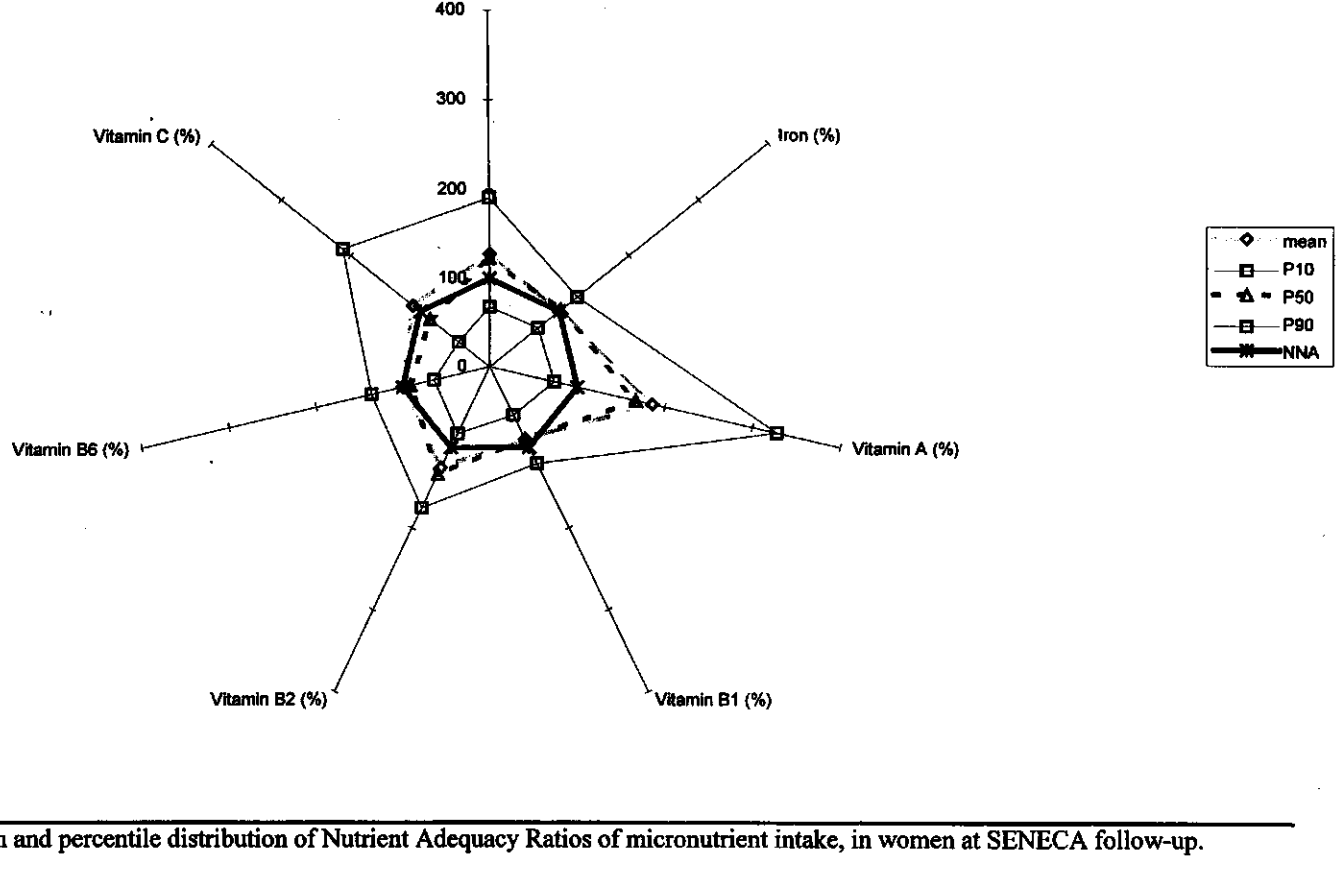

Figure 1d. Mean and percentile distribution of Nutrient Adequacy Ratios of micronutrient intake, in women at SENECA follow-up.

Test of a simple diet score to predict health and disability:

In table 2 the quartile distribution of daily consumption of the 8 components used in the diet score is presented. The spread in food intake shows relevant differences for use in a score. Especially the differences in milk intake are large. The diet score ranged between 3 through 21 in men and 1 through 20 in women. The cut-off point for the lowest quartile of the diet score was 8. The upper cut-off point was 14 for the highest quartile of the diet score.

In table 3 health, impairment, functional limitations and disability at SENECA baseline and follow-up are compared between the lowest and highest quartiles of the diet score.

At SENECA baseline participants defined into the lowest quartile of the diet score were significantly ($p<0.03$) older (73.7 years) than those defined into the highest quartile (72.9 years). Energy intake was significantly lower ($p<0.001$) in men from the lowest quartile (9.3±1.9 MJ/d) than in men from the highest quartile of the diet score (11.5±2.0 MJ/d). In women differences in energy intake (lowest quartile=7.0±2.0 MJ/d; highest quartile=8.0±1.7 MJ/d) between the two quartiles were borderline significant ($p<0.06$). No difference appeared in the type of education, relative physical activity level or in the use of supplements between the two quartiles of the diet score. At follow-up no significant differences between the lower and higher quartiles of the diet score were found in the above mentioned covariates.

Health

Neither at baseline nor at follow-up any differences in health variables were found between the lowest and highest quartile of the diet score. In both quartiles some 70 % of the participants reported to have a chronic disease. Regardless of this high percentage, participants perceived their health as good.

Impairments

At baseline no difference in problems with vision, mobility or chewing appeared between the lowest and highest quartiles of the diet score. However, participants from the lowest quartile had more problems with hearing at baseline than those defined into the highest quartile. By gender, this finding was only significant in women ($p<0.01$). Men from the lowest quartile had significantly

more chewing difficulties at baseline, than those defined into the highest quartile ($p<0.02$). At follow-up no differences in prevalences of impairments were found.

Table 2. Quartile distribution of daily consumption in grams for 8 components of the diet score in Danish men and women at SENECA baseline (1988/89)

	Men				Women			
	Q1	Median	Q3	Max	Q1	Median	Q3	Max
Components								
Cereal	143	194	269	559	109	148	185	655
Fruit	43	106	161	585	52	135	231	405
Vegetable	220	281	384	727	174	232	303	534
Meat	119	139	161	288	87	103	123	179
Milk	86	191	397	1125	81	173	284	1040
Cheese	15	30	40	111	15	21	35	242
MUFA/SFA	0.77	0.91	1.08	2.2	0.75	0.86	1.0	2.5
Alcohol	2	8	19	60	0	3	9	93

Functional limitations

Participants defined into the highest quartile of the diet score were better at balance as measured by the tandem test. By sex, this finding was only significant in women ($p<0.01$). Further, no differences were found for the physical performance test or the chair stand.

Disability

Participants defined into the lowest quartile tended to be more disabled at baseline than those defined into the upper quartile ($p<0.06$). This difference was only significant in men ($p<0.03$). Participants defined into the lowest quartile had significantly more difficulties in performing mobility activities than those defined into the highest quartile. This difference was highly significant in men ($p<0.003$). Most of the participants were able to manage self-care activities. Men classified into the lowest quartile of the diet score were, however significantly poorer in the management of self-care activities, than those defined into the highest quartile ($p<0.04$). At follow-up no differences in disability appeared between the lowest and highest quartiles of the diet score. In the multiple regression analysis the diet score (β=-0.2, SE=0.1), physical activity level (β=-1.3, SE=0.6) and disability at baseline (β=1.2, SE=0.2) significantly predicted disability 4 years later ($p<0.0001$). Age, sex, education, energy intake, supplement use and smoking became excluded from this model at the 10% level.

Cluster analysis of nutrient coverage:

Both among men and women 3 clusters could be identified: A) 'Danish core eaters', B) 'Milk drinkers' and C) 'Small eaters'. Further more a cluster of D) 'Gourmands' was identified in men and a cluster of E) 'Green eaters' was identified in women. Clusters of a sample size below 8 were excluded from further analyses. In both men and women 2 clusters were excluded (3 men and 8 women in total). Tables 4a and b present the daily intakes of nutrients at baseline used for the clustering and table 5a and b present the food group intake pattern at baseline in the different clusters.

Table 3. Comparison of health and performance characteristics at SENECA baseline (1988/89) and follow-up (1993) between Danish participants defined into the lowest and highest quartile of the diet score based on the baseline diet.

	SENECA Baseline		SENECA Follow-up	
	Lowest quartile	Highest quartile	Lowest quartile	Highest quartile
n	44	49	22	30
Diet score	6.0 ± 2.0	16.7 ± 2.2	6.0 ± 2.0	16.5 ± 2.2
Health				
Chronic disease	29 (66%)	36 (73%)	15 (68%)	20 (67%)
Self perceived Health				
Poor	5 (11%)	1 (2%)	3 (14%)	2 (7%)
Fair	8 (18%)	10 (20%)	4 (18%)	4 (13%)
Good	31 (71%)	38 (77%)	15 (68%)	24 (80%)
Impairments				
Problems with vision	0 (0%)	0 (0%)	1 (2%)	0 (0%)
Problems with hearing	22 (50%)	12 (24%)*)	10 (23%)	12 (25%)
Problems with mobility	8 (18%)	9 (18%)	3 (14%)	2 (7%)
Problems with chewing	7 (16%)	3 (6%)	3 (14%)	1 (3%)
Functional limitations				
Ranking of physical performance test				
poor			6 (30%)	9 (33%)
fair			4 (20%)	9 (33%)
good			10 (50%)	9 (33%)
Ranking of tandem test				*)
poor			0 (0%)	0 (0%)
fair			8 (38%)	1 (4%)
good			13 (62%)	26 (96%)
Ranking of chair stand				
good			8 (38%)	12 (44%)

fair			3 (14%)	3 (11%)
poor			10 (48%)	12 (44%)
Disability				
Ranking of all ADL items				
good	15 (34%)	24 (49%)	10 (45%)	18 (60%)
fair	9 (20%)	14 (29%)	5 (23%)	3 (10%)
poor	20 (45%)	11 (22%)	7 (32%)	9 (30%)
Ranking of all mobility items		*)		
good	11 (25%)	15 (31%)	6 (27%)	9 (30%)
fair	14 (32%)	26 (53%)	8 (36%)	14 (47%)
poor	19 (19%)	8 (16%)	8 (36%)	7 (23%)
Ranking of all self care items				
good	30 (68%)	36 (73%)	15 (68%)	23 (77%)
fair	14 (32%)	13 (27%)	7 (32%)	7 (23%)
poor	0 (0%)	0 (0%)	0 (0%)	0 (0%)

*) Significant difference in values between the lowest and highest quartiles of the diet score ($p<0.05$).

The Danish core eaters (n=52 men and 38 women) were characterised by an intake of most foods, energy and nutrients, which was close to the average intake of the total group. The usual Danish diet in men looks according to this, as follows:

Breakfast: 1 glass of milk, 2 slices of white bread, butter on all bread, 4 slices of cheese, 3 teaspoons of marmalade, 1 egg every second day.

Lunch: 1½ slice of rye bread, butter on all bread, herring, 2 slices of meat products, 1½ snaps

Dinner: 1½ meat balls, poultry for dinner once a week, 3 potatoes, 1 helping of another vegetable, 1 helping of sauce

In between meals: 5 cups of coffee with sugar, 4 biscuits and 1 small apple.

In women portion sizes of foods consumed were smaller - about 80%. Fruit was, however, consumed more often and alcoholic beverages less often in women than in men.

Milk drinkers (n=11 men and 9 women) had as the name suggest a much higher consumption of milk than the other clusters, resulting in high intakes of calcium and riboflavin. The female milk drinkers had the best coverage of energy and nutrients as compared to the other female clusters.

Small eaters (n=15 men and 35 women) were characterised by a much lower intake of most foods than the other clusters. As a result energy intake was low and the intake of most nutrients were marginal.

Gourmands (n=15 men) were characterised by a significantly higher intake of most foods than the other clusters, and as a result of this also a significantly higher intake of energy and most nutrients.

Green eaters (n=8 women) were characterised by a high intake of vegetables and fruits. Although the energy intake was low, the nutrient intake met the requirements and the vitamin C intake was much higher than the intake in the other clusters.

The median diet score was equal to 9 in small eating women, between 10 and 12 in core eaters, milk drinkers, small eating men and green eating women and equal to 15 in gourmands. This finding suggest that a high energy intake is crucial for a diet of high quality, if the diet is not changed in favour of nutritious foods

.Table 4a. Daily intake (mean and s.d.) of micronutrients at SENECA baseline according to four cluster including 93 Danish men.

	Cluster			
	'Danish core eaters'	'Milk drinkers'	'Small eaters'	'Gourmands'
	Men (n)			
	52	11	15	15
Calcium (mg/d)	1202 (266)	1997 (401)	895 (140)	1418 (173)
Iron (mg/d)	13.6 (2.2)	13.9 (3.2)	9.9 (2.1)	19.0 (2.7)
Vitamin B1 (mg/d)	1.2 (0.2)	1.4 (0.2)	0.9 (0.1)	1.5 (0.2)
Vitamin B2 (mg/d)	1.9 (0.3)	2.9 (0.4)	1.4 (0.2)	2.4 (0.3)
Vitamin B6 (mg/d)	1.3 (0.2)	1.5 (0.1)	0.9 (0.1)	1.8 (0.2)
Vitamin C (mg/d)	60.9 (25.9)	62.4 (23.2)	41.4 (24.6)	111.6 (41.8)

Table 4b. Daily intake (mean and s.d.) of micronutrients at SENECA baseline according to four cluster including 90 Danish women.

	Cluster			
	'Danish core eaters'	'Milk drinkers'	'Small eaters'	'Green eaters'
	Women (n)			
	38	9	35	8
Calcium (mg/d)	1172 (281)	1816 (194)	832 (214)	872 (181)
Iron (mg/d)	12.0 (1.8)	12.5 (2.1)	8.3 (2.0)	11.1 (2.1)
Vitamin B1 (mg/d)	1.1 (0.1)	1.3 (0.2)	0.7 (0.2)	1.1 (0.1)
Vitamin B2 (mg/d)	1.9 (0.3)	2.5 (0.3)	1.3 (0.3)	1.4 (0.2)
Vitamin B6 (mg/d)	1.2 (0.2)	1.4 (0.2)	0.9 (0.2)	1.2 (0.3)
Vitamin C (mg/d)	66.6 (27.6)	87.1 (34.2)	49.4 (24.0)	198.9 (50.0)

Table 5a. Daily intake (mean and s.d.) of energy, macronutrients and main food groups at SENECA baseline according to four cluster including 93 Danish men.

	Cluster			
	'Danish core eaters'	'Milk drinkers'	'Small eaters'	'Gourmands'
	Men (n)			
	52	11	15	15
Energy (MJ/d)	9.9 (1.4)[b]	11.1 (1.9)[a,b]	8.1 (0.9)[c]	11.8 (1.5)[a]
Protein (g/d)	71.1 (9.8)[b]	92.5 (11.6)[a]	56.0 (5.3)[c]	84.6 (11.4)[a]
Fat (g/d)	112.3 (24.1)	123.2 (35.7)	92.1 (16.5)	114.3 (29.8)
Carbohydrate (g/d)	241.5 (52.7)[b]	262.9 (63.9)[a,b]	192.9 (30.2)[c]	325.6 (59.7)[a]
Alcohol (g/d)	12.1 (15.2)	12.9 (11.8)	12.1 (8.0)	14.9 (13.9)
Milk products (g/d)	251 (163)[b]	697 (334)[a]	188 (135)[b]	324 (259)[b]
Eggs (g/d)	22 (20)	30 (24)	23 (28)	30 (22)
Meat (g/d)	128 (47)	115 (39)	123 (32)	129 (44)
Poultry (g/d)	18 (20)	15 (13)	12 (13)	23 (20)
Fish (g/d)	25 (21)[b]	20 (14)[b]	15 (12)[b]	48 (31)[a]
Fats (g/d)	51 (19)	50 (24)	41 (16)	51 (20)
Grain (g/d)	199 (64)[b]	231 (126)[a,b]	168 (125)[b]	290 (111)[a]
Vegetables (g/d)	300 (97)[a]	252 (86)[a,b]	183 (73)[b]	388 (190)[a]
Fruit (g/d)	107 (82)[a,b]	92 (73)[b]	65 (46)[b]	189 (132)[a]
Sugar products (g/d)	42 (39)	53 (27)	38 (39)	41 (32)

[a,b,c] no significant difference in intake between clusters with the *same* superscript

Table 5b. Daily intake (mean and s.d.) of energy, macronutrients and main food groups at SENECA baseline according to four cluster including 90 Danish women.

	Cluster			
	'Danish core eaters'	'Milk drinkers'	'Small eaters'	'Green eaters'
	Women (n)			
	38	9	35	8
Energy (MJ/d)	8.3 (1.3)[a,b]	9.4 (1.5)[a]	6.5 (1.5)[c]	7.2 (0.9)[b,c]
Protein (g/d)	63.2 (8.5)[b]	83.4 (7.5)[a]	46.9 (8.7)[c]	55.8 (7.7)[b,c]
Fat (g/d)	90.9 (18.3)[a,b]	103.4 (28.7)[a]	71.1 (21.5)[c]	72.9 (15.0)[b,c]
Carbohydrate (g/d)	213.8 (53.0)[a]	228.7 (36.0)[a]	161.7 (44.5)[b]	184.8 (18.9)[a,b]
Alcohol (g/d)	7.9 (12.1)	5.2 (10.0)	8.9 (17.0)	11.9 (13.5)
Milk products (g/d)	270 (153)[b]	538 (247)[a]	188 (132)[b]	150 (104)[b]
Eggs (g/d)	23 (21)	18 (19)	14 (12)	19 (20)
Meat (g/d)	100 (33)	94 (26)	81 (25)	96 (17)
Poultry (g/d)	16 (13)	13 (7)	13 (10)	11 (9)
Fish (g/d)	18 (15)	22 (16)	16 (14)	24 (23)
Fats (g/d)	41 (13)[a]	38 (18)[a,b]	30 (14)[b]	32 (9)[a,b]
Grain (g/d)	196 (101)[a]	182 (32)[a]	122 (46)[b]	115 (29)[b]
Vegetables (g/d)	261 (79)[a]	267 (78)[a]	196 (94)[b]	287 (112)[a]
Fruit (g/d)	132 (86)[a,b]	213 (113)[a]	101 (79)[b]	222 (100)[a]
Sugar products (g/d)	33 (25)	33 (26)	26 (27)	28 (21)

[a,b,c] no significant difference in intake between clusters with the *same* superscript

Discussion

This study showed, that a diet score was a significant predictor of disability in elderly Danes. This adds to the importance of diet in the maintenance of an independent life style. According to the Nutrient Adequacy Ratio (NAR) the diet of elderly Danes mediates adequate intakes of energy and nutrients. However, dietary risk profiles were identified by cluster analysis, which calls for specific nutritional guidance.

The NAR, the diet score and the cluster analysis have the same goal: to examine the healthfulness of the diet in elderly Danes. However, they explore different aspects of the diet. The efficacy of all 3 approaches depends on the population studied and the dietary assessment method used. Therefore, considerations regarding the population and dietary methodology employed are discussed, whereby the applicability of each approach in the investigation of diet and disability in elderly people are evaluated.

Population

Independently living people from Roskilde of 70-75 years of age are not expected to be representative for the total population of elderly Danes. Comparison with the nation-wide survey of the dietary patterns in Denmark from 1995 (49) revealed, however, comparable distributions of food and nutrient intakes between the SENECA participants and the 333 Danes aged 65 to 80 years. The dietary profiles extracted from the SENECA population should, therefore be generalisable to the elderly Danish population. The impact of dietary quality and physical activity on disability found in this study may be increasingly important with further ageing, since the general tendency is to decrease energy intake with increasing age without changing dietary patterns in favour of more nutritious foods (6, 50).

Dietary assessment

The dietary history technique employed in this study has been validated against a 3-day weighed record and shown to be able to adequately characterise the intake of energy, selected nutrients and foods of the research population (30,31). According to quantity the diet history method overestimates food intake as compared to the estimated record. However, when energy intake as measured by a similar modified dietary history method was compared with energy expenditure

measured in metabolic rooms, energy intake appeared to be underestimated by the diet history method by about 12% compared to energy expenditure (51). This means that the number of people with marginal intakes might be overestimated from this study.

Approaches

NAR

The Nutrient Adequacy Ratio (NAR) is the traditional way to evaluate the nutrient quality of the diet of a population. Recommended dietary allowances include a safety margin of 2 standard deviations of the mean demand of a population. Therefore it is not possible to point out individuals at risk of unfavourable food intake on the basis of inadequate intake of a single nutrient. If however, a single person is characterised by inadequate intakes of more than one nutrient, it is likely, that that person has an unfavourable food pattern, rather than low nutrient demands of all nutrients. Nevertheless, the NAR easily permits an evaluation of overall adequacy of nutrient intake in a population, also in elderly people.

Diet score

In the bivariate analysis the diet score only showed little association with the markers of health, impairments and functional limitations, but significant association with disability. Disability may be considered a summation dimension, which adds up all the small aggravations with age at each level of the disablement process (18). We found that dietary intake at baseline is predictive for this summation dimension, indicating a possible role of diet in the different steps of the pathway to disability. Like Schultz-Larsen, we also found, that disability in mobility items preceded disability in self-care activities, as a result of ageing and multiple chronic diseases (52).

In the multivariate analysis disability at baseline was the major factor in the prediction of disability 4 years later. It is expected that the effect of genetic disposition, sex, age, social status and lifestyle of a long life is incorporated in this baseline factor. The level of functional ability at age 70-75 years of age determines, therefore, the set-off in the '4 year race' for an independent life. Dietary quality and physical activity are modulating factors which can slow down or speed up the disablement process. It is helpful to think of total energy as being a rough indicator of physical activity in free-living populations (53). In the multivariate model used, it could, conversely, be expected, that the effect of energy intake is incorporated in the physical activity variable 'relative activity'.

Former studies of diet and disability have found an effect of low energy intake on poor functional ability, but not of dietary quality (54, 2). In NHANES and by Huijbregts et al disability was analysed against single dietary components. Both Trichopoulou et al and Osler found that the overall dietary score has a stronger association with health and longevity than individual nutritional components (10, 12). Because we used an overall diet score, this may be the reason why we were able to detect an association between dietary quality and disability. This score was not predictive of mortality so far, but it was not designed to be.

Several empirical dietary indexes have been developed to predict health outcomes. Which index is chosen depends on the applicability to the population and outcome of interest (9, 2). The healthy diet index (HDI), advocated by the WHO to predict chronic diseases was not applicable in elderly Danes, since the high fat content of the Danish diet would group the majority of the participants in the unhealthy group, making further discrimination of dietary quality impossible. Although many of the components are included in both the HDI and in the diet score used, the population based cut-off points (quartiles) in the employed score makes it possible to discriminate within another population of interest.

Cluster analysis

For the identification of the actual food pattern underlying the nutrient intake a cluster analysis was performed. Since cluster analysis is dependent on the statistical analysis system used and dimension criteria chosen, it is not a conclusive method. Moreover, clusters are derived from an empirical sample, so their applicability as a standard for evaluating diets of different populations is limited because of the number of factors that determine food selection (9). In a Danish setting, the result from this cluster analysis may, however, be essential for the conversion of nutritional risk profiles into comprehensible dietary patterns, which the general practitioner can recognise and use as basis for nutritional guidance to 70-80 year old Danes in this time period.

In a former cluster analysis of micronutrient intake in participants from the other SENECA towns, similar food profiles appeared . Thus in different populations of elderly people, using the same

dimension criteria the resulting clusters roughly present the same picture. This supposition is supported by the finding of comparable profiles in American settings (55, 56).

Does diet still matter?

The approach using a simple diet score to predict disability from food intake, showed that dietary quality and physical activity matters in maintenance of an independent life. Dietary quality cannot stand alone - the quantity is also essential as shown by the inclusion of relative physical activity in the multivariate analysis. Besides the effect of physical activity on balance, strength and condition, energy expenditure is essential for appetite, and thereby energy intake. Therefore, nutritional guidelines should be prioritised. First the energy requirements should be covered, then the quality of the diet should be evaluated.

The employed diet score may be interpreted as a balanced mixture of bread, fruit, vegetables, meat, fish, dairy products, monounsaturated fat and alcohol, in amounts which provides adequate intakes of energy and nutrients. This is in concordance with the WHO's definition of a healthful diet (57) and (not surprisingly) with the Mediterranean pyramid, which is a cultural model of healthy eating (58).

Comparisons with the NNA showed, that the Danish elderly do not have to eat Greek or Italian to get an adequate nutrient intake. The Danish diet is not homogeneous. A variety of food profiles were identified by cluster analysis from small eaters, over core eaters and milk drinkers to gourmands. Dietary recommendations should, therefore be targeted to different types of elderly people.

This may be done by adaptation of the findings of the diet score and the cluster analysis. First a rough estimate of energy intake can be obtained, through questions on the number of meals a day. Then the dietary profile can be identified by asking questions on food group intake.

The energy intake in small eating women was close to 6.3 MJ/d, which is the cut-off point for an adequate nutrient intake. Below this energy intake it is difficult to meet requirements for most nutrients (59). As a result the nutrient intake of this group was marginal. In recommendations to small eaters, general practitioners should focus on appetite stimulation. Like in recommendations

for the 'hospital diet' prevention of weight loss through intake of more energy, regardless of quality, is crucial.

A subgroup of small eating women, were 'the green eaters', who were characterised by an adequate nutrient intake despite a low energy intake (7 MJ/d). This group may gain from recommendations on more physical activity and thereby increase their food intake.

Conclusions

Many methods have been developed to measure the quality and healthfulness of the diet. Because of the nature of food intake, one measure alone cannot tell everything about food patterns and health associations. The use of a combined approach of nutrient adequacy ratio, cluster analysis and the use of a simple diet score appeared to be useful. The NAR permitted an evaluation of the diet of elderly Danes. The average Danish diet met the Nordic Nutrient Allowances. The cluster approach added some more nuances to the NAR by identifying groups of Danes with more or less favourable dietary profiles. Of paramount importance for the general practitioner was the identification of two major groups: 'The Danish core eaters' and the 'Small eating women', suggesting that the same nutritional guidance should not be given to all patients. Use of a diet score revealed, that dietary quality matters in the prevention of disability in elderly Danes.

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7

General Discussion

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Introduction

This thesis describes food patterns and their impact on health in elderly Europeans ageing from 70-75 to 74-79 years of age.

We were able to identify food patterns for each of the SENECA towns. However, the within centre variation appeared to be about as large as the between centre variation. On the pooled level food patterns across centres emerged, which did not coincide with the centre specific patterns. Food patterns appeared to be stable with age. Minor changes attributable to period were, however, found. Weight loss showed to be an indicator of poor health in Danish and Dutch elderly. In this study it was not possible to relate weight loss to reduced energy intake. Nevertheless, in the further analysis of the Danish data, both quantity and quality of the food pattern turned out to matter in the prevention of disability. Food intake of elderly Danes was associated with disability as measured by a questionnaire on activities of daily living. For the other indicators of the main stages of the disablement process[1] little association with food intake was observed.

The strength and limitations of the approaches, which led to these findings have been discussed in the accompanying chapters. Here, the more general issues are discussed. First, the applicability of SENECA data for the analysis of food patterns in elderly Europeans is considered. Secondly, the methodological limitations regarding the identification of food patterns are evaluated. Then the strength of the association between food patterns and health is discussed. Finally, implications for health policies are addressed.

SENECA

Towns

SENECA was designed to explore nutrition, health and performance in elderly people living in traditional towns. The towns were not meant to be representative for the country as a whole. However, in the Danish, Dutch and Spanish SENECA towns food patterns were comparable with those described by nation-wide surveys[2,3,4]. In other countries (Portugal, France, Switzerland, Italy)

2-3 towns were selected, as it a priori was expected that food patterns would vary substantially between different regions of the same country. However, the general food pattern in the French towns was characterised by the central European food culture. Likewise the general food pattern in the Portuguese towns could be characterised by the southern European food culture (*chapter 2*).

Subjects

In the SENECA surveys the subjects belonged to the birth cohorts 1913-1918.

The rationale for a study population ageing from 70-75 to 74-79 years of age was, that most elderly people are reasonably healthy when they enter the eighth decade, but at the same time vulnerable to changes in health and performance in the second half of the same decade[5,6]. As the ageing process progresses in different tempi, the elderly population within this narrow age range is expected to be very heterogeneous[7,8].

Non-response analysis of the SENECA study indicated that the participation was somewhat selective with a tendency towards a better participation of the relatively healthy elderly people[9,10]. Data on health and activity patterns at SENECA baseline also suggested that subjects who participated in both studies were more healthy than those who were examined at SENECA baseline, but not at follow-up (*chapter 5*).

The elderly people studied are, therefore, not representative of the general European population, but the food pattern is expected to give a realistic description of the cross-cultural variation in food patterns of relatively healthy elderly people across the participating centres in Europe.

Dietary assessment

Comparison of food intake data from different communities in Europe is often hampered by differences in the dietary assessment methodology employed. For international comparisons of food patterns data have often been taken from the food balance sheets of the Food and Agriculture Organisation of the United Nations (FAO). Although this macro level analysis may serve a useful purpose in planning food and nutrition policies, it can only give a crude indication of the average availability of foods[11].

The main advantage of the SENECA surveys is the use of the same modified dietary history method[12,13,14], thus enabling a valid comparison of habitual food intake between all the SENECA towns and identification of food patterns in segments of the study population. Individual patterns can be distinguished, but like in all field surveys it was also in this study hard to assess precisely the quantity of foods consumed by each subject. In nutritional epidemiology no 'gold standard' exists[15], which a dietary assessment method can be validated towards. Comparison of intake assessed by another method or with markers of energy expenditure give, however, insight in the size and direction of bias in the method used.

The dietary history technique employed has been validated against a 3-day weighed record and shown to be able to adequately characterise the intake of energy, selected nutrients and foods of the research population[13,14]. The diet history method overestimates food intake as compared to the estimated record. However, when energy intake as measured by a similar modified dietary method was compared with energy expenditure as measured in metabolic rooms, energy intake appeared to be underestimated as compared to energy expenditure[16]. Comparison with the physical activity index (PAI), derived by dividing reported energy intake by estimated basal metabolic rate (BMR), indicated a cultural difference in the under- and over-estimation of energy intake[14]. The bias presumably resulted from differences in the reporting of portion sizes of food items consumed. The use of a checklist of foods elaborated for each centre limited the omission of foods in the reporting of food intake. It is, therefore, assumed that the food pattern characteristics were unaffected of this bias.

Analysis of food patterns across Europe is complicated by the fact, that there is no common European food composition table. In SENECA, coding of food intake by the Eurocode system[17] allowed description and comparison of food intake by the same terms in all SENECA towns. For the comparison of food patterns on a food group level, the use of Eurocode can be recommended. A drawback of the code, however, related to its classification of meat, which is cut in a variety of ways in Europe. A classification system based on the fat content of various types of meat would be more unambiguous than the current coding, which includes only a few cuts of meat. The use of Eurocode might also be more user-friendly if it was attached directly to the food codes in the local food composition data bases.

Because, there are no nutrients connected to the Eurocode system, there is still a missing link between nutrients and foods. It is acknowledged, that a common European food composition table would only be a rough estimate of the energy and nutrient content of foods, as it would not be possible to take all existing variation, due to differences in growing and processing conditions into account. However, a common database would facilitate the identification of cross-cultural variation in food sources of specific nutrients.

Food patterns and nutrient intake

Description of food patterns and of nutrient intake are equally important in the evaluation of the nutritional status in elderly people. Nutrient intake data give some important clues about the quality of the diet. Food patterns identify the underlying food consumption, which leads to more or less adequate nutrient intakes. This adds to the understanding of 'the healthful diet[11]. For epidemiological research food patterns may be considered a way of testing the contribution of both nutrients and non-nutrients to health[18,19]

In *chapter 2* we were able to distinguish food patterns between European settings. The geographical gradient identified by nutrient intake at SENECA baseline[20] could be confirmed by the cross-sectional analysis of food intake at SENECA follow-up. The northern pattern (Hamme/Belgium, Roskilde/Denmark, Culemborg/The Netherlands, Marki/Poland, Balleymoney-Limavady-Portstewart/Northern Ireland) resembled that of younger adults in industrialised countries, intakes of vegetables and fruits were adequate, but with relatively high consumption of animal products (non-fish), luxury breads and sugar products. The southern food pattern (Padua/Italy, Betanzos/Spain, Coimbra/Portugal, Vila Franca de Xira/P) resembled the Mediterranean diet being rich in grain products, vegetables, fruits, lean meat and olive oil. The central European diet (Haguenau/France, Romans/France, Yverdon/Switzerland) encompassed aspects of both the northern and southern food patterns.

Cluster analysis over the pooled data set showed, that the diet of 'lean and green eaters' resembled that of a southern food pattern and that of 'milk drinkers' and 'gourmands' resembled a northern European food pattern. The northern and southern towns did not systematically segregate in the same clusters. 'Lean and green eaters' were not dominated by Italian and Spanish participants. 'Gourmands' were not made up by Frenchmen, and 'milk drinkers' were not a group of Danish and Dutch participants. All dietary profiles were represented in all sites. This is in agreement with the Seven Country Study, which longitudinally showed, that participants from five cohorts in Finland, the Netherlands and Italy approach each others diet[21].

Contrary, to our findings, Huijbregts et al (1997)[19] reported, that it was not possible to use cluster analysis in an international study, because 3 clusters emerged in their study characterised by the food patterns in the Dutch, Finnish and Italian settings. This reflects the importance of the dimension criteria used for the outcome of a cluster analysis of pooled international data. Huijbregts et al used energy intake and macronutrients as criteria for their cluster analysis[22]. Especially intake of fat types and alcohol show a geographically gradient in Europe, which affect the clustering. Therefore, cluster analysis is not a useful tool in the investigation of food patterns and cardiovascular risk in an international setting. Micronutrient intake in this study appeared to be less affected by centre specific food patterns, hence we were able to identify more or less favourable food profiles across food cultures.

Because clusters are derived from one particular sample, their applicability as a standard for the evaluation of diets of different populations is limited[18]. In a European setting, at a given time, the results from the empirical cluster analysis applied may, however, be essential for the conversion of nutritional risk profiles into comprehensible food patterns which policy makers can recognise and use as basis for nutritional guidance for 70-80 year old Europeans in this time period.

A cluster analysis on the basis of nutrient intake at SENECA baseline and one on the basis of nutrient intake at follow-up were performed, in elderly Danes participating in both surveys, to test the stability of the identified food profiles. The pattern showed up consistently, as a cluster of 'core eaters', 'milk drinkers', 'small eaters', 'gourmands' and 'green eaters' were identified at both surveys.

However, only 40% of the participants were classified into the same cluster at SENECA baseline and follow-up. The transition from one cluster to another could partly be explained by the different rates whereby participants decreased their energy intake. As an example, a 'gourmand' at baseline experienced an accelerated decrease in energy intake, due to development of disease between SENECA surveys resulting in a shift in food profile from gourmand to core eater. Fortyfour percent of the participants were classified into a different cluster reflecting such changes in energy intake. Finally, other fluctuations in the food pattern assessed may explain the variation in the remaining 17% of the participants.

Since the cluster analysis resulted in the same food profiles at both baseline and follow-up, these profiles are assumed to be archetypes reflecting the interrelations between foods and nutrients. This assumption is supported by the finding of similar profiles in American settings[23,24], on the basis of cluster analyses using micronutrient intake as dimension criteria. Therefore, at any point in time, an elderly person characterised by a certain food profile, will gain from specific nutrition guidance targeted to his present situation.

In *chapter 3* the longitudinal changes in food group intake of elderly Danish, Dutch, Swiss and Spanish women, representing the northern, central and southern food patterns are described. Food patterns appeared to be stable with age as portion sizes of most foods were smaller, with no greater decrease in single specific food items. However, Spanish women increased their intake of dairy products, fish and fruits over the 4 year follow-up period. This finding cannot be expected to be a result of ageing as it reflected the general trend in the Spanish population for that period[4].

The nutrient densities of riboflavin, calcium and iron were higher and the vitamin C density lower in Danish, Dutch and Swiss women than in the Spanish women, reflecting the relatively higher consumption of milk in the northern European sites and the higher intake of fruit in Spain. The increase in consumption of fruit and milk in the Spanish site was also reflected in an increase in the nutrient density of vitamin C and calcium during the period.

Another important issue was whether nutrient intake was mediated by the same food groups in different food cultures. Because no nutrient values are connected to the Eurocode system, it was not possible to detect directly, how the different foods contributed to the intake of each nutrient. We

tried, however, to do it for vitamin C in Danish and Dutch participants by the use of local food composition data bases[25,26] (*chapter 4*).

The Danish and Dutch SENECA participants were influenced by the food pattern in northern Europe. The major sources of vitamin C in these SENECA towns were potatoes and cabbages, which are characteristic ingredients in Danish and Dutch winter dishes. Fruiting and leafy vegetables hardly contributed to vitamin C intake as salads are not a natural part of the northern winter meal pattern.

This study was an example of how food choice and handling matters. The recommendation of 5 helpings of fruits or vegetables a day[27] may not be sufficient to cover needs, if nutrient poor sources are chosen and unfavourable storage and cooking methods are employed.

When vitamin C intake in the Danish and Dutch diet was calculated from food composition tables the median vitamin C intake was more than twice as high as the value corrected for losses during food handling. Individuals with a corrected vitamin C intake below the lowest European recommended dietary intake (30 mg/d) appeared to have a less favourable food selection. The food pattern of the southern SENECA towns with a high content of fresh fruits and vegetables is expected to have a much lower correction factor, than those found in the northern SENECA towns. Nevertheless this study clearly showed that values of vitamin C intake estimated from the local food composition tables underestimated the number of people at risk of inadequate vitamin C intake and most likely also for other thermo-labile vitamins. Therefore, in the nutritional evaluation of the food intake of elderly people, losses of micronutrients due to food handling should be estimated if possible or otherwise considered in the interpretation of data.

Food patterns and health

In the studies described above mainly the qualitative aspects of the food pattern have been in focus, however, the quantitative aspects may also be important. The southern food pattern appeared to fulfil the criteria of a healthful diet better, than the central and northern type. Yet, participants from Vila Franca de Xira in Portugal were characterised by more health complaints than participants

from the other centres[28]. Poverty, may restrict food intake. If energy intake is low, a healthful food selection is not sufficient to ensure an adequate nutrient intake[29] *(chapter 2)*.

To study the importance of the quantity of food intake into depth we investigated the consequences of energy intake on weight loss and health in a northern setting (*chapter 5*). We expected that over the 4 year period of follow-up the elderly people studied would undergo changes in body composition, energy intake and physical activity as a consequence of a combination of ageing, changes in lifestyle, living conditions and health. We tested this assumption in Danish and Dutch participants as food pattern and other lifestyle factors were comparable between these two SENECA towns. Weight loss, as well as changes in waist, hip and arm circumferences were indicators of poor health, but decrease in energy intake as an intermediary factor could not be deducted from our data. Other studies including larger sample sizes over a longer follow-up period confirm the association between weight loss and morbidity in elderly people[30,31]. However, the mechanisms by which this occur are as yet unknown because current epidemiological studies lack sufficient detail[32]. The health ABC study in the US is targeted to answer questions with regard to the health impact of weight and weight change in old age[32].
Van Staveren et al (1997)[33] demonstrated, that for a given sample size, the dietary assessment method used was fairly reliable to detect the small differences in mean daily energy intake needed to lose weight, given that measurements of diet and body weight were conducted in the dynamic phase of losing weight and all other determinants of energy balance were constant. An important reason for not finding an relationship between change in energy intake and weight loss might be the fact that the majority of people with a loss of body weight were most likely not in the dynamic phase of losing weight during the period of dietary assessment.

In elderly Danes (*chapter 6*) a broader picture was made of what is going on both with regard to the quantity and quality of food intake and their impact on health over the 4 year follow-up period. According to the Nutrient Adequacy Ratio (NAR)[34] the food pattern of elderly Danes mediates adequate intakes of energy and nutrients. The NAR easily permits an evaluation of overall adequacy of the nutrients of interest in a given population group. Recommended dietary allowances include a safety margin of two standard deviations of the mean demand of a population. Therefore, it is not

possible to point out individuals at risk of unfavourable food intake on the basis of inadequate intake of a single nutrient. If, however, a single person is characterised by inadequate intakes of more than one nutrient, it is likely, that that person has an unfavourable food pattern, rather than low nutrient demands of all nutrients.

For the identification of food patterns underlying the nutrient intake cluster analysis was performed. A segment of elderly Danes at risk of inadequate nutrient intake was identified. This calls for specific nutritional guidance.

Since cluster analysis is dependent on the statistical analysis system used and dimension criteria chosen, it is not a conclusive method. It is a hypothesis generating method which is useful in the analysis of large data sets, where it helps to visualise associations.

To explore the association between food patterns and disability a diet score was developed.

In a bivariate analysis the diet score only showed little association with the markers of pathology, impairment and functional limitations, but significant association with disability. Disability can be considered a summation dimension, which adds up all the small aggravations with age at each level of the disablement process[1]. Food intake at SENECA baseline was predictive of this summation dimension indicating a possible role of the food pattern in the different steps of the disablement process.

In a multivariate analysis disability at SENECA baseline was the major factor in the prediction of disability 4 years later. It is expected that the effect of genetic disposition, sex, age, social status and lifestyle of a long life is incorporated in this baseline factor. The level of functional ability at age 70-75 years determines, therefore, the set-off in the '4 year race' for an independent life. Food patterns and physical activity are buffers which accelerate or delay the disablement process (*chapter 6*).

Several empirical dietary indexes have been developed to predict health outcomes[18]. Which index is chosen depends on the applicability to the population and outcome of interest. The healthy diet index (HDI) [19,35], advocated by the WHO to predict chronic diseases was not applicable in elderly Danes, since the high fat content of the Danish diet would group the majority of the participants in the unhealthy group, making further discrimination of dietary quality impossible.

Although many of the components are included in both the HDI and in the diet score we have used, the population based cut-off points (quartiles) in the employed score make it possible to discriminate within another population of interest. Furthermore the macronutrients in the HDI are given as percentages of energy intake. By standardisation for energy intake, it becomes impossible to focus on the importance of energy intake. Willett (1997)[36] stated that energy intake should be adjusted for in epidemiologic research. We decided, not to correct for energy intake in our diet score, because recommendations on basis of an energy adjusted index are difficult to interpret, and the requirements of most nutrients are not related to energy intake. Instead, we included energy intake in a multivariate model together with the diet score and other covariates as independent predictors of disability. The association between disability as measured by Activities of Daily Living (ADL) at follow-up and the diet score at baseline, controlled for baseline ADL and relative physical activity was found to be highly significant ($p<0.0001$) in elderly Danes. Energy intake became excluded from this model at the 10% level. It is helpful to think of total energy intake as a rough indicator of physical activity in free-living populations[36]. Relative physical activity is a lifestyle measure, but may also be interpreted as an indicator of energy intake, and is therefore incorporated in the model.

MacMahon et al. (1990)[37]argued that due to the diluting effects of random fluctuations in exposure and outcome variables associations between risk factors and health parameters become substantially underestimated. Both the diet score, relative physical activity and ADL are characterised by a large intraindividual variation. When an association between food patterns and disability could be detected, in spite of this 'regression dilution bias' the *true* association can be expected to be stronger. Therefore, there is reason to believe that optimisation of food patterns can prevent further deterioration at the different levels of the disablement process. Intervention studies are needed to confirm the association between food patterns and disability. Intervention studies to prove the importance of favourable food patterns for functional capacity are difficult to conduct as all lifestyle interventions are[38]. They should involve great numbers of people over many years and cannot be controlled. Besides it would be unethical. SENECA has taken advantage of the *natural experiment* going on in Europe. Differences in functional abilities between groups of Europeans may partly result from cultural differences in food patterns.

So far, no intervention studies, only descriptive studies have been performed relating diet and disability in elderly people. In these studies single dietary components have been related to activities of daily living. Low energy intake was the only factor found to be associated with poor functional ability[19,39]. In studies relating dietary quality and mortality, however, the associations were stronger, using an overall dietary score rather than individual nutritional components[40,41].

In summary both quality and quantity of food intake appeared to be essential for functional ability. The higher the diet score and the higher the physical activity level (indicating energy intake), the better the functional abilities. The importance of sufficient energy was also suggested by the cluster analysis of pooled data from all the SENECA towns. Adequate nutrient intake was found in individuals with high energy intakes The majority of participants were small eaters. They had low energy intakes associated with less favourable health and lifestyle characteristics.

Dietary recommendations

If the food patterns identified reflect the food intake of a long life in a population of healthy agers, each of the SENECA food patterns reported could, by definition be interpreted as a healthful diet. The southern pattern seemed to fulfil better the demands of a healthful diet, as their food pattern reflected the Mediterranean diet pyramid, which is now accepted as a cultural model for healthy eating[42]. However, if food intake is restricted, even a diet of high quality can not provide an adequate intake of nutrients.
Therefore, nutritional guidelines should be prioritised. First the energy requirements should be covered, then the quality of the diet should be evaluated.

The evaluation of the Danish food pattern by the NAR showed, that the elderly Danes, do not have to eat Italian or Spanish to get an adequate nutrient intake. The diet score employed can be interpreted as a balanced mixture of bread, fruit, vegetables, meat, fish, dairy products, monounsaturated fat and alcohol, in amounts which provide adequate intakes of energy and nutrients. These foods are also a natural part of a traditional Danish diet. However, vulnerable

groups were identified by cluster analysis. Dietary recommendations should, therefore, be targeted to specific food patterns.

This may be done by derivations of the findings of the diet score and the cluster analysis. First a rough estimate of energy intake can be obtained, through questions on the number of meals a day. Then the dietary profile can be identified by asking questions on food group intake. In addition body weight should be measured, as unintended weight loss is an indicator of poor health.

General conclusions

This thesis underlines the importance of food patterns of elderly people in Europe today for their ability to manage activities of daily living tomorrow.

Food patterns incorporate many dimensions of food culture, and different approaches are, therefore, essential in the exploration of the different aspects and their effects on health. In this thesis focus was given to food consumption and food handling. The NAR is the traditional way of evaluating the nutrient quality of the food intake. It was useful for this purpose. Cluster analysis of micronutrient intake consistently identified food patterns mediating more or less adequate nutrient intakes. Nutritional guidance should be targeted to these groups. The developed diet score was designed to predict disability in elderly Danes. It was sensitive enough to discriminate dietary quality and predict disability over time.

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Summary

Summary

This thesis aimed at exploring food patterns of elderly Europeans, to focus on the impact of food intake on health and performance, and to identify vulnerable groups with respect to unfavourable food patterns to facilitate the formulation of nutritional recommendations to specific groups of elderly people (*chapter 1*).

Food and, therefore, energy and nutrient intake decrease with age. If the food pattern is not changed in favour of nutritious foods, this may lead to concurrent nutrient inadequacies and consequently enhance health deterioration.

Description of nutrient intake and food patterns are equally important in the evaluation of nutritional status in elderly people. Nutrient intake give some important clues about the quality of the diet. Food patterns identify the underlying food consumption, which leads to more or less adequate nutrient intakes. This adds to the understanding of ' the healthful diet'. For epidemiological research food patterns may be considered as a way of testing the contribution of both nutrients and non-nutrients to health.

The standardised methodology employed in the SENECA surveys (Survey in Europe on Nutrition and the Elderly a Concerted Action) provided a unique opportunity to study the relationship of different food patterns in their social context with the health and performance of elderly people in Europe. Although, the same validated dietary history technique was used, description and comparison of food patterns in SENECA were complicated by the fact that there is no common European Food Composition Table. At SENECA baseline (1988/89), food intake was coded by local food composition data bases and only the calculated energy and nutrient intake of the SENECA participants were centrally stored. At SENECA follow-up (1993) questions on food intake as coded by the Eurocode system was requested allowing a description and comparison of food intake by the same terms in all SENECA towns.

In *chapter 2* , cross-sectional analysis and cluster analysis were used to identify food patterns in the 647 men and 710 women aged 74-79 years participating in the SENECA follow-up study. The geographical gradient identified by nutrient intake at SENECA baseline could be confirmed by a similar gradient in food intake. The northern type of diet (H/B, R/DK, C/NL, M/PL, BLP/NI/UK) was characterised by adequate intakes of vegetables and fruits but also by a relatively high

consumption of animal products (non-fish) leading to a high saturated fat content of the diet. The Southern diet (P/I, B/E, C/P, V/P) appeared to be the most healthful being rich in grain products, vegetables and fruits, less meat, saturated fats, luxury breads and sugar products. Nevertheless, if energy intake was low, consuming a Mediterranean type of diet could not provide for them sufficient nutrients to promote health. The central European type encompassed aspects of both the northern and southern food patterns. Because the following food profiles: 'small eaters', 'green eaters', 'milk drinkers' and 'gourmands' consistently emerged from cluster analysis of micronutrient intake in different samples of elderly Europeans, these profiles can be perceived as archetypes suggesting global nutrition guidelines targeted at subgroups of Europeans with more or less favourable food patterns.

Health and performance characteristics were compared across the identified food profiles. No strong association was found between food profiles and health, however clusters with a high energy intake tended to perform better than those with a lower energy intake. A sufficient energy intake seemed, therefore, to be necessary for an adequate nutrient intake.

An in depth study was performed to analyse the stability of food patterns with time in Danish (n=55), Dutch (n=65) , Swiss (n=79) and Spanish (n=46) women, representing the northern, central and southern food patterns. Investigators from each of these SENECA towns agreed to retrieve the locally coded actual food intake at SENECA baseline and to recode it by the Eurocode system. Because of the decrease in energy intake with age it would be favourable if food patterns changed concurrently towards a more nutritious food intake consuming less of low nutrient dense foods. The longitudinal changes in food group intake in Danish, Dutch, Swiss and Spanish women as the aged from 70-75 to 74-79 years of age are described in *chapter 3*. Food patterns appeared to be stable with age as portion sizes were smaller rather than decrease in intake of a single specific food item. However, Spanish women increased their intake of dairy products, fish and fruits over the 4 year follow-up period. This finding cannot be expected to be a result of ageing, as it reflected the general trend in the Spanish population in that period.

The study described in *chapter 4* was performed to investigate whether nutrient intake was mediated by the same food groups in different food cultures, or the cross-cultural variation identified earlier, also showed up here. Because no nutrient values are connected to the Eurocode

system, it was not possible to detect directly how the different foods contributed to the intake of each nutrient. This was only practical achievable by the use of Danish and Dutch food composition databases. Vitamin C was used as an example of a nutrient appearing in many different foods and exposed to high losses during storage and cooking. Vitamin C intake was quantified by the use of a classification system developed to divide foods by their liability to losses of vitamin C during storage or cooking. The food intake of Danish (n=115) and Dutch (n=121) SENECA participants was influenced by the northern food pattern. The major food sources of vitamin C in these SENECA towns were potatoes and cabbages, which are characteristic ingredients in Danish and Dutch winter dishes. Fruiting and leafy vegetables hardly contributed to vitamin C intake as salads are not a natural part of the northern winter meal pattern.

When vitamin C intake in the diet of Danish and Dutch participants was calculated from food composition tables the median vitamin C intake was more than twice as high as the value corrected for losses during food handling. Based on these corrected data 37% of the participants had vitamin C intake below the lowest European Recommended dietary intake (30mg/d) as compared to 7% of the men and 11 % of the women before this correction.

If cooking losses of vitamin C are underestimated, losses of other labile vitamins like folic acid should also be considered in the nutritional evaluation of the food intake of elderly people.

In *chapter 5* we examined the relationship between a negative energy balance and health. We expected that over the 4 year period of follow-up the elderly people studied would undergo changes in body composition, energy intake and physical activity as a consequence of a combination of ageing, change in lifestyle, living conditions and health. We tested this assumption in Danish (n=115) and Dutch (n=121) participants as food pattern and other lifestyle factors were reasonable comparable between these two SENECA towns. Weight loss, as well as changes in waist, hip and arm circumferences were indicators of poor health, but decrease in energy intake as an intermediary factor could not be proven. The dietary history technique employed should be able to detect the small differences in energy intake needed to lose weight, given that measurements of diet and body weight were conducted in the dynamic phase of losing weight and while the other determinants of energy balance were constant. Presumably, the majority of people with a loss of body weight were most likely not in the dynamic phase of losing weight during the period of dietary assessment.

Among 115 Danes ageing from 70-75 to 74-79 years of age we examined further the implications of food patterns on health in a design giving weight to both quantity and quality of food intake (*chapter 6*). The Nutrient Adequacy Ratio (NAR), cluster analysis on the basis of micronutrient intake and a diet score developed to predict disability were used in the exploration of association between the Danish food pattern and health. According to the NAR the food pattern of elderly Danes mediates adequate intakes of energy and most nutrients. Nevertheless, a segment of elderly Danes at risk of too low nutrient intake was identified by cluster analysis. Use of the diet score developed to predict disability showed that favourable food patterns today matter in the prevention of disability tomorrow. A physical active lifestyle ensures, besides other beneficial effects on health, that energy intake is sufficiently high to secure an adequate nutrient intake.

In *chapter 7* the general issues concerning the studies described in this thesis were discussed. SENECA data were applicable for identification of food patterns of relatively healthy elderly people living in the participating centres in Europe. SENECA is one example, that multi-centre studies in Europe need a common European food composition table. Even if such a table would only be a rough estimate of the energy and nutrient content of foods, it would facilitate the identification of cross-cultural variation in food sources of specific nutrients. At present the Eurocode system can be recommended in the comparison of food group intake. The current coding of meat-cuts, however, needs to be revised.

Many methods have been developed to measure the quality and healthfulness of the diet. Because of the nature of food intake, one measure alone cannot tell everything about food patterns and health associations. Applications of several instruments is therefore useful for the evaluation of the nutritional quality of the diet, for the identification of more or less favourable food patterns and for the study of associations between food patterns and disability. The NAR and the diet score to predict disability employed in this thesis proved to be helpful in the exploration of food patterns and health in elderly Europeans. Cluster analysis of micronutrient intake provided insight in food patterns underlying inadequate nutrient intakes.

The studies presented in this thesis underlined the importance of food patterns of elderly people today for their ability to manage activities of daily living tomorrow. Although the general food pattern in each of the European settings studied appeared to mediate adequate intakes of energy and nutrients, vulnerable groups of elderly Europeans can be identified by questions on number of

meals a day, food group intake and assessment of weight change. Policy makers and health care professionals should put a joined effort in optimising the food intake of these vulnerable elderly people: On one hand by stimulating physical activity to animate food intake and on the other hand by facilitating the availability of attractive nutritious foods.

Sammenfatning

Sammenfatning

Introduktion

Formålet med denne PhD-afhandling var at identificere ældre europæeres kostvaner og undersøge deres betydning for bevarelsen af et godt helbred og evnen til at klare sig langt op i alderen. Ældre mennesker med et lavt næringsindtag blev identificeret og deres kostvaner karakteriseret for at lette formuleringen af kostråd til grupper af sårbare ældre (*kapitel 1*).

Indtagelsen af levnedsmidler falder med alderen. Hvis kostvanerne ikke ændres til fordel for en næringsrigtig kost, kan dette føre til utilstrækkelig næringsindtagelse og fremskynde funktionstab.

Beskrivelse af kostvaner og næringsindtag er lige væsentlige i vurderingen af ældre menneskers ernæringstilstand. Information om næringsstofindtagelsen giver vink om kostens kvalitet. Kostvaner identificerer det bagvedliggende fødevareindtag, der fører til mere eller mindre acceptable næringsindtag. Dette fremmer forståelsen af 'den rigtige kost'. Kostvaner opsummerer effekten af alle kostens komponenter i et mål, og er derfor relevant i befolkningsundersøgelser, hvor kostens betydning for helbred ønskes belyst.

Afhandlingen tager udgangspunkt i den longitudinelle, multi-center undersøgelse SENECA. SENECA står for Survey in Europe on Nutrition and the Elderly a Concerted Action, og har til formål at undersøge ældre menneskers kost i relation til deres levekår, livsstil og helbred. I alt 2591 70-75-årige fra 19 mindre byer i 12 europæiske lande deltog i basisundersøgelsen i 1988/89 og 1357 74-79-årige fra 12 centre i 10 lande deltog i genundersøgelsen i 1993. Det danske SENECA center lå i Roskilde. Merete Osler har beskrevet kost og helbredsdata på de i alt 202 danskere der deltog i basisundersøgelsen. Heraf blev 115 danskere genundersøgt i 1993.
SENECA valgte at studere 70-80-årige ud fra en forventning om, at skiftet fra 'unge gamle' til 'gamle gamle' sker lige omkring de 75 år.
SENECAs styrke ligger i anvendelsen af standardiserede metoder i samtlige centre, på en befolkning med stor variation i kost- og livsstilsfaktorer, hvorfor en stor variation i helbreds- og funktionsvariable også kan forventes.

Undersøgelsen

Ældre Roskilde-borgere, der havde deltaget i SENECA's basisundersøgelse, blev kontaktet per brev og telefon. Folk, der ikke ønskede at deltage, blev bedt om at besvare et *ikke-deltager-interview*. Deltagere blev besøgt i eget hjem og interviewet om en række *baggrundsvariable* (socio-økonomisk status, socialt netværk, helbred og livsstil). Herudover gennemførte deltageren en *mini-mental test*, og fik instruktion i brugen af en *kost-dagbog*, hvori al mad og drikke i husholdningsmål blev skrevet op i 3 på hinanden følgende dage (1 week-end dag + 2 hverdage). Kostdagbogen blev så brugt som udgangspunkt for det *kosthistoriske interview* (reference periode 1 måned) ved det andet besøg og de mest almindelige husholdningsmål blev vejet af intervieweren. Selvom den samme validerede kosthistoriske metode blev anvendt i samtlige SENECA centre var beskrivelse og sammenligning af kostvaner i SENECA kompliceret af, at der ikke findes en fælles europæisk levnedsmiddeltabel. Ved SENECAs basisundersøgelse (1988/89) blev deltagernes kostdata indtastet i lokale kostdatabaser og kun det beregnede indtag af energi og næringsstoffer blev lagret centralt. Ved SENECAs opfølgning blev kostdata kodet med *Eurocode* for at muliggøre beskrivelse og sammenligning af fødevareindtag med de samme termer i alle SENECA centre.
Ved et besøg på hospitalet blev der taget en *blodprøve* til bestemmelse af biokemiske variable (hæmatologi, albumin, vitamin-spejl), dernæst blev deltagerens *vægt, højde, hudfolder, hofte, talje og overarms omkreds* målt. Endelig gennemførte deltageren en række *fysiske funktionstests* til bestemmelse af funktionsevnen.

Resultater

En tværsnitsanalyse af kosthistoriske interviews på de i alt 647 mænd og 710 kvinder, der deltog i SENECAs opfølgning blev gennemført for at identificere kostvaner i forskellige europæiske byer. Resultaterne er beskrevet i *kapitel 2*. Heraf fremgår det, at kostvaner varierer mellem de 12 SENECA centre. Mænd og kvinders kostvaner minder om hinanden i de forskellige centre, omend mændene spiser mere end kvinderne. Der er en hvis geografisk tendens, således at de nordeuropæiske centre havde et stort indtag af animalsk fedt, kød, kartofler, sukker og øl, mens de sydeuropæiske centre havde et højere indtag af vegetabilsk fedt, fisk, frugt, grønsager og vin. De centraleuropæiske centres indtag lå et sted midt imellem. De fleste ældre havde en sund og nærende kost med rimelig balance mellem indtag af animalske og vegetabilske produkter. Umiddelbart så det ud til, at de sydeuropæiske lande bedst opfyldte kravene om en sund kost. Ikke desto mindre, kunne ikke engang

'Middelhavskosten' sikre et tilstrækkeligt højt næringsindtag til at bevare et godt helbred, hvis kostens energiindhold var lavt.

Af SENECAs basisundersøgelse fremgik det, at ældre europæere især havde problemer med tilstrækkelig indtagelse af B-vitaminerne, C-vitamin, calcium og jern. Cluster analyse af indtagelse af disse mikronæringsstoffer blev derfor gennemført for at identificere hvilke kostprofiler, der var associeret med mere eller mindre hensigtsmæssige næringsindtag. Den fundne nord-syd gradient resulterede ikke i nord-, central- eller sydeuropæiske kostprofiler ved cluster analysen. I stedet blev følgende kostprofiler identificeret: 'småtspisere', 'grøntspisere', 'mælkedrikkere' og 'gourmander'. Da disse profiler fremkom konsistent ved cluster analyse af vitamin og mineral indtagelse af forskellige stikprøver af ældre europæere kan de betragtes som arketyper. Dette betyder, at globale næringsanbefalinger bør udvikles rettet mod undergrupper af ældre med mere eller mindre gode kostvaner. Variation i kostvaner mellem og i europæiske byer viste sig at være af nogenlunde samme størrelsesorden.
Ingen stærk association blev fundet mellem de fundne kost profiler, helbred og funktionsevne. Imidlertid var der en tendens til at deltagere karakteriseret ved en kostprofil med et højt energi indtag klarede sig bedre i dagligdagen, end dem der var karateriseret ved kostprofil med et lavere energiindtag.

Som tidligere nævnt falder indtagelsen af levnedsmidler, og dermed af energi og næringsstoffer, med alderen, og øger risikoen for mangel af visse næringsstoffer, med mindre den ældre ændrer sin kost i retning af en mere næringstæt kost. Spørgsmålet er derfor om den ældre får mindre energi ved at spise mindre af alting (kostvaner uændret) eller ved at spise mindre af særlige levnedsmidler? Risikoen for at komme i næringsskud øges hvis kostomlægningen tilgodeser fødevarer rige på tomme kalorier. En longitudinel analyse af danske, hollandske, schweiziske og spanske kvinders kosthistoriske interviews, kodet med Eurocode, blev gennemført for at undersøge dette spørgsmål (*kapitel 3).*
Kostvaner bevares med alderen, idet portionsstørrelser af de fleste fødevarer var mindre.
De spanske kvinder indtog, imidlertid, mere mælk, fisk og frugt med alderen - eller over tid. Dette skete samtidig med en generel stigning i forbruget af disse levnedsmidler overalt i Spanien. Dette

tyder på, at kostvanerne er præget af den kultur de forekommer i, samt at ældre følger fødevare-tendenser på samme måde som yngre mennesker.

I *kapitel 4* har vi analyseret betydningen af fødevarevalg og -behandling for indtagelsen af vitamin C. Da der ikke er nogen forbindelse mellem levnedsmidler kodet med Eurocode og næringsstoffer var det kun praktisk muligt at gennemføre analysen ved brug af danske og hollandske kostdatabaser. Det aktuelle indtag af vitamin C blev kvantificeret ved brug af et klassificeringssystem udviklet til at inddele fødevarer efter sandsynligheden for tab af vitamin C under opbevaring og tilberedning. De danske (n=115) og hollandske (n=121) deltagere var præget af de nordeuropæiske kostvaner. Den væsentligste kilde til vitamin C i disse lande var kartofler og kål, der er karakteristiske ingredienser i danske og hollandske vinterretter. Tomat og bladgrønsager var stort set betydningsløse for vitamin C indtagelsen blandt de nordeuropaiske deltagere, da salater ikke er en naturlig del af deres vintermenu.

Når vitamin C indholdet i de danske og hollandske deltageres kost blev beregnet fra levnedsmiddeltabeller var median indtagelsen af vitamin C mere end dobbelt så høj , som værdien vi havde korrigeret for tab under processen fra jord til bord. Før vores korrektion for tab havde 7% af mændene og 11% af kvinderne et vitamin C indtag, der var lavere end de laveste europæiske anbefalinger (30mg/d). Efter korrektionenen havde 37% af deltagerne et vitamin C indtag, der var lavere end 30 mg/d.

Den sydeuropæiske kost med et højt indtag af frisk frugt og grønsager kan forventes at have en lavere korrektionsfaktor end den, der blev fundet i det danske og hollandske SENECA center. Ikke desto mindre underestimerer levnedsmiddeltabeller antallet af mennesker i risiko for marginal indtagelse af vitamin C. Tilsvarende må man være opmærksom på at indtagelsen af folinsyre og andre labile næringsstoffer reelt kan være lavere end de laveste næringsstofanbefalinger på grund af opbevarings/tilberedningstab.

I *kapitel 5* undersøgte vi sammenhængen mellem en negativ energibalance og helbred nærmere. Vi forventede at deltagerne i løbet af de fire år opfølgningen varede ville ændre kropssammensætning, energiindtagelse og fysisk aktivitetsniveau, som konsekvens af en kombination af aldring, forandring i

livsstil, levekår og helbred. Vi testede denne antagelse på danske (n=115) og hollandske (n=121) deltagere, eftersom kostvaner og andre livsstils faktorer var rimeligt sammenlignelige mellem disse to SENECA byer. Vægttab, samt ændringer i talje-, hofte- og overarms-omkreds var associerede med dårligt helbred, men fald i energiindtag, som en mellemliggende faktor kunne ikke vises udfra vores data. Givet, at undersøgelsen af kost og vægtændring blev foretaget i den dynamiske fase af vægttab, og at alle andre parametre i energibalancen var uændrede, skulle den anvendte kosthistoriske metode være tilstrækkelig præcis til at måle de små ændringer i dagligt energiindtag, der er nødvendige for et vægttab. Sandsynligvis var størstedelen af de deltagere, der gik ned i vægt, ikke i den dynamiske fase af vægttab, mens genundersøgelsen blev foretaget.

Herefter undersøgte vi betydningen af ældre danskeres (n=115) kost ved 70-75-årsalderen for deres helbred ved 75-79-årsalderen, i et design, der lagde vægt på både kostens kvantitet og kvalitet (*kapitel 6.*). Til belysning af sammenhænge mellem danskernes kost og helbred anvendtes a) Forholdet mellem indtagelsen af et næringsstof og anbefalingerne for dette næringsstof (Nutrient Adequacy Ratio, NAR), b) cluster analyse på basis af mikronæringsstoffer, samt c) et kostscore udviklet til at forudsige svækkelse. Ifølge NAR-værdien var ældre danskeres kostvaner generelt i stand til at dække behovet for energi og næringsstoffer. Imidlertid blev en undergruppe af ældre danskere, i risiko for utilstrækkeligt næringsindtag, identificeret ved cluster analyse. Anvendelsen af kostscoret udviklet til at forudsige svækkelse viste, at gode kostvaner i dag har betydning for evnen til at klare sig selv i morgen. Et fysisk aktivt liv betød, udover andre helbredsgevinster, at fødeindtagelsen blev tilstrækkeligt høj til at sikre et tilfredstillende næringsindtag.

I *kapitel 7* har vi diskuteret de generelle emner vedrørende denne afhandlings studier. SENECAs data er anvendelige for identifikation af kostvaner blandt forholdsvis raske ældre fra deltager-landene i Europa. SENECA er et eksempel på, at multicenter-undersøgelser i Europa behøver en fælles europæisk levnedsmiddeltabel. Selvom en sådan tabel kun kan blive et groft estimat af fødevares energi og næringsindhold, ville den være en afgørende hjælp i analysen af variation i fødevarekilder til forskellige næringsstoffer. Indtil da, kan Eurocode systemet anbefales til sammenligning af fødevareindtag mellem europæiske lande.

Mange metoder er udviklet til at måle kostens næringsmæssige og helsefremmende kvaliteter. På grund af kostens natur kan en metode alene ikke sige alting om sammenhængen mellem kost og helbred. Anvendelsen af flere metoder er derfor hensigtsmæssig i vurderingen af kostens næringsmæssige kvalitet, for identifikationen af mere eller mindre fordelagtige kostvaner og for studiet af relationer mellem kost og svækkelse. NAR og det udviklede kostscore viste sig at være nyttige i belysningen af ældre europæeres kost og helbred. Cluster analysen af mikronæringsstoffer gav indsigt i de bagvedliggende kostvaner, der fører til et utilstrækkeligt næringsindtag.

Undersøgelserne, beskrevet i denne afhandling, understreger betydningen af gode kostvaner i dag for at kunne klare sig selv i morgen. Skønt kostvanerne i hver af de europæiske byer generelt set imødekom næringsanbefalingerne, kan sårbare ældre identificeres ved spørgsmål om antallet og typen af måltider per dag samt vurdering af vægttab. Der bør fra centralt hold og fra de personer der er i berøring med ældre mennesker tages initiativ til en optimering af fødevareindtagelsen blandt de særligt sårbare ældre. På den ene side ved at stimulere fysisk aktivitet for at øge fødeindtagelsen, og på den anden side ved at gøre appetitlige næringsrige levnedsmidler lettere tilgængelige.

About the author

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Kirsten Schroll Bjørnsbo was born on the 12th of May 1968 in Århus, Denmark. In 1987 she completed secondary school at 'Amtsgymnasiet' in Roskilde and started her studies at the Royal Veterinary and Agricultural University in Copenhagen. As part of her training in Food Science, she was an exchange student at the Human Nutrition Course at Ulster University in Northern Ireland for 9 months in 1989/90. During the summer 1990 she spent 3 months of practical research at Trinity College, Dublin, studying dietary compliance in HIV positive patients. In 1992 she defended her thesis for her MSc in Food Science.

From October 1992 to August 1997 she was appointed as PhD fellow in the Netherlands Postgraduate Programme in Human Nutrition at the Department of Human Nutrition, now the Division of Human Nutrition and Epidemiology, Wageningen Agricultural University, the Netherlands. During this appointment she conducted the research described in this thesis. In October 1992 she attended the Course on Production and Use of Food Composition Data, Doorwerth, The Netherlands.

During spring 1993 she completed the fieldwork for the Danish part of the SENECA follow-up. In June 1993 she attended the Fifth European Postgraduate Summer Course in Public Health Nutritional Epidemiology at Southampton University, United Kingdom. In October 1994, she followed the Course in Quantitative Methods in Epidemiology at the School of public Health, Brussels, Belgium. The next step in her career is a three year post doc position at Department of Physical Education, Odense University, Denmark. As a part of a research team she will study the effect of training on the food pattern and nutritional status in 75 year old people living in Odense.

During the PhD study Kirsten Schroll Bjørnsbo married Anders Hegelund Bjørnsbo and gave birth to Mads Schroll Bjørnsbo and Ida Schroll Bjørnsbo.

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When I decided to return to Denmark, and finish my studies there, Department of Physical Education at Odense University most kindly offered me a desk. I'm very grateful for your interest in my work and the friendly atmosphere in the everyday.

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Appendix:

Results of the general questionnaire in Danish participants at SENECA follow-up (1993).

General Questionnaire - SENECA 1993		Men n = 58	Women n = 57
{q0b} Interviewer's code 1)		52	53
{q0b} Interviewer's code 2)		48	47
{q0f} Type of dwelling 1) institution		2	4
	2) dwelling related to or connected with institution	0	0
	3) apartment building, flat	29	41
	4) family house with garden	64	54
	5) family house without garden	2	2
	6) farm	2	0
	7) other	2	0
{q0g} Area of residence 1) urban		83	95
2) suburban		10	5
3) rural		7	0

Part A: General information; marital status

Marital status

{q3a} What is your marital status nowadays? 1) single		7	16
	2) married	66	23
	3) divorced/ separated	3	7
	4) widowed	19	51
	5) living with partner	5	4
{q3b} For how long have you been divorced/widowed? < 10 years		7	16
	> 10 years	17	42

Part B: Socio-economic Status

Education respondent

{q4} What kind of schools did you go through? 1) primary education		14	42
	2) secondary education	67	44
	3) higher education	19	14
	4) illiterate	0	0

Occupation of respondent

{q5b} What was your working situation? 1) employer or own-account worker		57	12
	2) employee	41	49
	3) unemployed	2	0

	4) housekeeper	0	39
	8) question irrelevant	0	0
5c} Did you have more than one subordinates or employees?	1) yes	47	12
	2) no	36	61
	8) question irrelevant	17	26
5d} Classification of profession	1) Unskilled manual worker	9	33
	2) Skilled manual worker	35	19
	3) Intermediate non-manual worker	11	23
	4) Self employed, no subordinates	11	2
	5) Self employed, more than one subordinate	16	7
	6) Lower professional	2	14
	7) Higher professional	18	2
6a} Do you still undertake work activity?	1) yes	7	0
	2) no	93	100
6b} If yes, what is your main occupation nowadays?	1) low activity level	4	0
	2) middle activity level	3	0
	3) high activity level	0	0
6c} If yes, for how many hours per week?	1) 0-10 hours per week	3	0
	2) 10-20 hours per week	1	0
	3) 20-30 hours per week	3	0
6d} At work I sit	1) never	3	0
	2) seldom	0	0
	3) sometimes	3	0
	4) often	0	0
	5) always	1	0
	8) question irrelevant	93	100
6e} At work I stand	1) never	4	0
	2) seldom	0	0
	3) sometimes	3	0
	4) often	0	0
	5) always	0	0
	8) question irrelevant	93	100
6f} At work I walk	1) never	1	0
	2) seldom	0	0
	3) sometimes	3	0
	4) often	0	0
	5) always	3	0
	8) question irrelevant	93	100
6g} At work I lift heavy loads	1) never	5	0
	2) seldom	1	0
	3) sometimes	1	0
	4) often	0	0
	5) always	0	0
	8) question irrelevant	93	100
6h} At work I am tired	1) never	6	0

	2) seldom	1	
	3) sometimes	0	
	4) often	0	
	5) always	0	
	8) question irrelevant	93	10
{q6i} At work I sweat	1) never	3	
	2) seldom	1	
	3) sometimes	2	
	4) often	0	
	5) always	1	
	8) question irrelevant	93	10
{q6j} My work is physically in comparison with others	1) much lighter	0	
	2) lighter	1	
	3) as heavy	1	
	4) heavier	1	
	5) much heavier	1	
	8) question irrelevant	93	10
	9) no answer/ do not know	3	

Occupation of partner

{q7b} What was his/her working situation?	1) employer or own-account worker	10	4
	2) employee	57	4
	3) unemployed	0	
	4) housekeeper	26	
	8) question irrelevant	7	
{q7c} Did he/she have more than one subordinates or employees?			
	1) yes	9	3
	2) no	72	3
	8) question irrelevant	19	2
	9) no answer/ do not know	0	
{q7d} Classification of profession	1) Unskilled manual worker	39	
	2) Skilled manual worker	16	
	3) Intermediate non-manual worker	19	
	4) Self employed, no subordinates	0	
	5) Self employed, more than one subordinate	4	2
	6) Lower professional	12	
	7) Higher professional	2	
	8) question irrelevant	9	
{q8a} Does your partner still undertake work activity?	1) yes	7	
	2) no	64	2
	8) question irrelevant	29	
{q8b} If yes, for how many hours per week?	1) 0-10 hours per week	2	
	2) 10-20 hours per week	5	
	3) 20-30 hours per week	2	
	4) 30-40 hours per week	2	
	8) question irrelevant	90	

rt C: Housing; Facilities

ving situation

)}	How long have you been living at your present address?	< 10	24	19
		10-20	10	23
		21-30	24	23
		31-40	26	20
		>40	17	16
0}	How many people are living here with you?	0)	26	63
		1)	72	33
		2)	0	2
		3)	2	0
		4)	0	2
1}	Who else is in your household?			
	0) none		26	63
	1) spouse/ partner only		69	28
	2) spouse/ partner and children/grandchildren		2	4
	3) spouse/ partner and friends/ relatives other than children/grandchildren		0	0
	4) relations but not spouse/ partner		2	4
	5) people other than relations (institute)		0	0
	6) friends		2	0
	7) other		0	2

cilities

a}	Do you have a telephone?	yes	95	98
b}	Do you have a television ?	yes	97	97
c}	Do you have a radio?	yes	98	98
a}	Do you have cooking facilities?	own	98	98
		shared with others	2	2
b}	Is there a fridge?	yes	100	100
c}	Is there a deep freeze?	yes	98	98
d}	Is there a tap for cold water ?	yes	100	100
e}	Is there a tap for warm water?	yes	98	98
a}	Do you prepare your own meals ?	0) never	60	4
		1) sometimes	5	4
		2) often	0	5
		3) always	35	88
b}	Are you able to cook a hot main meal ?	1) with ease	41	93
		2) able to manage	38	0
		3) with difficulty	10	4
		4) not at all	10	4

{q15a} How far is the nearest shop that sells food?	1) close by	41	4
	2) at walking distance	41	3
	3) at bicycle distance	14	1
	4) other transportation distance	2	
	9) no answer/ do not know	2	
{q15b} How often do you go shopping for food?	0) never shop for food	9	
	1) about weekly	28	3
	2) twice or more weekly	51	4
	3) daily	12	1
{q15c} If you go out for shopping, what kind of transportation?	0) I never go out	7	
	1) car	40	2
	2) public transportation	12	1
	3) bicycle	22	2
	4) walking	16	1
	8) question irrelevant	3	
{q16a} Do you find going to the food-shops is	1) a real problem	7	
	2) an inconvenience	0	
	3) no problem	88	1
	8) question irrelevant	5	

16b What is the reason for not going to the food-shops?

{q16b1} - distance	2
{q16b2} - budget	0
{q16b3} - carrying bags	2
{q16b4} - other reasons	5

Part D: Activities of daily living

17a. Are you able:

{q17a01} to move outdoors			
	1) yes, without difficulty	85	1
	2) yes, with difficulty, but without help	12	
	3) yes, only with help	3	
	4) no	0	
{q17a02} to walk between rooms			
	1) yes, without difficulty	95	9
	2) yes, with difficulty, but without help	5	
	3) yes, only with help	0	
	4) no	0	
{q17a03} to use stairs			
	1) yes, without difficulty	79	
	2) yes, with difficulty, but without help	21	2
	3) yes, only with help	0	
	4) no	0	
{q17a04} to walk at least 400 m			
	1) yes, without difficulty	86	
	2) yes, with difficulty, but without help	7	

	3) yes, only with help	2	2
	4) no	5	5
17a05}	to carry a heavy thing		
	1) yes, without difficulty	79	60
	2) yes, with difficulty, but without help	9	19
	3) yes, only with help	0	2
	4) no	12	19
17a06}	to use the toilet		
	1) yes, without difficulty	95	97
	2) yes, with difficulty, but without help	2	2
	3) yes, only with help	3	2
	4) no	0	0
17a07}	to wash yourself		
	1) yes, without difficulty	95	97
	2) yes, with difficulty, but without help	5	0
	3) yes, only with help	0	2
	4) no	0	2
17a08}	to dress and undress		
	1) yes, without difficulty	95	97
	2) yes, with difficulty, but without help	2	0
	3) yes, only with help	3	2
	4) no	0	2
17a09}	to go in and out of bed		
	1) yes, without difficulty	98	93
	2) yes, with difficulty, but without help	2	5
	3) yes, only with help	0	2
	4) no	0	0
17a10}	to cut toe-nails		
	1) yes, without difficulty	72	75
	2) yes, with difficulty, but without help	17	14
	3) yes, only with help	0	4
	4) no	10	7
17a11}	to use the telephone		
	1) yes, without difficulty	93	93
	2) yes, with difficulty, but without help	3	2
	3) yes, only with help	3	5
	4) no	0	0
17a12}	to take own medication		
	1) yes, without difficulty	97	95
	2) yes, with difficulty, but without help	2	0
	3) yes, only with help	2	4
	4) no	0	2
17a13}	to manage finances		
	1) yes, without difficulty	88	90
	2) yes, with difficulty, but without help	3	0
	3) yes, only with help	2	4
	4) no	7	7
17a14}	to feed yourself		
	1) yes, without difficulty	95	100
	2) yes, with difficulty, but without help	5	0
	3) yes, only with help	0	0

	4) no	0	
{q17a15}	to do light housework		
	1) yes, without difficulty	93	9
	2) yes, with difficulty, but without help	3	
	3) yes, only with help	2	
	4) no	2	
{q17a16}	to do heavy housework		
	1) yes, without difficulty	83	7
	2) yes, with difficulty, but without help	3	1
	3) yes, only with help	2	1
	4) no	12	
{q17a17}	to stay alone overnight		
	1) yes, without difficulty	100	9
	2) yes, with difficulty, but without help	0	
	3) yes, only with help	0	
	4) no	0	
{q17b}	Did health problems affect activities? yes	38	3

Part E: Physical activity

Housework

{q18}	Do you do the light housework?		
	0) never/ occasionally	24	
	1) mostly, but with assistance	9	
	2) mostly, without assistance	9	
	3) always (alone)	59	9
{q19}	Do you do the heavy housework?		
	0) never/ occasionally	38	1
	1) mostly, but with assistance	7	2
	2) mostly, without assistance	22	2
	3) always (alone)	33	4
{q20}	For how many persons do you keep house? 0)	2	
	1)	35	6
	2)	63	3
	3)	0	
{q21a}	How many rooms do you actually clean? 0	10	
	1-5	59	3
	6-10	26	5
	> 10	5	
{q21b}	Over how many floors? 0)	5	
	1)	75	6
	2)	10	1
	3)	10	1
{q22}	Do you use a vacuum cleaner to clean the floors		
	0) never clean floors	10	

	1) always	69	84
	2) often	0	2
	3) sometimes	0	0
	4) never (only broom floors)	3	4
	8) question irrelevant	17	5
23} Do you use an electric washing machine to do washes?			
	0) never do washes	43	5
	1) always	35	74
	2) often	0	2
	3) sometimes	3	4
	4) never (only do handwashes)	3	11
	8) question irrelevant	16	5
24} How many hours/day housekeeping?	0	24	7
	1-10	30	11
	11-20	32	30
	21-30	10	32
	> 30	5	21
25} Are you tired after housekeeping			
	0) never	55	54
	1) sometimes	9	23
	2) often	2	9
	3) always	10	11
	8) question irrelevant	24	4

Sports

26a} Do you take part in a physical active sport?	yes	41	39
26b} If yes, which sport do you play most frequently?			
	intensity 0.76	10	0
	intensity 1.26	29	37
	intensity 1.76	2	2
26c} How many hours a week?	0.1	0	2
	0.5	5	7
	1.5	19	26
	2.5	7	2
	3.5	2	0
	4.5	9	2
26d} How many months a year?	0.04	0	0
	0.17	2	0
	0.42	3	7
	0.67	9	5
	0.92	28	25
	1.67	0	2
26e} If you take part in a second sport, which one?			
	intensity 0.76	5	0
	intensity 1.26	10	7
	intensity 1.76	0	0
26f} How many hours a week?	0.5	5	0
	1.5	7	5
	2.5	2	2
	3.5	0	0

	4.5		2	
{q26g} How many months a year?	0.04		0	
	0.17		2	
	0.42		2	
	0.67		5	
	0.92		7	

Other activities

{q27} What kind of transportation in your hometown?		0) I never go out	0	
		1) car	38	2
		2) public transport	19	3
		3) bicycle	26	1
		4) walking	17	2
{q28} How many flights of stairs?	0) do not climb stairs		35	2
	1) 1-5		30	3
	2) 5-10		11	2
	3) > 10		25	1

29 Do you undertake other physical activities?

29a walking, movements arm or hands

{q29a1} intensity * 10-3			
	0.0	70	8
	0.297	4	
	0.89	0	
	1.368	26	1
{q29a2} hours per week * 10-1			
	0.5	2	
	1.5	5	
	2.5	2	
	3.5	7	
	4.5	2	
	6.5	2	
	7.5	4	
	8.5	7	
	8.8 question irrelevant	70	8
{q29a3} months a year * 10-2			
	0.17	2	
	0.42	4	
	0.85	2	
	0.92	23	1
	8.88 question irrelevant	70	8

29b walking, body movements

{q29b1} intensity * 10-3			
	0.0	68	6
	1.368	28	3
	1.89	4	
{q29b2} hours per week * 10-1			
	1.0	2	
	1.5	5	
	2.5	5	

	3.5	9	9
	5.5	4	4
	7.5	4	5
	8.5	4	11
	8.8 question irrelevant	68	63
{29b3}	months a year * 10-2		
	0.67	7	2
	0.92	25	35
	8.88 question irrelevant	68	63
	29c cycling		
{29c1}	intensity * 10-3		
	0.0	76	88
	1.26	0	2
	1.89	24	11
{29c2}	hours per week * 10-1		
	1.5	7	4
	2.5	3	5
	3.5	3	4
	5.5	2	0
	7.5	7	0
	8.5	2	0
	8.8 question irrelevant	76	88
{29c3}	months a year * 10-2		
	0.17	3	0
	0.42	2	2
	0.67	7	4
	0.92	12	7
	8.88 question irrelevant	76	88
	29d gardening		
{29d1}	intensity * 10-3		
	0.0	32	46
	1.368	0	2
	1.89	68	53
{29d2}	hours per week * 10-1		
	0.4	2	2
	0.5	2	2
	1.5	7	6
	2.5	12	7
	3.5	2	9
	4.5	5	4
	5.5	4	0
	6.5	4	5
	7.5	5	7
	8.5	27	14
	8.8 question irrelevant	32	46
{29d3}	months a year * 10-2		
	0.17	4	4
	0.42	2	4
	0.67	51	42
	0.92	12	5
	8.88 question irrelevant	32	46

{q29e} sum-score over remaining activities	0	58	
	0.1 - 5	25	
	5.1- 10	11	
	10- 15	5	
	> 15	2	
{q30} Do you sweat during activities?	1) never	53	
	2) sometimes	22	
	3) often	9	
	4) always	14	
	8) question irrelevant	2	
{q31} How many hours per day do you sit down to watch TV, listen to the radio or read?			
	1) more than 4 hours per day	41	
	2) 3-4 hours per day	43	
	3) 1-2 hours per day	14	
	4) less than 1 hour per day	2	
{q32} How many hours per day do you play games e.a. ?	1) more than 4 hours per day	3	
	2) 3-4 hours per day	7	
	3) 1-2 hours per day	24	
	4) less than 1 hour per day	24	
	5) not at all	40	
	9) no answer/ do not know	2	
{q33a} How many hours do you rest/sleep during the day?	1) more than 2 hours	2	
	2) 1-2 hours per day	33	
	3) ½-1 hour per day	26	
	4) 1/4-½ hour per day	9	
	5) less than 1/4 hour per day	31	
{q33b} How many hours do you rest/sleep during the night?	1) 10 hours or more	0	
	2) 8-10 hours	26	
	3) 6-8 hours	66	
	4) 4-6 hours	9	
	5) less than 5 hours	0	
{q34a} How active do you consider yourself ?	1) much less active	7	
	2) less active	10	
	3) average active	17	
	4) more active	35	
	5) much more active	26	
	9) no answer/ do not know	5	
{q34b} How active in comparison to four years ago?	1) far less active	16	
	2) somewhat less active	22	
	3) as active	55	
	4) more active	7	
	8) irrelevant	0	

Exposure to sunlight

§35a}	How often do you go outside during the sunny periods?	0) avoid to go outside	0	2
		1) less than once a week	0	0
		2) 1-2 times a week	0	2
		3) more than 2 times a week	2	2
		4) every day	98	93
		9) no answer/ do not know	0	2
§35b}	Outside, do you stay in the sun?	1) never	0	2
		2) try to avoid sunshine	22	28
		3) sometimes	16	21
		4) as much as possible	43	42
		5) every day	19	7
§36a}	Do you ever go away on holiday to a sunny place?	1) yes	22	21
§36b}	If yes, how often?	1) more than once a year	3	2
		2) once a year	12	14
		3) once in 1-5 years	5	7
		4) less than once 1-5 years	2	0
		8) question irrelevant	78	77
37	When outdoors during the sunny months, do you mostly wear			
§37a}	jacket, coat, suit or sweater		2	5
§37b}	long sleeved shirt, blouse, dress or T-shirt		12	16
§37c}	short sleeved shirt, blouse, dress or T-shirt		59	54
§37d}	swim-wear or light beach clothes		35	32
§37e}	hats, shawls, kerchiefs		48	28
§38a}	Do you use sun(ray)-lamps?	1) yes	2	7
§38b}	If yes, how often?	1) sometimes	0	0
		2) often	2	7
		8) question irrelevant	98	93

Part F: Social network

Relatives/friends

§39a}	Do you have children ?	1) yes	88	81
§39b}	If yes, how many?	1)	7	12
		2)	47	30
		3)	21	21
		4)	9	11
		5)	2	4
		6)	2	0
		7)	2	0
		8)	0	2

	88) question irrelevant	12	2
39c	**Where do they live? (fill in the number of children)**		
{q39c1}	**in the same household 0**	85	7
	1 or more	3	
{q39c2}	**in the same neighbourhood 0**	74	7
	1 or more	14	
{q39c3}	**in the same town 0**	43	3
	1 or more	45	4
{q39c4}	**in the same country less than a 1-hour trip away 0**	35	3
	1 or more	53	4
{q39c5}	**in the same country more than a 1-hour trip away 0**	55	5
	1 or more	33	2
{q39c6}	**in another country 0**	76	7
	1 or more	12	1
{q40}	**About how often do you receive visits/phone-calls e.a.?**		
	1) never	2	
	2) rarely, less than once a month	5	
	3) monthly, 1-2 times a month	5	
	4) weekly, 1-2 times a week	29	3
	5) daily, up to 3-4 times a week	35	3
	6) more than once a day	22	2
	9) no answer/ do not know	2	
{q41}	**Are there persons that you would call real friends? 0**	21	2
	1	14	1
	2-5	26	3
	>5	24	1
	9) no answer/ do not know	14	
{q42}	**About how often do you contact friends or others? 1) never**	5	
	2) rarely, less than once a month	9	
	3) monthly, 1-2 times a month	9	1
	4) weekly, 1-2 times a week	36	3
	5) daily, up to 3-4 times a week	26	2
	6) more than once a day	14	1
	9) no answer/ do not know	2	

Community activities

{q43a}	**Do you participate in any community organizations? 1) yes**	67	6
{q43b}	**How many community organizations do you participate? 1**	29	1
	2-3	27	2
	4-5	7	1
	6-7	3	
	88 question irrelevant	33	3
{q43c}	**How many of these activities are for seniors ? 0**	33	
	1	26	
	2-3	7	

	4-5		2	6
	88 question irrelevant		33	39

Neighbours

4}	How many neighbours do you know well enough to call on?	0	10	16
		1	17	18
		2-3	34	35
		4-5	10	11
		6-7	24	21
		8-9	3	0
5}	Can you rely on help from other people when ill?			
	0) no, no one		9	7
	1) yes, from people I live with		21	9
	2) yes, from neighbours, people in the neighbourhood		9	12
	3) yes, from friends, acquaintances or family		38	44
	4) 1 + 2		0	2
	5) 1 + 3		9	0
	6) 2 + 3		9	16
	7) 1 + 2 + 3		3	2
	9) no answer/ do not know		3	9

rt G: Health

6a}	Are you suffering from a chronic disease?	1) yes	57	74
6a01}	diabetes	1) yes	3	5
6a02}	hypertension	1) yes	7	18
6a03}	ischaemic heart disease	1) yes	17	18
6a04}	stroke	1) yes	2	2
6a05}	malignancy	1) yes	2	2
6a06}	arthritis/arthrosis	1) yes	29	42
6a07}	inflammatory bowel disease	1) yes	5	14
6a08}	respiratory problems	1) yes	17	9
6a09}	chronic liver disease	1) yes	0	0
6a10}	osteoporosis	1) yes	0	2
6a11}	parkinson	1) yes	2	4
6a12}	others	1) yes	22	26
6b}	How many chronic diseases do you have?	0	36	25
		1	41	32
		2	7	28
		3	9	7
		4	5	5
		5	2	4
7a}	How would you judge your present health in general?	1) very poor	3	2
		2) poor	3	11
		3) fair	19	9
		4) good	40	51
		5) very good	35	28

{q47b} What do you think has contributed the most to health?

	1) nothing special	0
	2) I go in for sports and physical exercise	12
	3) I eat wholesome foods	3
	4) I try to eat less food	0
	5) I try to quit/ limit smoking	0
	6) I try to limit my alcohol consumption	2
	7) I try to avoid too much work	0
	8) I try to get enough sleep	2
	9) genetics	10
	10) other	40
	88) irrelevant	26
	99) no answer/ do not know	5

48a. Which of the following events occurred during the past 4 years?

{q48a10}	- fracture		3
{q48a11}	no. of times	1	2
		2	2
		7	0
{q48a20}	- stroke		2
{q48a21}	no. of times	1	2
{q48a30}	- myocardial infarction		2
{q48a31}	no. of times	1	2

48b Complaints.

{q48b1}	- pain	
	1) yes, bothered a lot	28
	2) yes, bothered a little	14
	3) no	59
{q48b2}	- headaches	
	1) yes, bothered a lot	5
	2) yes, bothered a little	10
	3) no	85
{q48b3}	- palpitation	
	1) yes, bothered a lot	2
	2) yes, bothered a little	5
	3) no	93
{q48b4}	- anxiety, nervousness, restlessness	
	1) yes, bothered a lot	5
	2) yes, bothered a little	16
	3) no	79
{q48b5}	- insomnia	
	1) yes, bothered a lot	5
	2) yes, bothered a little	7
	3) no	88
{q48b6}	- fatigue	
	1) yes, bothered a lot	7
	2) yes, bothered a little	9
	3) no	85
{q48b7}	- abdominal pains	

1) yes, bothered a lot		2	4
2) yes, bothered a little		10	4
3) no		88	93
{8b8} - eczema, skin rash, itching			
1) yes, bothered a lot		10	5
2) yes, bothered a little		14	21
3) no		76	74
48c Bothering about			
{8c1} - colds, coughing	1) yes	48	47
{8c2} - respiratory trouble, breathlessness	1) yes	24	21
{8c3} - fever	1) yes	21	25
{8c4} - being bound to bed during due to inf. disease	1) yes	16	12
48d During the last two years have you			
{8d01} been hospitalised	1) yes	29	23
{8d02} received outpatient treatment	1) yes	26	14
{8d03} visited a specialist	1) yes	47	49
{8d04} visited a general practitioner	1) yes	95	90
{8d05} visited a dentist	1) yes	62	63
{8d06} visited a physiotherapist	1) yes	22	32
{8d07} received home-help for medical reasons	1) yes	7	11
{8d08} received home-help for the household	1) yes	12	16
{8d09} received meals on wheels	1) yes	7	2
{8d10} received help from social worker(s)	1) yes	3	5
{9} Do you find yourself getting up feeling unrested?			
	1) yes	12	16
	2) no	88	79
	3) occasionally	0	2
	9) no answer/ do not know	0	4
{0} Do you have hearing problems?			
	1) no	53	63
	2) yes, always	29	25
	3) yes, only within a group of people	16	12
	9) no answer/ do not know	2	0
{1} Do you use a hearing aid?			
	1) yes	26	25
	2) no	74	74
{2} Can you read the newspaper or books			
	1) easily	85	83
	2) with difficulty	12	12
	3) do not read at all	2	2
	4) cannot read	2	4
	8) illiterate	0	0
{3} Do you have problems with your legs or feet?			
	1) yes, always/ occasionally	9	11
	2) no	91	90

Medicines

{q54a} Are you presently using medicines? 1) yes	67	8
{q54a010} analgesics		
time code 1) actual use	5	
2) long term use (> 2 years)	17	1
3) no use	78	7
{q54a011} frequency 1) daily	14	
2) 3-5 times per week	0	
3) 1-2 times per week	5	
4) less than once a week	3	
8) irrelevant/ no use	78	7
{q54a020} sleeping tablets		
time code 1) actual use	2	
2) long term use (> 2 years)	7	
3) no use	91	8
{q54a021} frequency 1) daily	9	1
2) 3-5 times per week	0	
3) 1-2 times per week	0	
4) less than once a week	0	
8) irrelevant/ no use	91	8
{q54a030} psychotropics		
time code 1) actual use	2	
2) long term use (> 2 years)	3	1
3) no use	95	8
{q54a031} frequency 1) daily	2	1
2) 3-5 times per week	2	
3) 1-2 times per week	0	
4) less than once a week	2	
8) irrelevant/ no use	95	8
{q54a040} digitalis		
time code 1) actual use	0	
2) long term use (> 2 years)	9	
3) no use	91	9
{q54a041} frequency 1) daily	9	
2) 3-5 times per week	0	
3) 1-2 times per week	0	
4) less than once a week	0	
8) irrelevant/ no use	91	9
{q54a050} diuretics		
time code 1) actual use	5	
2) long term use (> 2 years)	14	2
3) no use	81	7
{q54a051} frequency 1) daily	19	2
2) 3-5 times per week	0	
3) 1-2 times per week	0	
4) less than once a week	0	
8) irrelevant/ no use	81	7
{q54a060} trinitrine		
time code 1) actual use	3	

	2) long term use (> 2 years)	5	2
	3) no use	91	98
4a061}	frequency 1) daily	7	2
	2) 3-5 times per week	0	0
	3) 1-2 times per week	2	0
	4) less than once a week	0	0
	8) irrelevant/ no use	91	98
4a070}	anti-hypertensive drugs		
e code	1) actual use	2	4
	2) long term use (> 2 years)	7	11
	3) no use	91	86
4a071}	frequency 1) daily	7	12
	2) 3-5 times per week	0	2
	3) 1-2 times per week	2	0
	4) less than once a week	0	0
	8) irrelevant/ no use	91	86
4a080}	hormones		
e code	1) actual use	5	0
	2) long term use (> 2 years)	9	12
	3) no use	85	88
4a081}	frequency 1) daily		11
	2) 3-5 times per week	7	0
	3) 1-2 times per week	3	0
	4) less than once a week	3	2
	8) irrelevant/ no use	85	88
	9) no answer/ do not know	2	0
4a090}	laxatives		
e code	1) actual use	4	2
	2) long term use (> 2 years)	6	4
	3) no use	90	95
4a091}	frequency 1) daily	7	5
	2) 3-5 times per week	2	0
	3) 1-2 times per week	2	0
	4) less than once a week	0	0
	8) irrelevant/ no use	91	95
da100}	insulin		
e code	1) actual use	2	0
	2) long term use (> 2 years)	0	0
	3) no use	98	100
4a101}	frequency 1) daily	0	0
	2) 3-5 times per week	0	0
	3) 1-2 times per week	2	0
	4) less than once a week	0	0
	8) irrelevant/ no use	98	100
da110}	oral anti-diabetics		
e code	1) actual use	3	0
	2) long term use (> 2 years)	0	4
	3) no use	97	96
4a111}	frequency 1) daily	2	4
	2) 3-5 times per week	0	0
	3) 1-2 times per week	2	0

	4) less than once a week	0	
	8) irrelevant/ no use	97	9
{q54a120} stomach tablets			
time code	1) actual use	5	
	2) long term use (> 2 years)	14	
	3) no use	81	9
{q54a121} frequency	1) daily	17	
	2) 3-5 times per week	0	
	3) 1-2 times per week	2	
	4) less than once a week	0	
	8) irrelevant/ no use	81	9
{q54a130} antibiotics			
time code	1) actual use	5	
	2) long term use (> 2 years)	2	
	3) no use	93	9
{q54a131} frequency	1) daily	3	
	2) 3-5 times per week	0	
	3) 1-2 times per week	3	
	4) less than once a week	0	
	8) irrelevant/ no use	93	9
{q54a140} theophylline			
time code	1) actual use	2	
	2) long term use (> 2 years)	5	
	3) no use	93	9
{q54a141} frequency	1) daily	5	
	2) 3-5 times per week	0	
	3) 1-2 times per week	2	
	4) less than once a week	0	
	8) irrelevant/ no use	93	9
{q54a150} non-steroid anti-inflammatory drugs			
time code	1) actual use	7	
	2) long term use (> 2 years)	9	
	3) no use	85	8
{q54a151} frequency	1) daily	12	
	2) 3-5 times per week	0	
	3) 1-2 times per week	3	
	4) less than once a week	0	
	8) irrelevant/ no use	85	8
{q54a160} cytostatics			
time code	1) actual use	2	
	2) long term use (> 2 years)	0	
	3) no use	98	10
{q54a161} frequency	1) daily	0	
	2) 3-5 times per week	0	
	3) 1-2 times per week	2	
	4) less than once a week	0	
	8) irrelevant/ no use	98	10
{q54a170} DOPA			
time code	1) actual use	2	
	2) long term use (> 2 years)	2	
	3) no use	97	

§54a171} frequency	1) daily	2	5
	2) 3-5 times per week	0	0
	3) 1-2 times per week	2	0
	4) less than once a week	0	0
	8) irrelevant/ no use	97	95
§54a180} anti-coagulants			
me code	1) actual use	0	4
	2) long term use (> 2 years)	26	7
	3) no use	74	90
§54a181} frequency	1) daily	22	11
	2) 3-5 times per week	0	0
	3) 1-2 times per week	3	0
	4) less than once a week	0	0
	8) irrelevant/ no use	74	90
§54a190} cholesterol lowering drugs			
me code	1) actual use	2	0
	2) long term use (> 2 years)	0	0
	3) no use	98	100
§54a191} frequency	1) daily	0	0
	2) 3-5 times per week	0	0
	3) 1-2 times per week	2	0
	4) less than once a week	0	0
	8) irrelevant/ no use	98	100
§54a200} others			
me code	1) actual use	7	4
	2) long term use (> 2 years)	21	26
	3) no use	72	70
§54a201} frequency	1) daily	24	26
	2) 3-5 times per week	0	2
	3) 1-2 times per week	2	0
	4) less than once a week	0	2
	8) irrelevant/ no use	72	70
	9) no answer/ do not know	2	0
§54b} Do you use any vitamin- or mineral supplements?	1) yes	76	72
vitamin/mineral supplementation (/day):			
§54b01} thiamin (10-1 mg)	0.5 - 16.5	64	56
§54b02} riboflavin (10-1 mg)	0.4 - 16.7	64	56
§54b03} vitamin B6 (10-1 mg)	1.1 - 50	62	54
§54b04} folate (µg)	20 - 1500	59	48
§54b05} vitamin B12 (µg)	1 - 300	59	46
§54b06} ascorbic acid (mg)	45 - 1260	64	54
§54b07} vitamin A (µg, retinol)	250 - 11110	60	50
§54b08} á-carotene (mg)	> 0	0	2
§54b09} vitamin D (µg)	3 -200	59	50
§54b10} vitamin E (mg)	5 -336	63	50
§54b11} iron (10-1 mg)	0.6 - 600	53	39
§54b12} calcium (mg)	8 - 900	6	8
§55} Are you happy and content with your everyday life?	1) no (hardly ever)	5	7
	2) yes, now and then	0	4

	3) yes, most of the time	16	1
	4) yes, always	80	7
	9) no answer/ do not know	0	
{q56} Do you feel well enough to do what you want to do?	1) no (hardly ever)	17	1
	2) yes, now and then	2	
	3) yes, most of the time	19	1
	4) yes, always	62	6
{q57} If you compare your health with that of other persons you know of your age, is your own health			
	1) worse	9	
	2) about the same	26	2
	3) better	60	5
	9) no answer/ do not know	5	1

Part H: Living habits; diet habits

Smoking habits

{q58a} Have you ever smoked regularly, almost every day?	1) yes	93	5
{q58b} If yes, for how many years?	1 - 10	10	
	11 - 20	11	
	21 - 30	6	1
	31 - 40	10	
	41 - 50	17	
	51 - 60	15	1
	> 60	21	
	99) no answer/ do not know	2	
{q59a} Do you smoke regularly, now?	1) yes	28	2
{q59b} When did you stop smoking?	< 5 years ago	15	
	5 - 10 years ago	21	
	11 - 20 years ago	5	1
	21 - 30 years ago	9	
	31 - 40 years ago	10	
	41 - 50 years ago	2	
	> 50 years ago	3	

How many cigarettes, cigars and pipe-fulls do/did you smoke daily, or how much tobacco do/ did you chew?

{q60a} cigarettes			
	1) zero	36	1
	2) 1-4	14	1
	3) 5-14	28	1
	4) 15-24	9	
	5) 25 or more	3	
	8) Question irrelevant	7	4
	9) no answer/ do not know	3	
{q60b} cigars			

	1) zero	57	39
	2) 1-4	19	4
	3) 5-14	11	11
	4) 15-24	0	2
	5) 25 or more	2	0
	8) Question irrelevant	7	46
	9) no answer/ do not know	2	0
q60c} pipe-fulls			
	1) zero	55	53
	2) 1-4	17	0
	3) 5-14	11	0
	4) 15-24	2	0
	5) 25 or more	2	0
	8) Question irrelevant	7	47
	9) no answer/ do not know	4	0
q60d} tobacco			
	1) zero	93	53
	8) Question irrelevant	7	47
q61} Do/did you inhale the smoke? 1) yes		55	19

Diet habits

q62} How often do you eat a cooked meal?	1) every day	97	91
	2) regularly	2	9
	3) occasionally	2	0
	4) never	0	0
q63} What are you doing with left-overs?	1) throw away	2	11
	2) reheat them always	85	79
	3) reheat them some times	9	11
	4) reheat them never	0	0
	8) Question irrelevant	2	0
	9) no answer/ do not know	3	0
64a During the last week, how main meals at noon and evening did you eat in			
q64a1} local restaurant/cafe/pub/fast food restaurant	0)	98	98
	1-2)	2	2
q64a2} organization for elderly people	0)	98	91
	1)	0	4
	2 or more	2	5
q64a3} home of friends/relatives	0)	76	61
	1)	16	23
	2 or more	9	16
q64a4} home, delivered	0)	2	4
	1)	0	2
	2 or more	98	94
q64a5} other places away from home	0)	83	98
	1)	7	0

		2 or more	10	
{q64b} How many days a week do you eat lunch alone at home?		0	7	
		1-3	3	
		4-7	90	9
{q64c} How many days a week do you eat supper alone at home?		0	5	
		1-3	2	
		4-7	93	9
{q64d} If we would provide for a meal, would you prefer		1) to have a meal delivered at home	19	4
		2) to have this meal at a nearby club	3	1
		9) no answer/ do not know	78	4
65 Are you wearing removable dentures?				
{q65a} in the upper jaw	1) yes		83	8
{q65b} in the lower jaw	1) yes		55	6
66 How many teeth do you have of your own				
{q66a} in the upper jaw	1) none		47	7
	2) some		14	
	3) many		33	1
	4) all		7	
{q66b} in the lower jaw	1) none		29	4
	2) some		16	1
	3) many		35	1
	4) all		21	2
{q67} Do you have chewing difficulties?	1) yes		12	1
{q68a} Are you on a specific diet?	1) yes		3	1
{q68b} If yes, for how long?	1) less than a year		2	
	2) 1 - 3 years		0	
	3) more than 3 years		2	1
	8) question irrelevant		97	8
{q69a} Did you start this diet for health reasons?	1) yes		3	1
69b If yes, for which reason ?				
{q69b1} obesity	1) yes		0	
{q69b2} undernutrition	1) yes		0	
{q69b3} diabetes	1) yes		0	
{q69b4} hypercholesteremia	1) yes		0	
{q69b5} hypertension	1) yes		2	
{q69b6} other reasons	1) yes		2	1
{q69c} Who prescribed this diet to you?	1) doctor		2	
	2) dentist		0	
	3) dietitian/ nutritionist		2	
	4) you yourself		0	
	5) other		0	
	8) question irrelevant		97	8
69d What kind of diet is it?				

q69d1} low calorie/energy	1) yes	0	4
q69d2} low fat	1) yes	3	2
q69d3} low salt	1) yes	0	2
q69d4} low protein	1) yes	0	0
q69d5} low lactose	1) yes	0	0
q69d6} diabetic	1) yes	0	4
q69d7} vegetarian	1) yes	0	0
q69d8} other	1) yes	97	11
q70} If you could choose would you rather take some medication than change your diet? 1) yes		5	4
q71a} Is someone else of your household on a diet? 1) yes		9	4
71b What kind of diet is it?			
q71b1} low calorie/energy		7	0
q71b2} low fat		2	2
q71b3} low salt		0	2
q71b4} low protein		0	0
q71b5} low lactose		0	0
q71b6} diabetic		0	0
q71b7} vegetarian		0	2
q71b8} other, namely		3	2
q72a} Has there been any change in your dietary habits? 1) yes		29	40
q72b} If yes, specify	0) no change	71	60
	1) eating more in general	3	9
	2) eating less in general	16	11
	3) eat more of some specific foods	3	5
	4) eat less of some specific foods	2	4
	5) prescribed diet	2	2
	6) other changes	3	11
q73a} Is there anything you especially like to eat? 1) yes		72	65
q73b} If yes, specify	1) vegetables	5	19
	2) fruit	2	5
	3) meat or fish	12	12
	4) dairy products	2	4
	5) sweets, candy, cake	3	2
	6) cereals	0	5
	7) traditional dishes	40	12
	8) other products	9	5
q74a} Do you include certain foods in your meals for health reasons? 1) yes		26	35
q74b1} raw vegetables and fruit		12	18
q74b2} yoghurt, buttermilk and other sour milk products		3	7
q74b3} vegetable margarine, dietetic margarine		0	5
q74b4} coarse bread		0	2
q74b5} dietary supplements (vitamins, minerals)		2	5
q74b6} health foods, biodynamic vegetables		0	2
q74b7} flour free of chemicals		0	0

{q74b8}	alcoholic drinks	2
{q74b9}	other, specify	10

{q75a}	Do you avoid certain foods and foodstuffs in your meals for health reasons? 1) yes	45
	75b If yes, which ?	
{q75b01}	meat in general	7
{q75b02}	very fatty meat	3
{q75b03}	fried and burned meat	0
{q75b04}	smoked foodstuffs	9
{q75b05}	sausages (frankfurters and salami)	0
{q75b06}	heavy cream/whipped cream/butter	2
{q75b07}	candy and cake	0
{q75b08}	salt and salty foodstuffs	0
{q75b09}	sugar	0
{q75b10}	food with a lot of artificial colouring	0
{q75b11}	coffee	0
{q75b12}	in-between meals	0
{q75b13}	dairy products	0
{q75b14}	alcoholic drinks	3
{q75b15}	other	35

	75c. What is the main reason you avoid these foods?	
{q75c01}	indigestion	19
{q75c02}	dislike taste	14
{q75c03}	ethical/religious/cultural reasons	3
{q75c04}	food allergy/sensitivity	3
{q75c05}	inconvenient to buy/prepare	0
{q75c06}	expensive	0
{q75c07}	avoid because of taking drugs	0
{q75c08}	other health reasons	5
{q75c09}	other reasons ..... specify	12

{q76a}	Do you buy ready-made meals for reheating?	1) yes	35
{q76b}	If yes, are they	1) canned	3
		2) frozen	24
		3) other	5
		8) question irrelevant	67

{q77a}	Do you use any home produced food (= home grown)		
		1) yes, regularly (at least once a week)	40
		2) yes, sometimes	20
		3) no	40
	77b If yes, which ?		
{q77b1}	vegetables	1) yes, regularly	29
		2) yes, sometimes	14
		3) no	17
{q77b2}	fish or meat	1) yes, regularly	5
		2) yes, sometimes	0
		3) no	55
{q77b3}	fruit	1) yes, regularly	38
		2) yes, sometimes	9

		3) no	14	18
7b4}	eggs	1) yes, regularly	7	4
		2) yes, sometimes	0	2
		3) no	53	41
7b5}	milk	1) yes, regularly	0	0
		2) yes, sometimes	0	0
		3) no	60	47
7b6}	alcoholic drinks	1) yes, regularly	3	0
		2) yes, sometimes	0	0
		3) no	57	47
7b7}	other	1) yes, regularly	0	2
		2) yes, sometimes	2	0
		3) no	58	45
8}	Has the subject been living on agriculture	1) yes, full time	7	0
		2) yes, part time	3	11
9}	How much time per day do you on average spend on eating your major meal?			
		1) less than 15 min.	10	12
		2) 15 min	28	28
		3) more than 15 min, but less than 30 min	29	23
		4) 30 min	24	30
		5) more than 30 min but less than 60 min	9	7
		6) 60 min or longer	0	0
9}	How much time per day do you on average spend on preparing major meal			
		1) less than 15 min.	3	2
		2) 15 min or longer, but less than 30 min	7	16
		3) 30 min or longer, but less than 60 min	19	49
		4) 60 min or longer, but less than 90 min	7	23
		5) 90 min or longer	2	5
		8) question irrelevant	60	0
		9) no answer/ do not know	2	5
	81 Do you			
a}	drink alcohol with friends or relatives?	1) never	16	12
		2) rarely	21	46
		3) occasionally	24	23
		4) fairly often	36	16
		5) frequently	3	4
b}	what about on your own?	1) never	47	60
		2) rarely	3	7
		3) occasionally	5	9
		4) fairly often	9	16
		5) frequently	36	9
}	Do you have alcoholic drinks most days?	1) yes	59	21
ome				
}	For how long have you been retired? 0 years		0	0

	1 - 5 years	3
	6 - 10 years	37
	11 - 15 years	46
	> 15 years	15
84	What are your basic sources of income?	
{q84a}	professional work	10
{q84b}	pension	90
{q84c}	dependence on family including spouse	7
{q84d}	social care	2
{q84e}	investments	14
{q84f}	other	19
{q85}	Do you find it difficult to budget your food? 1) always	0
	2) quite often	3
	3) sometimes	3
	4) rarely	2
	5) never	91
86	During the interview did the subjects's behaviour strike you as:	
{q86a}	mentally alert	100
{q86b}	depressed and/or tearful	9
{q86c}	suspicious (more than reasonable)	2
{q86d}	passive or indifferent	0
{q86e}	bizarre or inconsistent in thought or action	2
{q87}	Opinon about answers physical health	
	1) optimistic	0
	2) about right	100
	3) pessimistic	0
{q88}	Do you think the subject's other answers were:	
	1) optimistic	0
	2) about right	100
	3) pessimistic	0
{q89}	The interviewer's evaluation of the interview	
	1) easy to carry out	95
	2) difficult to carry out	5
{q90a}	Did the respondent answer the questions independently? 1) yes	85
{q90b}	If not, specify informant	
	1) first degree relative	7
	2) other relative	2
	3) in-law	0
	4) other	5
{q91}	If possible, SES score	
	1) low SES	10
	2) lower middle SES	55
	3) higher middle SES	26
	4) high SES	9
	9) do not know	0