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Diet and Mortality in a Cohort of Elderly People in a North European Community

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Background. In studies from Italy and Greece a Mediterranean dietary pattern predicts overall survival. Despite an increase in the movement of food around the world, there is still a wide spectrum of dietary patterns and the aim of the present study was to examine the association between a Mediterranean dietary pattern and mortality in a cohort of elderly people living in a North European Community.
Methods. Diet and nutritional status was studied among 202 men and women born 1914–1918 and living in a Danish Municipality (Roskilde) in 1988. They were followed for 6 years.
Results. A diet score, with seven dietary characteristics of the Mediterranean diet, was associated with a significant reduction in overall mortality. A one unit increase in the diet score predicted a 21% (95% confidence interval 2–36%) reduction in mortality. Subjects with high diet scores (⩾4) had significantly higher plasma carotene levels than those with a low score and plasma carotene was negatively associated with mortality.
Conclusion. A Mediterranean diet score predicts survival in a North European population. Plasma carotene may serve as an intermediate factor in this association.
Keywords: dietary pattern, elderly, mortality, longitudinal study

Mortality from coronary heart disease and cancer in the elderly have partly been attributed to a diet high in fat and low in fruits and vegetables.[1,2] Recent prospective studies among the elderly in Greece[3] and Italy[4] have related specific diet scores, devised on the basis of characteristics of the Mediterranean diet, to overall survival.

In the Greek study the diet score included the following eight dietary components: i) high monosaturated: saturated fat ratio; ii) moderate ethanol consumption; iii) high consumption of cereals; iv) high consumption of fruits; v) high consumption of vegetables; vi) high consumption of legumes; vii) low consumption of meat and viii) low consumption of milk and dairy products. Despite an increase in the movement of foods around the world, there is still a wide spectrum of dietary patterns. In each country food groups are composites of food items specific to the dietary pattern in that country.[5–7] The association between the Mediterranean diet and mortality found in the Greek cohort might be caused by food items specific to the Greek diet. Therefore, the question remains whether the results from this study could be replicated in a population with a North European food pattern and lifestyle. Biochemical dietary measures such as serum lipids and antioxidants are often used for monitoring dietary intake as they are not affected by errors due to differences in reporting and coding of food intake. Hence, we also found it of interest to know how the Mediterranean diet score associated with these biochemical measures.

In the present study, we examine the influence of a Mediterranean diet score on overall survival in a cohort of 202 Danish elderly followed for 6 years. We also analyse the association between this diet score and selected biochemical dietary measures.

METHODS

The study was a part of the Euronut SENECA study, which is an investigation of the diet and health of elderly people from 19 towns in 12 European countries. In each country, towns with a population of 10 000–20 000 and a socioeconomic structure comparable to the country or the region as a whole were selected. Data were collected between December 1988

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and March 1989. Subject selection and data collection were done according to a strictly standardized protocol.[8] In each town, 50–75 subjects of each sex and year of birth from 1913 to 1918 were randomly selected on the assumption that non-participation would leave 30, 35 and 45 subjects of both sexes from the birth cohorts 1913–1915, 1916–1917 and 1917–1918, respectively.

In the Danish centre in the municipality of Roskilde, 101 men and 101 women participated (participation rate 46%). No significant differences were observed between participants and non-participants regarding gender, age, marital status or the number of admissions to hospital over the last i2 years (1977–1989).[9] The vital status of the population sample was followed until I July 1995 by using the unique person identification number in the National Central Person Register.

The observation time for each participant was the time from the initial examination (1988–1989) until I July 1995 or until death (n = 52).

Dietary intake data were collected by trained dieticians with a modified diet history. The method consisted of a 3–day estimated record and a frequency checklist of foods, based on the Danish meal pattern and with the previous month as a reference period. Portion sizes were checked by weighing quantities of food and household measures. This instrument was thoroughly validated as a part of the baseline study.[10,11]

A diet score, comparable to the score devised for the Greek study on diet and survival in elderly people[3] was developed. The intake of foods in grams per day were considered in the main groups as recommended by the Eurofood organization, and were adjusted for energy intake. The following seven dietary components each contributed one point to the sum score: i) high monosaturated: saturated fat ratio; ii) moderate ethanol consumption; iii) high consumption of cereals; iv) high consumption of fruits; v) high consumption of vegetables and legumes; vi) low consumption of meat and vii) low consumption of milk and dairy products. The median values specific for each sex were used as cutoff points. Potential score range was 0–7 points. The higher the score the better the dietary behaviour. The food groups were comparable with the groups used in Greek study. However, in the present study starchy roots were grouped with vegetables and not with cereals as in the Greek study.

In a general structured interview in the participant's home, information was obtained on potential determinants of diet and health (e.g. smoking habits). Details about collected data are reported elsewhere.[8]

Fasting blood samples were collected. Total serum cholesterol was measured by an enzymatic calorimetric method using Boehringer-Mannheim reagents.[12] High density lipoprotein (HDL) cholesterol was determined after apo-beta-lipoprotein precipitation with Dextran sulphate-MG2+ by enzymatic CHOP-PAP method.[13] Analysis of carotene and vitamin E were carried out in the laboratories of Hoffmann-La Roche, using the high-performance liquid chromatography (HPCL) methods described by Villeumier *et al.*[14] Blood samples were taken from 184 of the 202 Danish participants.

The data were analysed using Cox's proportional hazards regression. For each dietary variable a Cox model was developed that controlled for age at enrolment (in years), sex (0 = males, 1 = females), and smoking status (0 = current smoker, 1 = ex-smoker, 2 = non-smoker) and evaluated the individual dietary variables as predictors of the hazard of death. Survival curves were plotted by using the Kaplan-Meier method. Differences in means of biochemical measures were tested in one-way-analysis with sex and age as covariates.

RESULTS

Fifty-two of the study subjects died during the follow-up period; 28 (54%) were men, 28 (54%) were current smokers, and their mean age at enrolment was 73.4 years. Among the 150 survivors; 73 (49%) were men, 53 (35%) were current smokers, and their mean age at enrolment was 72 years.

Table 1 shows that cereal products were associated with a 10% increase in the risk of death for every 20 g increase in daily intake, adjusted for energy. The six other individual models yielded no significant results. When the food group with cereal products was subdivided into wheat, rice and other grain products, respectively, and each of these groups was related to mortality in alternative Cox models (data not shown), only the model with other grain products showed a significantly positive association with mortality. The composite diet score was significantly associated with a reduced risk of death (Table 2). Figure 1 shows the Kaplan-Meier survival curves for subjects with diet scores 0–3 and $\geqslant 4$.

Table 3 gives the biochemical measures in relation to diet score and mortality status. Subjects with a high diet score (>3) had significantly higher plasma carotene levels compared to those with a low score. Both serum cholesterol and plasma carotene were significantly associated with a reduced risk of death.

DISCUSSION

The present study was based on data collected using standardized procedures and a validated dietary method.[8–11] The personal identification number ensured

TABLE 1 *Mean (SD) daily consumption in grams adjusted for energy[a] for seven components of diet score and rate ratio estimates (95% confidence intervals) derived from alternative Cox's models with each variable separately*

Component	Dead (n = 50)	Survivors (n = 144)	Rate ratio[b] (95% confidence interval)
Vegetables	291 (148)	290 (117)	0.99 (0.95–1.04)[c]
Fruits	143 (122)	136 (104)	1.02 (0.97–1.08)[c]
Dairy products	312 (242)	291 (221)	1.00 (0.99–1.01)[c]
Cereals	213 (121)	191 (74)	1.10 (1.03–1.17)[c]
Meat	116 (49)	116 (44)	0.99 (0.86–1.13)[c]
Ethanol	8 (10)	11 (17)	0.81 (0.63–1.05)[d]
Monosaturated:saturated fat ratio	0.9 (0.2)	1.0 (0.3)	0.24 (0.07–1.13)
Energy (MJ)	8.6 (0.3)	9.1 (0.4)	

[a] To 10.5 MJ for men and 8.4 MJ in women.
[b] From model including age, sex, and smoking status.
[c] Per 20 g change.
[d] Per 10 g change.

TABLE 2 *Rate ratio estimates (95% confidence intervals) derived from Cox's models with diet score, sex, age and smoking status as preditcors of survival time*

Predictor variable	Rate ratio (95% confidence interval)
Age (1 year)	1.22 (1.41–1.03)
Sex (men 0, women 1)	0.98 (0.54–1.80)
Smoking status:	
(smoker 0, ex-smoker 1)	0.47 (0.24–0.94)
(smoker 0, non-smoker 2)	0.41 (0.19–0.89)
Diet score (1 unit)	0.79 (0.64–0.98)

a complete follow-up, and in order to prevent bias from the known inaccuracies in death certification in elderly people, we used all-cause mortality only.

The analysis showed that a diet score, originally developed to evaluate the beneficial effect of the Greek variant of the traditional Mediterranean diet, could predict mortality in a North European population. In particular, at the beginning of the follow-up period the probability of survival was high among those with the most favourable diet score. The same feature was seen in the Greek study. The Mediterranean diet differs from the North European diet both with regard to the types and the qualities of foods eaten. The Mediterranean diet includes many cooked meals, soups and salads rich in olive oil and a variety of fresh vegetables which are consumed in large amounts. The Greek diet also includes many different fresh fruits. The intake of milk is rather low, whereas the consumption of yogurt is high.[3,6,7] In comparison, sandwich-based meals, rich in butter, sausages, pate and cheese characterize the North European diet. The intake of milk is high, while fresh vegetables and fruits are consumed in rather limited amounts.[6,7] Due to these differences in food intake, we had expected that the Mediterranean diet score would not be predictive for mortality in the Danish population. On the other hand, a recent study of ageing cohorts of men in Finland, Italy and the Netherlands has recognized that in old age, the variation in food intake of different cultures becomes smaller.[5] Surprisingly, cereals were associated with an increased mortality. This association was restricted to the group with non-wheat products, which due to a high consumption of ryebread are the most important cereal in the Danish diet. The positive association between intake of non-wheat cereals and mortality is in contrast to the literature on diet and health. Studies from Italy and the Netherlands have shown a significant decrease in overall mortality in men in relation to higher intake of carbohydrates and fibre, respectively.[4,15] Further studies are needed to substantiate whether the association between non-wheat cereals and mortality is causal or is a marker of an increased risk.

The diet score was also associated with plasma carotene, which suggests that this antioxidant serves as an intermediate factor in the association between diet and mortality. The association between survival and increased concentrations of serum cholesterol found in the present study may be connected to the age of our subjects. Several studies have shown a negative relation

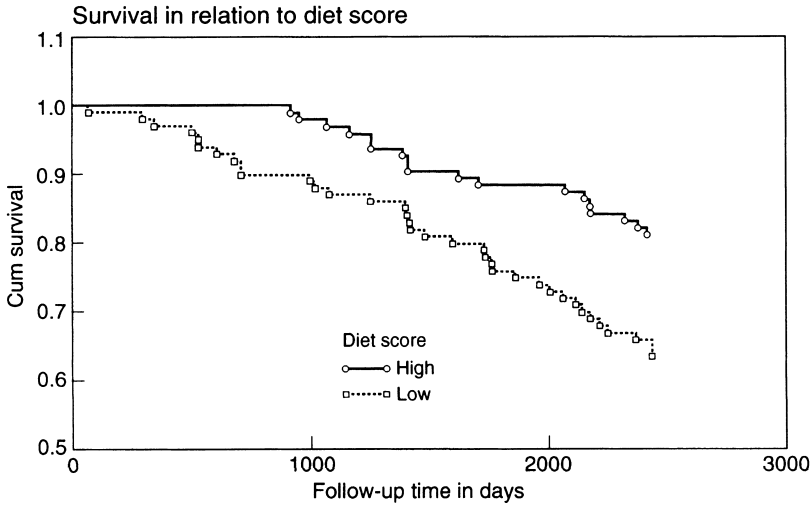

FIGURE 1 *Kaplan-Meier survival curves for individuals with diet score <3 and ≥4*

TABLE 3 *Mean (SD) serum total and HDL cholesterol, HDL:total cholesterol ratio, carotene and vitamin E plasma levels and rate ratio estimates (95% confidence intervals) derived from alternative Cox's models with each variable a separate predictor of survival time*

Component	Low diet score	High diet score	*P*	Dead (n = 47)	Survivors (n = 137)	Rate ratio[a] (95% confidence interval)
Serum total cholesterol (mmmol/l)	6.4 (1.3)	6.7 (1.2)	0.06	6.1 (1.2)	6.7 (1.2)	0.96 (0.94–0.99)
HDL cholesterol (mmol/l)	1.4 (0.4)	1.4 (0.4)	0.52	1.3 (0.4)	1.4 (0.4)	0.89 (0.80–0.99)
HDL/total cholesterol ratio	0.5 (0.1)	0.5 (0.1)	0.66	0.5 (0.1)	0.5 (0.2	1.10 (0.91–1.34)
Vitamin E (umol/l)	30 (10)	33 (11)	0.06	29 (13)	32 (2)	0.95 (0.88–1.03)
Vitamin E/total cholesterol ratio	4.7 (1.2)	4.8 (1.0)	0.21	4.6 (1.2)	4.6 (1.0)	0.99 (0.92–1.04)
Carotene (umol/l)	0.5 (0.4)	0.7 (0.5)	0.00	0.5 (0.7)	0.7 (0.5)	0.48 (0.34–0.70)

[a] From model including age, sex, and smoking status.

between serum cholesterol concentration and overall mortality in those aged over 65.[1,16] vitamin E is fat soluble and has been found to be strongly correlated with the plasma lipid concentrations. The vitamin E results were therefore also expressed as the ratio of Vitamin E to cholesterol. This measure was not significantly associated with mortality.

The results from the present study substantiate the evidence that a Mediterranean diet pattern favourably affects survival in elderly people. Today it is accepted that adherence to dietary recommendations may be better, and compliance more easy to monitor, if they are formulated in terms of foods rather than nutrients. In this context results from this study are easy to use in the obvious advice: reduce the intake of foods of animal origin and include a lot of fruits and vegetables.

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