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The traditional Greek food pattern and overall survival in elderly people

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Abstract Evidence in support of the beneficial properties of the traditional Greek food pattern (TGFP) has recently become available. In prospective cohort studies of elderly people in rural Greece ($n = 182$), Greek-born ($n = 189$) and Anglo-Celtic Australians ($n = 141$), and Danes in Denmark ($n = 202$), it was found that adherence to the TGFP was associated with lower overall mortality and longer survival, irrespective of the types of foods consumed within food groups and the mode of food preparation. A higher TGFP score was significantly associated with a sharply reduced risk of death, by 17-23% per one unit increase and by more than 50% per four unit increase in the different cultural settings. Elderly Anglo-Celtic Australians had 80% higher mortality than the elderly Greek-born Australians; 37% of the excess mortality of the Anglo-Celts could be explained in terms of their different dietary habits and specifically their different extent of adherence to the TGFP. The key messages from these studies are: 1. a TGFP is beneficial to survival of elderly people; 2. the longevity of Mediterranean people can be explained in part by their varied diet; 3. the overall TGFP is more important for longevity than individual food groups; and 4. similar survival advantage can be obtained by applying the TGFP to other dietary cultures, irrespective of the types of foods consumed and the mode of food preparation. Whether or not further mortality benefit may have been obtained in the non-Greek cohorts if foods were prepared according to Greek cuisine, requires further study. [*Aust J Nutr Diet* 1998;55(4 Suppl):S20-S23].

Keywords: all-cause mortality, overall survival, elderly, Greek-born Australians, Anglo-Celtic Australians, rural Greeks, Danes, traditional Greek food pattern, Mediterranean diet, mono-unsaturated fat.

Introduction

It is becoming apparent that people with different food cultures may have comparable life expectancy and morbidity rates (1,2). The challenge is to identify common food patterns in different cultures that confer less morbidity and

mortality. The value of cuisine (i.e. the way foods are combined and prepared) in contributing to low morbidity and mortality requires further study.

In the 1960s, Greeks in Greece had the longest life expectancy in the world, followed by the Japanese (3). In the 1990s, Japanese have the longest life expectancy at birth in the world of about 80 years. However, people in the European Mediterranean countries continue to have long life expectancies ranging between 78.1 and 78.3 years, as documented by World Health Organization mortality statistics (4).

Since the 1960s components of the traditional Greek diet have been associated with very low rates of coronary heart disease (CHD) and cancers of the colon and breast (3). In the Seven Countries Study (5) the incidence of CHD in Crete was one-thirtieth the incidence in Finland (6). High intakes of mono-unsaturated fat from olive oil and low intakes of saturated fats from animal foods, were associated with low mortality rates from CHD and cancer (5). Willett (3) subsequently developed the 'Mediterranean diet pyramid: a cultural model for healthy eating' which captures the food patterns of the region.

Nevertheless, epidemiological studies to date have not properly documented an association between precisely

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defined food patterns and overall survival (8). Furthermore, the association between the Mediterranean diet and the mortality advantage of Mediterranean people might be caused by food items and food preparation or cuisine specific to these cultures. Therefore, it remains in question whether mortality advantage can be replicated with the traditional Greek food pattern in non-Greek cultures.

This paper reviews the findings from three prospective cohort studies investigating the relationship between the traditional Greek food pattern (TGFP) and overall survival in people aged 70 years and over (2,9-11).

The traditional Greek food pattern score

Composite scores are often used to describe total diet and food patterns (14). A score was developed by Trichopoulos et al. (9) to describe total diet and characterise it in comparison to the Greek variant of the traditional Mediterranean diet. The mode of food preparation could not be accounted for in the calculation of the composite score. This score was used in both the International Union of Nutritional Sciences 'Food habits in later life' program and survey in Europe on nutrition and the elderly (Euronut) mortality follow-up studies and the food intake assessment methodologies used in these studies have been reported in detail elsewhere (9-11). TGFP was scored in terms of eight food component characteristics: 1. high consumption of vegetables; 2. high consumption of legumes; 3. high consumption of fruits; 4. high consumption of cereals; 5. low consumption of dairy products; 6. low consumption of meat and meat products; 7. moderate ethanol consumption; 8. high mono-unsaturated:saturated fat (M:S) ratio. A score of 1 was given for each food component when the diet of an individual contained at least the median amount (determined for each population, and specific for each gender) of vegetables, legumes, fruits, cereals, and the M:S ratio; and less than or equal to the median amount of dairy and meat products and alcohol. These were then summed to give a score ranging between 0 and 8. Food quantities in grams per day were adjusted to daily intakes of 2500 kcal for men and 2000 kcal for women (15). It was hypothesised that a more varied diet with four or more of these food groups would have beneficial health and survival effects and would resemble more closely the TGFP whereas a diet with fewer of these components (< 4) would be less healthy. These considerations are based on the collective epidemiological and biological evidence (3,12).

The statistical analyses were undertaken by modelling data through Cox's proportional hazards regression (15). This approach takes into account not only the event of death but also the time until its occurrence. An assumption in the model is that the rate ratio is constant over follow-up time. Initially, eight Cox's models were developed; these controlled for age at enrolment (in three month intervals), gender (0 = female, 1 = male), current smoking status (at time of enrolment, 0 = non-smoker, 1 = smoker), ethnic origin (in Melbourne study only; 0 = Greek-born Australian, 1 = Anglo-Celtic) and evaluated alternatively the eight individual components of the diet score, adjusted for energy. An additional Cox's model was then developed that controlled for age at enrolment, gender, smoking status at enrolment and evaluated the TGFP score as a predictor of the hazard of death. In Melbourne, the inclusion or exclusion of ethnic origin as a

predictor variable in the nine Cox models that included all study participants would indicate whether the food groups or the TGFP score provides mortality advantage regardless of ethnic origin. Current smokers at enrolment included those who had stopped smoking within five years and non-smokers included those who had not smoked for more than five years.

IUNS five-year mortality follow-up study of elderly Greeks in rural Greece

Between October 1988 and June 1990 the food habits of 91 men and 91 women aged 70 years and over resident in three Greek villages 20 km from Athens were recorded over a period of one year (9). Study subjects were recruited using the electoral rolls; the response rate, following contact, was 89%. A validated extensive quantitative food frequency questionnaire (190 food items and beverages) was used to determine habitual dietary habits over the year. Between April 1993 and January 1994 the three villages were revisited to ascertain the exact date of death of 53 subjects who had died and confirm the survival of the 129 remaining subjects. Of the deceased, 57% were men, 32% were current smokers at enrolment and their mean age at enrolment was 78.5 years. Among the survivors, 47% were men, 23% current smokers at enrolment and their mean age at enrolment was 75.4 years.

The eight individual models yielded no significant results for any of the eight components with the exception of dairy products, which were associated with a 4% increase of the hazard of death for every 20 g increase in daily consumption adjusted for energy (rate ratio 1.04; confidence interval [CI] 1.01-1.07; $P = 0.01$). The individual components of the TGFP score had weak and generally non-significant associations with survival, whereas the overall score had a substantial and significant effect. From the model including a combined TGFP score, older age was, as expected, a highly significant predictor of the hazard of death, which increased by 10% for every one year increase in age, for those aged over 70 years. In contrast, current smoking at enrolment and male gender were not significantly associated with this hazard. About 60% had a TGFP score of 4 or more. A higher TGFP score was significantly associated with a sharply reduced risk of death, by 17% per unit increase (rate ratio 0.83; CI 0.69-0.99; $P = 0.04$ two-tailed test) and by more than 50% per four unit increase ($P < 0.05$) (Table 1). Exclusion of deaths that occurred during the first year of follow-up did not alter the regression coefficients related to tobacco and diet.

IUNS five-year mortality follow-up study of elderly Greek-born and Anglo-Celtic Australians in Melbourne

Between January 1990 and December 1992 the food habits of 189 Greek-born Australians (GA, males = 94, females = 95) and 141 Anglo-Celtic Australians (AA, males = 70, females = 71) aged 70 years and over were recorded over a period of one year residing in Melbourne, Australia (10). Study subjects were recruited using the telephone directory; the response rate, following contact, was 84% for GA, 70% for AA. Subjects were defined as

Anglo-Celtic if they had both maternal and paternal grandparents from the United Kingdom and/or Ireland. A validated extensive (250 food items and beverages) quantitative food frequency questionnaire was used to determine the habitual dietary habits over the year. In April 1996 the date of death of the 24 GA and 14 AA who had died was obtained from the death registry, and survival of the remaining 292 was confirmed. Of the deceased GA and AA, 54% and 71% were men respectively.

Compared with the mortality follow-up study in rural Greece, there were fewer deaths overall in the Melbourne study (30% versus 10% deceased, respectively). This may be due to declining mortality in the relevant age groups in Australia and to the fact that participating individuals had, in general, a fairly healthy lifestyle. However, this does not introduce a bias in the comparison of the effects of variable degree of adherence to the principles of the Mediterranean diet, but may reduce study power. The eight individual models yielded significant results ($P < 0.05$) for three of the eight components. With every 20 g increase in fruit or cereals there was a 5 to 8% decrease in the hazard of death, adjusted for energy (rate ratios: 0.95, CI 0.91–1.01 for fruit; and 0.92, CI 0.85–0.99 for cereals). For every unit increase in the mono-unsaturated:saturated fat ratio there was 55% decrease in the hazard of death, adjusted for energy (rate ratio 0.45, CI 0.36–0.97). However, this ratio was a significant predictor of mortality only when ethnic origin was not included as an independent risk factor. As with the study in rural Greece, the individual components of the TGFP score had weak and generally non-significant associations with survival, whereas the overall score appeared to be a better descriptor of the apparent health effects of diet. From the model which included age, gender, current smoking status, plus or minus ethnic origin, and TGFP score, only older age was a significant predictor of the hazard of death, which increased by about 10% for every year increase in age in the group aged 70 years and older. Although the associations with the other predictor variables with survival were not statistically significant, they were all plausible, sub-

stantial and in the 'expected' directions. Mortality of men was 60% higher than that of women; smokers had 40 to 50% higher mortality than non-smokers; and elderly AA had 80% higher mortality than GA. In the most relevant model with all study subjects, and where ethnic origin was not included as predictor variable, a higher TGFP score was associated with a reduced risk of death, by 17% per one unit increase (rate ratio 0.83; CI 0.67 to 1.02, $P = 0.07$ two-tailed test or $P = 0.03$ if a one-tail test was to be accepted). This result is identical to the result in rural Greece. However, it failed to reach significance, probably because of the fewer deaths in Melbourne ($n = 38$) compared with Greece ($n = 53$) (Table 1). In the model that does include ethnic origin as a predictor variable, the TGFP score was even less significant. These results suggest that the TGFP may provide mortality advantage regardless of ethnic origin.

A greater percentage of GA had TGFP scores of 4 or more (81%) compared with AA (28%) and rural Greeks (57%), which indicated that GA tended to follow a more traditional Greek food pattern. The rate ratio (95% CI) for subjects with a TGFP score of 4 or more was 0.36 (0.08–1.67) among AA, 0.72 (0.27–1.88) among GA, and 0.58 (0.3–1.12) among all participants. Whilst none of these are significant, in the latter instance the P -value approached significance ($P = 0.10$, two-tailed test). It was also calculated that 37% of excess mortality of AA over that of GA could be explained in terms of their different dietary habits and specifically their different extent of adherence to the TGFP (10).

Euronut six-year mortality follow-up study of elderly Danes in Denmark

Between December 1988 and March 1989 the food habits of 101 men and 101 women resident in Roskilde, Denmark, and aged between 74 and 78 years were recorded over a period of one month (11). The response rate was 46% and there were no significant differences between responders and non-responders regarding gender, age, marital status or the number of admissions to hospital over the previous 12 years. A validated modified diet history which included a three-day estimated record and a frequency checklist of foods was used to represent usual intake over one month, and portion sizes were checked by weighing (18). In July 1995 the date of death of the 52 subjects who had died was obtained from the death registry, and survival of the remaining 150 subjects was confirmed. Of the deceased, 55% were men, 54% were current smokers and their mean age at enrolment was 73.5 years. (Smoking status was defined as current smoker, ex-smoker or non-smoker at enrolment.) Among the survivors, 49% were men, 35% current smokers and their mean age at enrolment was 72 years. In this study legumes were included in the vegetable group, decreasing the number of food components in the TGFP score from eight to seven. The seven individual models yielded no significant results for any of the seven components with the exception of cereals, which were associated with a 10% increase in the hazard of death for every 20 g increase in daily consumption, adjusted for energy (rate ratio 1.10; CI 1.03–1.17; $P < 0.05$). This association was restricted to the group with non-wheat products, namely rye bread. Further studies are required to determine if this association is causal or a marker of an increased risk.

Table 1. The traditional Greek food pattern score as predictor of survival time using Cox's proportional hazards model in Greek and non-Greek elderly cohorts (9–11)

	Predicted reduction in mortality per unit increase in TGFP ^(a) score %	Confidence interval	P-value
Rural Greece ($n = 182$)	17	1–31	0.04
Greek-born and Anglo-Celtic Australians ($n = 330$)	17	2–33	0.07
Danes in Denmark ($n = 202$)	23	2–39	<0.05

(a) TGFP (traditional Greek food pattern) score ranging from 0–8. The score was made up of eight food groups or components (high intake of vegetables, legumes, fruits, cereals; low intake of dairy products, meat; moderate intake of ethanol; high mono-unsaturated:saturated fat ratio). Food groups and components of the score were adjusted to 2500 kcal for men and 2000 kcal for women.

As with the rural Greek and Melbourne studies, current smoking, male gender and the individual components of the TGFP score had weak and generally non-significant associations with survival, whereas the overall score had a substantial and significant effect. The TGFP score was significantly associated with a reduced risk of death by 23% per unit increase (rate ratio 0.77; CI 0.61–0.98; $P < 0.05$ two-tailed test) (Table 1).

Strengths and limitations of these mortality studies

These studies have the strength of prospective cohort studies with complete follow-up and an indisputable outcome, thereby minimising selection bias and outcome-related information bias. The small study sizes are compensated for by the inherently high mortality among subjects, allowing the generation of significant results with respect to TGFP score. The follow-up period was not very long but this does not compromise validity in dynamic cohorts defined on the basis of steady-state dietary habits (16). All-cause mortality was used in both the IUNS and Euronut studies in order to prevent bias from the known inaccuracies in death certification in elderly people (4,11). The samples of elderly people were found to be representative of the wider community from which they were sampled according to gender and age distribution (11,17). However, representativeness is not a precondition for internal validity in a cohort investigation (13,16). Residual confounding by smoking or age is unlikely as neither of these variables were strongly related to TGFP score and age was controlled for in sufficiently narrow intervals. Energy intake and expenditure are predictors of mortality and are associated with the consumption of food intake (15), but nutritional data were adjusted for energy. Biochemical measurements and blood pressure were not modelled in the analyses, but these variables are thought to be intermediate factors rather than confounders (9). Confounding by variables such as social support, physical activity and sleep patterns that were not introduced into the model need to be considered in future analyses.

Conclusion

The mortality studies reviewed provide evidence that the overall food pattern may be more important than the way in which food is prepared. The mortality advantage conferred by the food pattern of the traditional Greek diet (defined as high in plant foods, low in animal foods, high in mono-unsaturated fat but low in saturated fat, and moderate in alcohol) was observed in different cultural settings (e.g. Danish, Anglo-Celtic) irrespective of the types of foods consumed and the mode of food preparation. Whether or not further mortality benefit may have

been obtained in non-Greek cohorts if foods were prepared according to Greek cuisine, requires further study.

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