Viewpoint article

'Morbidity mortality paradox' of Greek-born Australians: possible dietary contributors

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Abstract First generation Greek-born Australians (GA) are one of the longest lived populations in the world, despite unfavourable cardiovascular disease (CVD) risk factors, poor self-rated health and functional disabilities. The purpose of this paper is two-fold: to draw attention to the morbidity mortality dissociation using national health and mortality statistics along with supporting data from smaller studies; and to formulate a 'morbidity mortality paradox' hypothesis by re-examining recent and distant past food intake data and lifestyle habits from a study of 104 Greeks in rural Greece. 189 GA and 140 Anglo-Celtic Australians aged 70 years and over. The analysis suggests that the more frequent use of energy dense foods such as sweets and animal foods high in saturated fat (especially in the first 20 years in Australia), plus changes to meal patterns, serving sizes, cooking practices, physical activity and siesta habits may have had a significant impact on the development of obesity, diabetes and CVD in GA. Possible dietary factors contributing to the longevity of GA include: the proportionately high intake and variety of plant foods relative to animal foods; the tendency to return to the traditional Greek food pattern in old age; and the continued high intake of mono-unsaturated fats, n-3 fatty acids and phytochemicals (e.g. lycopene and flavonoids) from the wide variety of plant foods consumed. In particular, the retention of certain putatively protective foods (e.g. fish, legumes, leafy greens, onions, garlic, tomatoes, melons, herbs, olive oil, grapes and wine) may have helped to make the CVD risk factors 'benign'. The influence of Greek cuisine (e.g. vegetables cooked or served with olive oil) on the bio-availability of certain phytochemicals requires further investigation. Possible mechanisms are briefly examined since further studies are needed to substantiate the hypothesis formulated. (**Aust J Nutr Diet 1999;56:97–107**).

Key words: morbidity mortality paradox, cardiovascular disease risk factors, functional disability, traditional Greek food pattern, phytochemicals, fatty acids, Greek-born Australians, Anglo-Celtic Australians.

Introduction

Greek-born Australians (GA) have one of the lowest levels of mortality of any birthplace group in Australia (1–4). This is mainly accounted for by their significantly lower mortality from cardiovascular diseases (CVD) and cancer (see Table 1). They are even living longer than their counterparts in Greece, with death certification rates for CVDs well below those in Greece (2,5,6). However, even though GA have low mortality levels, they have been reported to have unexpectedly high morbidity levels, especially from CVD risk factors, functional disabilities and poorer self-rated health (3,7–10). A full explanation for this apparent dissociation between morbidity and mortality is likely to involve interaction among social, cultural (which includes traditional cuisine), economic, environmental, biological, and genetic factors, and the migration process. This paper examines the food intake data and lifestyle habits of elderly GA from the International Union of Nutritional Sciences (IUNS), 'Food habits in later life' study (11,12) in order to formulate a 'paradox' hypothesis. The contribution of non-dietary factors to the paradox will be briefly discussed, but an in-depth analysis, especially with respect to psycho-social variables (such as stress of migration, social support and activities), is beyond the scope of this paper.

International Union of Nutritional Sciences 'Food habits in later life' study

To date, most of the dietary studies on GA provide inadequate and incomplete data on their food habits and nutrient intakes and inadequate sampling of elderly GA, thus making it difficult to investigate possible dietary contributors to the paradox (13–17). Elderly people are more likely than their younger counterparts to adhere to traditional cuisine and thus may provide more useful information on the protective components of such a diet. During the 1950s and 1960s when mass migration to Australia took place, the majority of Greek migrants came from rural Greek villages (16,18). People in these rural regions of Greece still follow a more traditional Greek food pattern than people in urban regions (19) and their diet can therefore act as a surrogate measure of the Greek diets which were prevalent at the time migration occurred (10). Examination of any differences between this traditional Greek diet and the diet of elderly Greeks who migrated to Australia may provide some insight into the impact of such dietary changes on health status and

Table 1. Standardised mortality ratios (SMRs) for Greek-born Australians, by major causes of death, men and women, aged 15 years and over, 1992 to 1994 (2)[(a)]

	Cause of death—standardised mortality ratios			
	Cancer	*Diabetes mellitus*	*Cardio-vascular diseases*	*All causes*
Men	0.66*	1.00	0.69*	0.66*
Women	0.68*	1.37	0.66*	0.67*

* $P < 0.01$ significantly different than SMRs for total Australian-born population.

(a) SMR, observed number of deaths/expected number of deaths for a given birthplace group × 100. An SMR of less than 1.0 indicates a lower level of mortality relative to the total population in Australia.

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mortality (10). An international study was established to investigate such cross-cultural food habits in later life across six countries, including Greeks who migrated to Australia. Coordinated by the IUNS, this study compared the food habits, health status and lifestyle of 189 GA (94 men, 95 women) with those of 104 Greeks in rural Greece (GG, 51 males, 53 females) and 140 Anglo-Celtic Australians (AA, 70 men, 70 women). All subjects were aged 70 years and over. About 75% of GA in the study had migrated in the 1950s from traditional rural villages from the Greek islands or the mainland (18). The mean length of stay in Australia for the GA sampled was 30 years (18). Subjects were defined as Anglo-Celtic if they had both maternal and paternal grandparents from the United Kingdom and/or Ireland. GA and AA were randomly sampled from metropolitan Melbourne. GG were randomly sampled from a rural village (Spata), 20 km from Athens. Institutionalised elderly were not included. Study subjects were recruited using the telephone directory in Melbourne and from the electoral rolls in Greece. The samples were found to be representative of the wider community from which they were sampled according to gender and age distribution. The response rate, following contact, was 84% for GA, 70% for AA and 89% for GG.

The study in rural Greece was conducted in 1988 and the study in Melbourne between 1990 and 1992. The details regarding the survey instruments utilised, methodology and validation of the food frequency questionnaires have been reported elsewhere (10–12,20). All survey instruments were administered by a single interviewer fluent in both Greek and English. A validated, extensive quantitative food frequency questionnaire (250 food items and beverages) was used, accompanied by food photographs, which included Greek dishes to ascertain portion size. An anthropological method (rapid assessment procedure) (21) was used to obtain qualitative information on past food intake before migration and in the first 15 to 20 years after migration (22). Health complaints reported were cross-checked by the interviewer with prescribed medications to ensure complaints were not self-perceived but were diagnosed by their doctor. An SAS package software (Statistical Analysis Systemm, version 6.12, 1997, SAS Institute, Cary, NC, USA) was used to perform all the statistical analyses.

Evidence for the paradox

According to the Australian Bureau of Statistics, GA have low mortality levels (1,2,4). Bennett (9) reported that the low rates of CVD mortality of GA were insufficiently explained by the traditional risk factors. He concluded that factors other than the traditional risk factors were important for GA and that blood lipids played little part in explaining CVD mortality differences. However, systolic blood pressure was the best single explanatory factor for variation in CVD mortality among GA men, and smoking prevalance the best explanatory factor among GA women. Itsiopoulos et al. (23) have also identified the apparent dissociation between mortality from coronary heart disease and higher rates of the identified risk factors (especially diabetes and obesity) in Greek migrants from the large Melbourne collaborative cohort study.

In contrast to the low mortality levels, GA have been reported as having high morbidity levels from a variety of different studies (7–10), including the 1990 and 1995 national health surveys (unpublished data presented in Tables 2 and 3. See also Figure 1.) (3,24). Differences in the methodology between these studies resulted in different estimates of prevalence of some of these morbidities. However, there was consistency in the results in some respects. Compared with the AA or Australian-born (AB), the GA in the national health surveys and the IUNS study had: a two to three times higher prevalence of type 2 diabetes, obesity and sedentary lifestyle; three to nine times the rate of hypercholesterolaemia; a similar prevalence of heart disease and hypertension; and in men there was up to double the prevalence of smoking. Elderly GA rarely participated in a leisure sport such as tennis, jogging, gym, lawn bowls or golf whereas 30% of elderly AA reported such sports at least once a week (12,18). Studies on GA have also shown they tend to report poorer self-rated health (40–60%) than other ethnic groups and the AB (10–40%) (2,7,8). However, in the IUNS study only 10% of the elderly GA men and 30% of the GA women reported poor health compared with 40 to 50% of AA (12). Overall, males tended to claim better health than females and self-rated health tended to decline with age (7,8,12). Studies have also shown that elderly GA, especially the women, tend to report markedly more functional disability (according to activities of daily living, ADL) than the AA, AB and other ethnic groups (7,8,12). In the IUNS study 80% of the GA women and 60% of the men were unable to perform all ADLs compared with less than 30% of AA (12,18). Poorer self-rated health and functional disability are consistent with higher prevalences of obesity and diabetes amongst GA (especially the women).

Possible explanations for the paradox

Bennett suggests that a full explanation for this apparent dissociation between morbidity and mortality,

> is likely to involve interaction among social, economic, cultural, environmental, biological, genetic factors and the migration process...the lead time between exposure to major coronary risk factors and subsequent effects on mortality also varies among immigrant groups (9).

For example, there may be a lag time between a rise in morbidity and a rise in mortality which is difficult to assess due to the relatively small window of measurement. The migration process itself tends to be highly selective for health (2), both explicitly by the health criteria applied by the Australian government to people seeking to migrate to Australia and also because people who are in poor health are less likely to have the ability and economic resources to migrate. Although it is likely that these selection effects explain a considerable part of the observed mortality differentials, a number of other factors are also likely to contribute, including differences in diet and lifestyle, socioeconomic status and working conditions, and access to health facilities and subsequent diagnosis of health problems. However, immigrants from Europe have been reported to have a similar frequency of visits to general practitioners compared with the AB (2,11,18). In the IUNS study, 75% of GA and 85% of AA reported visiting a doctor at least three times in the past 12 months. Another possible explanation of the paradox in long-lived elderly populations may be due to the extension of longevity or prevention of death with the concomitant increase in chronic diseases that commonly

Table 2. Prevalence of self-reported diabetes, heart disease, hypercholesterolaemia, hypertension, and cancer of Australian-born and Southern European-born subjects from the 1990 national health survey, Australian Bureau of Statistics (unpublished data), all ages and those older than 70 years, living in Australia (3)[a]

	Australian-born				*Southern European-born migrants*[b]			
	Men		*Women*		*Men*		*Women*	
	All ages %	*70+ years* %	*All ages* %	*70+ years* %	*All ages* %	*70+ years* %	*All ages* %	*70+ years* %
N	6 564 000	353 900	6 689 000	553 700	385 800	25 800	336 400	25 900
Diabetes type 2	2.0	5.0	1.0	3.0	4.0	13.0	3.0	12.0
Heart disease	1.8	11.0	1.6	10.0	2.7	11.0	1.8	7.0
Hypercholesterolaemia	2.0	2.0	2.0	3.0	5.0	19.0	6.0	10.0
Hypertension	6.0	23.0	7.0	32.0	10.0	22.0	14.0	42.0
Cancer	1.7	8.0	1.6	5.0	0.6	5.5	1.0	6.0

(a) Self-administered questionnaire was used.
(b) Greeks, Italians and Maltese.

Table 3. Prevalence of diabetes (type 2), overweight and obesity, exercise levels, and smoking in Australian-born and Greek-born subjects from the 1995 national health survey, Australian Bureau of Statistics (unpublished data), all ages and those older than 70 years, living in Australia (24)[a]

	Australian-born				*Greek-born migrants*			
	Men		*Women*		*Men*		*Women*	
	All ages %	*70+ years* %	*All ages* %	*70+ years* %	*All ages* %	*70+ years* %	*All ages* %	*70+ years* %
N	7 005 500	417 900	7 130 800	637 400	65 000	4 900	55 900	2 300
Diabetes type 2	0.81	4.2	0.84	3.3	3.5	8.2	3.7	13.0
Overweight (BMI 25–30)	34.9	34.5	20.5	23.7	45.4	44.9	35.3	17.4
Obese (BMI >30)	10.3	5.8	10.4	8.7	21.6	14.3	18.2	34.8
Low exercise level	30.2	28.6	39.4	30.1	27.2	28.6	29.7	0.0
Sedentary exercise level	31.2	41.6	32.3	51.8	53.0	46.1	54.2	100.0
Smoker	27.6	12.3	22.6	7.7	38.9	18.4	9.6	0.0
Ex-smoker	30.7	57.4	22.6	20.0	32.6	41.0	10.7	13.0
Never smoked	41.7	30.1	55.5	72.3	28.7	38.8	79.7	8.7

(a) Self-administered questionnaire was used.

occur in older individuals. This probably explains only part of the paradox since chronic diseases need not be associated with longevity.

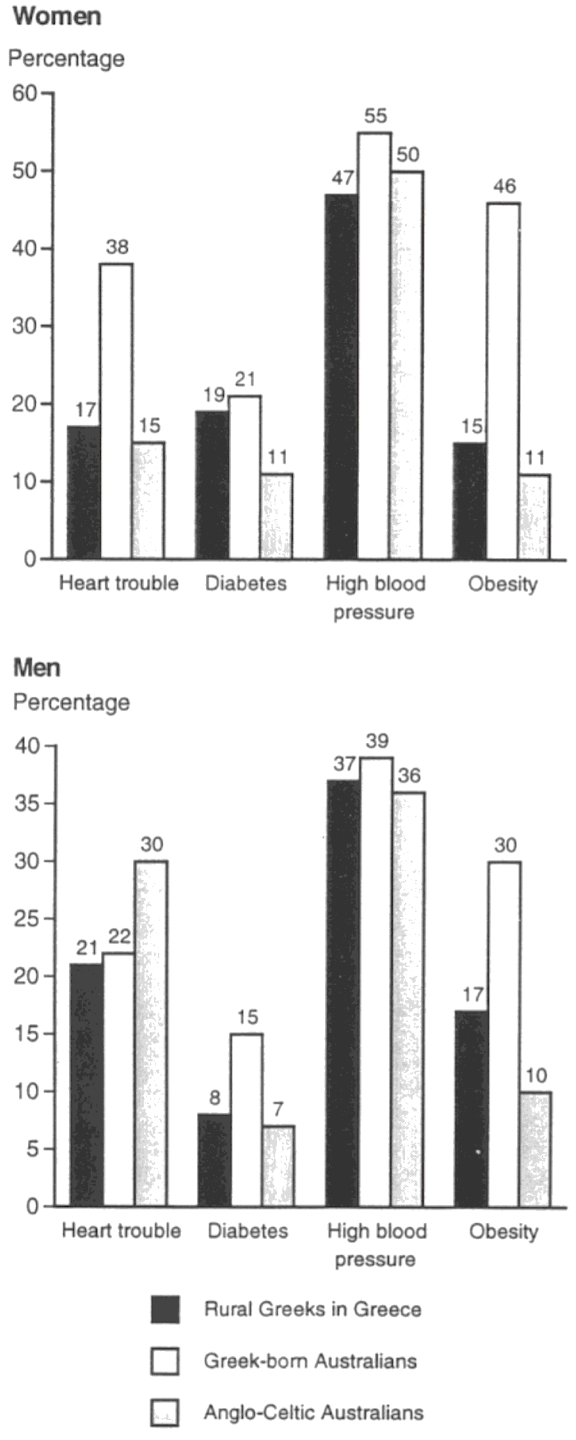
In an attempt to explain the mortality advantage of GA, Powles suggested (with no further analysis) that retention of some 'protective' elements of the traditional Greek food pattern (TGFP) may be responsible, such as plant food, fish and olive oil (5). On the other hand it may be possible to develop a more 'benign' form of diabetes, obesity or CVD depending upon the kind of foods consumed. For example, becoming overweight by eating large serves of foods rich in phytochemicals as opposed to foods rich in saturated fat, may have different effects on arterial compliance and therefore risk of CVD.

Furthermore, major changes to food habits of GA appear to have occurred in the first 20 years after migration, which may have had a significant impact on current morbidity levels. Before we can identify which protective traditional foods may have changed on migration, it is useful to firstly describe the TGFP.

Defining the traditional Greek food pattern

The abundant consumption of plant foods and olive oil is a hallmark of the TGFP (19). In the IUNS study, GA were asked to describe their diet circa 1960 before migrating to Australia (Table 4) (11,18,22). The dietary pattern described is consistent with the 'optimal traditional Mediterranean diet pyramid' circa 1960 (25) except that more details about specific foods and dishes are also provided. The elderly indicated that a characteristic feature of most traditional Greek dishes is the tomato-based sauce (made with tomatoes, onions, garlic, parsley, herbs and olive oil) into which vegetables, rice and sometimes legumes are cooked. These vegetarian-style dishes, also called *ladera* in Greek (made with oil) are eaten a few times a week, along with fish or chicken, and red meat is eaten only occasionally. Another important characteristic of the TGFP is the raw and boiled salads made with wild greens (see Table 4). These salads are flavoured with ample lemon juice and olive oil. The addition of olive oil (especially extra virgin) to vegetables and legumes enhances taste, facilitating their consumption (26). The TGFP also includes a variety of fresh fruits and nuts; the intake of milk is low, whereas the consumption of fermented milk (yoghurt) and cheese (fetta) is relatively high (25). The

Figure 1. Percentage of Greeks in rural Greece (GG, 71 females, 73 males), Greek-born Australians (GA, 95 females, 94 males) and Anglo-Celtic Australians (AA, 70 females, 70 males) aged 70 years and over and reporting heart trouble, diabetes and high blood pressure in the IUNS study using an interviewer-administered questionnaire in Greek or English[a]



(a) Obesity was defined as a body mass index of ≥30 kg/m^2(11). Self-reported health complaints were cross-checked by the interviewer with prescribed medications to ensure the complaint was not merely self-perceived. 'Heart trouble' included angina and heart attack. Statistical analyses (χ^2 test) were significant at 5% level for women reporting heart trouble and for obesity (for men and women). All the elderly GG, GA and AA women were defined as having abdominal (android) fat distribution, in contrast to 97% of GG, GA and 85% of AA men.

elderly also indicated that before migrating to Australia the largest or main meal of the day was consumed for lunch and was then followed by a siesta and a light snack (e.g. yoghurt or bread and olives) for dinner (27).

Evidence for the health benefits of the Mediterranean diet

The health benefits of a traditional Mediterranean diet have been described in a supplement to a previous issue of this Journal (28). However, the results of three studies provide insight into the possible reasons for the morbidity mortality paradox of GA. The classic seven countries study, led by Ancel Keys (6), demonstrated that Greek men from Crete had a very low rate of coronary heart disease. This was associated with their low intakes of saturated fat although their intake of total and mono-unsaturated fatty acids (MUFA), nearly all from olive oil, were high. The Lyon diet heart study in France showed that adherence to a Mediterranean diet significantly reduced the number of cardiovascular deaths and recurrent myocardial infarction in survivors of a first myocardial infarction over five years (29). Compared to the control group, the Mediterranean diet group consumed significantly more fruit and vegetables, bread, canola margarine and olive oil; less red meat, butter or cream; and similar amounts of fish, legumes, cheese and milk. As a percentage of total energy intake, the Mediterranean diet group compared with the controls had significantly lower intakes of total fat (30% versus 34%), saturated fat (8% versus 12%), total polyunsaturated fat (4.6% versus 6.1%) and n-6 linoleic acid (3.6% versus 5.3%), but a higher intake of MUFA (13% versus 11%) and n-3 linolenic acid (0.84% versus 0.3%). The authors concluded that the protective effect could be through the anti-thrombogenic and anti-arrhythmic effects of n-3 linolenic acid and the anti-oxidant effects of α-tocopherol, ascorbic acid and phytochemicals, especially flavonoids (30).

Further evidence in support of the TGFP has come from three prospective cohort studies which described the food habits of people aged 70 years and over in Greece (GG) (26), Australia (GA, AA) (20), and Denmark (31). Subjects were followed up five to six years later to ascertain survival status (32). Subjects with food patterns consistent with the TGFP had approximately half the risk of dying, even at age 70 years and older. Smoking and male gender were not significant predictors of mortality. The TGFP was defined as consisting of two-thirds plant foods and one-third animal foods, with a high mono-unsaturated to saturated fat ratio (higher than 1) (26). Subjects achieved greater mortality advantage if they followed the entire food pattern, suggesting synergy between food groups. The optimal traditional Mediterranean diet pyramid developed by Willet et al (25) has been based upon food patterns in Greece (Crete) and southern Italy circa 1960s, reported in the seven country study (6).