

Original Article

Morbidity mortality paradox of 1st generation Greek Australians

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There is evidence in Australia that 1st generation Greek Australians (GA), despite their high prevalence of cardiovascular disease (CVD) risk factors (e.g. obesity, diabetes, hyperlipidaemia, smoking, hypertension, sedentary lifestyles) continue to display more than 35% lower mortality from CVD and overall mortality compared with the Australian-born after at least 30 years in Australia. This has been called a 'morbidity mortality paradox' or 'Greek-migrant paradox'. Retrospective data from elderly Greek migrants participating in the International Union of Nutrition Sciences Food Habits in Later Life (FHILL) study suggests that diets changed on migration due to the: (i) lack of familiar foods in the new environment; (ii) abundant and cheap animal foods (iii) memories of hunger before migration; and (iv) status ascribed to energy dense foods (animal foods, white bread and sweets) and 'plumpness' as a sign of affluence and plant foods (legumes, vegetable dishes, grainy bread) and 'thinness' as a sign of poverty. This apparently resulted in traditional foods (e.g. olive oil) being replaced with 'new' foods (e.g. butter), 'traditional' plant dishes being made more energy dense, larger serves of animal foods, sweets and fats being consumed, and increased frequency of celebratory feasts. This shift in food pattern contributed to significant weight gain in GA. Despite these potentially adverse changes, data from Greece in the 1960s (seven countries study) and from Australia in the 1990s (FHILL study) has shown that Greek migrants have continued to eat large serves of putatively protective foods (leafy vegetables, onions, garlic, tomatoes, capsicum, lemon juice, herbs, legumes, fish) prepared according to Greek cuisine (e.g. vegetables stewed in oil). Furthermore, GA were found to return to the traditional Greek food pattern with advancing years. We suspect that these factors may explain why GA have recently been found to have over double the circulating concentrations of antioxidant carotenoids, especially lutein, compared with Australians of Anglo-Celtic ancestry. This in turn may have helped to make the CVD risk factors 'benign' and reduce the risk of death. This raises the question whether specific dietary guidelines need to be developed for recent migrants to Australia, encouraging them to retain the best of their traditional cultures and include the best of the mainstream culture.

Key words: Anglo-Celtic Australians, Australian Bureau of Statistics, cardiovascular disease, food habits in later life, Greek-born Australians, morbidity mortality paradox, traditional Greek food pattern.

Introduction

A morbidity mortality paradox exists when there is an apparent dissociation between disease specific mortality and its risk factors. For example, a population group may exhibit a high prevalence of cardiovascular disease (CVD) risk factors, such as, obesity, hypertension, hyperlipidaemia and yet mortality from CVD is lower than expected.¹

Evidence

The interest in 1st generation Greek-born Australians (GA) began in the 1980s when mortality data indicated they were the 2nd longest lived population in the world after the Japanese in Hawaii – they lived even longer than their counterparts in Greece.² In the 1990s, GA continue to have one of the lowest levels of all-cause mortality mainly due to about 35% lower mortality from CVD and cancer compared with the Australian-born (Fig. 1; Tables 1,2).^{3–5} However, this is in spite of the 2–3 times higher prevalence of obesity, diabetes, hyperlipidaemia, hypertension, inactivity and smoking (Table 3).^{6–9}

Low mortality

The evidence for the low mortality rates has come from:

1. The Australian Bureau of Statistics Causes of Death data in 1980–1982,² 1984–1986, 1987–1989,³ 1992–1994,⁴ and 1997.⁵
2. Food Habits in Later Life (FHILL) – Phase II. Mortality follow-up study of elderly cohorts: GA, Anglo-Celtic Australians (ACA), Greeks in Greece, Japanese, Swedes (Fig. 2).^{10,11}

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High morbidity

The evidence for the high morbidity rates has come from:

1. The 1980, 1983, 1989 Risk Factor Prevalence Surveys of people aged 20–69.⁶
2. Two studies on elderly migrant Australians aged 60 and over conducted in 1981 and 1986.^{12,13}
3. Unpublished data from the Australian Bureau of Statistics National Health Surveys in 1990 and 1995 (Table 3).^{7,8}
4. Food Habits in Later Life (FHL) – Phase I. A descriptive study of elderly GA aged 70 years in 1990–1992, elderly Greeks in rural Greece, and Anglo-Celtic Australians (ACA).⁹

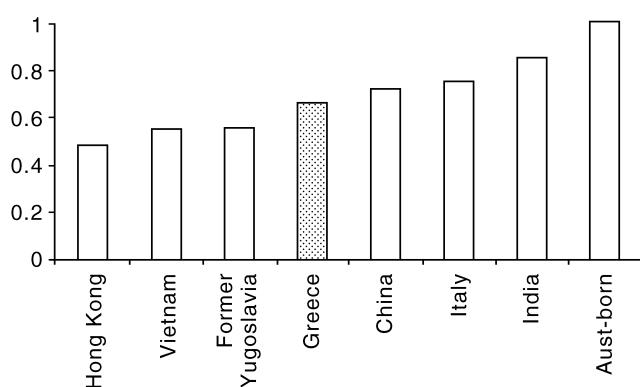


Figure 1. Australian Bureau of Statistics mortality differentials (standardized mortality ratios [SMR]¹). All causes, by ethnic group in Australia, 1992–1994, > 15 years. Source: adapted from reference 4.¹ SMR, observed number of deaths/expected number of deaths for a given birthplace group × 100. An SMR < 100 indicates a lower level of mortality relative to the total population in Australia.

5. Health 2000 ‘Melbourne Collaborative Cohort Study’, Anti-Cancer Council 1997.¹⁴

In 1993, Bennett first reported that the low rates of CVD mortality of GA were insufficiently explained by the traditional risk factors (blood lipids, diabetes, blood pressure, body mass index, physical inactivity, smoking, alcohol intake) from the 1980, 1983 and 1989 Risk Factor Prevalence Surveys.⁶ In 1996, we confirmed Bennett’s observation or ‘morbidity mortality paradox’ when we studied the food habits, health and lifestyle of elderly GA between 1990 and 1992 and obtained mortality data in 1996.^{9–11} Mortality for the slimmer Anglo-Celtic elderly Australians (BMI ≥ 30, 10%) was 80% higher than the more overweight GA (BMI ≥ 30, 30–46%). It was estimated that 40% of the higher mortality of elderly ACA over that of GA could be explained in terms of their different dietary habits and

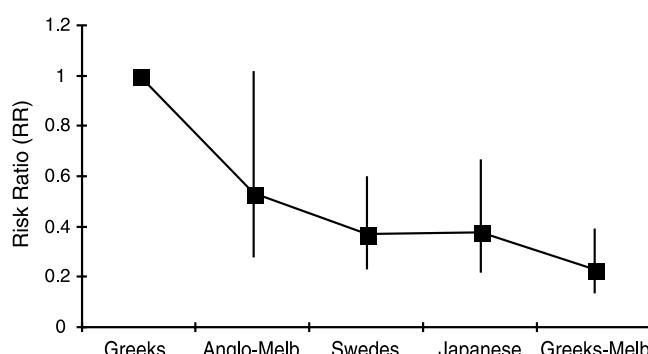


Figure 2. Mortality risk ratio after 5 years follow-up for elderly cohorts in Greece, Melbourne (Greek-born, Anglo-Celts), Sweden and Japan (95% CI, Cox Proportional Hazards Regression) in the ‘Food Habits in Later Life Study’.¹¹

Table 1. Standardized mortality ratios for Greek-born Australians by major causes of death, men and women, aged 15 years and over, 1992–94†

Gender	Cause of death (standardized mortality ratios)			
	Cancer	Diabetes mellitus	Cardiovascular diseases	All causes
M	0.66*	1.00	0.69*	0.66*
F	0.68*	1.37	0.66*	0.67*

* $P < 0.01$ significantly different than SMR for Australian-born.

† Table reproduced with permission from reference 1.

SMR, standardized mortality ratios.

Table 2. Causes of death in Australia, by country of birth in 1997*†

Birthplace	Neoplasms	Circulatory system	Digestive system	Respiratory system
Australia	198	306	23	78
UK and Ireland	192	260	21	76
Italy	160	219	19	46
Greece	129	212	10	37
China	129	173	12	41
Vietnam	110	116	11	30

* Indirect standardized death rate per 100 000 of the mid-year 1997 Australian population.

† Adapted from reference 5.

Table 3. Percentage prevalence of diabetes (type 2), overweight and obesity, exercise levels, and smoking in Australian-born and Greek-born from the 1995 National Health Survey, Australian Bureau of Statistics (unpubl. data), all ages and 70+, living in Australia.*

Age group	Australian-born			Greek-born		
	Men	all ages	70+	Women	70+	all ages
n	7 005	500	417 900	7 130 800	637 400	65 000
Diabetes type 2	0.81	4.2	0.84	3.3	3.5	4.900
Overweight (BMI > 25–30)	34.9	34.5	20.5	23.7	45.4	8.2
Obese (BMI > 30)	10.3	5.8	10.4	8.7	21.6	44.9
Low exercise level	30.2	28.6	39.4	30.1	27.2	28.6
Sedentary exercise level	31.2	41.6	32.3	51.8	53.0	46.1
Smoker	27.6	12.3	22.6	7.7	38.9	18.4
Ex-smoker	30.7	57.4	22.6	20.0	32.6	41.0
Never smoked	41.7	30.1	55.5	72.3	28.7	38.8

*Reference source: unpublished data from the 1995 National Health Survey⁸ provided by the Australian Bureau of Statistics on request; self-administered questionnaire was used. Table reproduced with permission from reference 1.

specifically their different level of adherence to the traditional Greek diet of the 1960s.¹⁰

The morbidity mortality profile of 2nd generation Greek Australians is unknown.

Possible explanations for the ‘morbidity mortality paradox’ of Greek-born Australians

Bennett suggests that a full explanation for this apparent disassociation 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’.⁶ For example there may be a lag time between a rise in morbidity and a rise in mortality that is difficult to assess due to the relatively small window of measurement. Mathers suggests that: ‘... it is very likely that the lower mortality of many overseas-born people is due to health selection effects upon migration, combined with cultural factors, such as, a healthier diet for some groups’.⁴ These factors may conceal adverse health effects associated with work, or with poorer socioeconomic status, for some immigrant groups in Australia.

Migration process

The migration process itself tends to be highly selective for health, 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. Migrants may represent a cohort of survivors of hardships, such as, World War II. On the other hand the stress associated with migrating to a new country and not knowing the language or not knowing many people may have contributed to morbidity. Although it is likely that these selection effects explain a considerable part of the observed mortality differentials, a number of other factors, especially cultural factors are also likely to contribute.

Cultural factors

Social Migration may increase social cohesion because of the similar circumstances that migrants find themselves in, resulting in greater social networks and activities. In the FHILL study, elderly GA had the highest social network scores and the second highest social activity scores compared with the Anglo-Celts, Greeks in Greece, Swedes and Japanese. However, social factors were not predictive of survival in GA.¹¹ This suggests that social factors may not be the most important contributors to the mortality advantage of GA.

Physical activity When migration occurs from rural villages to urban areas there is usually an inherent decline in physical activity. For example, more than 80% of Greeks migrated from rural villages in Greece (where they did a lot of physical activity associated with farm life) to urban parts of Australia. Much of the physical activity on migration was confined to factory work – many of them ended up standing

for hours on production lines or sitting for hours, for example, sewing/cutting material. In the FHILL study, GA had the lowest physical activity scores compared with other elderly cohorts and physical activity was a strong predictor of survival (risk ratio 0.58, $P = 0.02$).¹¹ This suggests that physical activity may be an important contributor to the paradox.

Diet The high prevalence of CVD risk factors and obesity is not necessarily evidence that the Greek diet is unhealthy or obesogenic, but rather a reflection of how migration may have influenced food habits. Also, it is important to remember that traditional plant-based cuisines, such as, Greek and Asian, have the potential to be made more energy dense (and thus obesogenic) by increasing the proportion of animal food and fat and decreasing the proportion of plant food of traditional dishes.

In an attempt to explain the mortality advantage of GA, Powles *et al.* suggested (with no further analysis) that retention of some ‘protective’ elements of the traditional Greek diet (e.g. plant food, fish and olive oil) may be responsible for the mortality advantage of GA.¹⁵ This type of food pattern (high plant food, low animal food, high fish, high monounsaturated fat, low saturated fat) has been found in FHILL to be predictive of survival not only in GA but also in other elderly cohorts.^{10,11,16} Also, this food pattern was a more important predictor of survival than lifestyle, social and health variables.¹¹

On the other hand, it has also been suggested that this food pattern, due to its content of antioxidants and omega 3 fatty acids, may offset any adverse effects of the CVD risk factors. The question has thus been raised that it may be possible to develop ‘benign’ CVD risk factors depending upon the kind of foods consumed.^{17,18}

Diet as a main contributor to the morbidity mortality paradox

For the reasons outlined above, this paper will focus on diet, since it is the most likely candidate explaining the paradox, along with physical activity.

REASONS

- **Lack of familiar foods in the new environment**
(olive oil not widely available in Australia before 1980)
- **Abundant and cheap foods (especially animal foods) in Australia**
- **Memories of hunger and starvation prior to migration**
- **‘Status’ ascribed to various foods**
energy dense foods (animal foods, white bread and sweets) and ‘plumpness’ as a sign of affluence and plant foods (legumes, vegetable dishes, grainy bread) and ‘thinness’ as a sign of poverty.

RESULT

- **Traditional foods (e.g. olive oil) replaced with ‘new foods’ (e.g. butter)**
- **Traditional plant dishes made more energy dense with animal foods and fat**
- **Larger serves of animal foods and other energy dense foods**
- **Weight gain**

Changes to diet on migration

What are GA eating and how has their diet changed since migration? In the FHILL we asked the elderly to describe how and why their diets changed on migration – most changes occurred in the first year and persisted for about 20 years (Fig. 3).^{19,20} Data from Greece in the 1960s (7 countries study)²¹ and from Australia in the 1990s (FHILL) suggest that on migration animal food intake increased significantly (~60%), plant food intake changed less (decreased by 25%), but the overall energy density of the diet increased and composition of dietary fat also changed markedly (Fig. 4).¹⁰ These dietary changes probably contributed to the currently observed high morbidity. This information was used to develop a hypothesis for the paradox (Fig. 5).

High morbidity hypothesis

In order to demonstrate the foods that may have contributed to the high morbidity, 1960s data from Greece (7 counties study)²¹ were compared to 1990s data from elderly Greek migrants and Anglo-Celts in Melbourne (Fig. 6).^{1,9,10} The intakes of foods that appear to have increased markedly on migration include meat, milk, cheese and sweets whereas the intake of olive oil and cereals decreased. Total fat intake in 1960s Greece was about 90 g/day, of which 80 g was derived from olive oil (about 4 tablespoons/day) and 10 g from fish, nuts and leafy greens high in omega 3 fatty acids. Animal fat intake was low due to low intake of animal foods. In contrast, total fat intake of elderly Greek migrants in the 1990s in Australia was also about 90 g/day, but only 20 g was derived from olive oil, 20 g from margarine/vegetable oils and the remaining 50 g mainly from animal foods. As a result, saturated and omega 6 fat intake has almost doubled on migration and monounsaturated fat has decreased. Elderly Anglo-Celts in Melbourne consumed about 60 g fat daily, of which 20 g was mainly from margarine and 40 g from animal fats (Fig. 5).

The consumption of sweets (e.g. syrupy pastries) was less than 50 g/day in the 1960s in Greece and more than 100 g/day in the 1990s amongst GA. The frequency of

Figure 3. Changes to diet on migration by first generation Greeks.

FOOD PATTERN OF GREEKS PRIOR TO MIGRATION (1960s)¹

1.2 kg plant food/day
 0.3 kg animal food/day
 plant: animal = 4
 40% fat (mainly monounsaturated and omega 3)
 (energy density of the diet < 4 kJ/g)

FOOD PATTERN OF GREEKS AFTER 30–40 YEARS IN AUSTRALIA (1990s)²

0.9 kg plant food/day
 0.5 kg animal food/day
 plant: animal = 2.7
 40% fat (monounsaturated + saturated + omega 6)
 (energy density of the diet > 4kJ/g)

¹ Based on data from the 7 countries study in the 1960s (20)

² Based on data from the FHILL study in the 1990s on Greek migrants in Melbourne (1, 9)

Figure 4. Food pattern of Greeks before migration (1960s) and after 30–40 years in Australia (1990s).

High morbidity

1. **Increased intake of saturated fat** (due to increased intake of animal foods)
2. **Decreased intake of monounsaturated fat and increased intake of omega 6 fats** (due to decreased intake of olive oil and increased intake of margarine, vegetable oils)
3. **Positive energy balance** (due to less physical activity, increased intake of energy dense foods, fatty animal foods, serving sizes, increased frequency of celebratory feasts)
4. **Increased glucose load of the diet** (due to higher intakes of sweets, white bread, serving sizes)

Low mortality

1. **Retained high intake of antioxidant rich plant foods** (especially leafy greens, tomato, capsicum, onions, garlic, herbs, lemon juice)
2. **Retained high intake of legumes**
3. **Retained high intake of fish**
4. **Retained Greek cuisine** (especially for vegetables) which may increase bioavailability of antioxidants
5. **Return to the traditional Greek food pattern of the 1960s with advancing years**

Figure 5. Dietary factors that may be contributing to high morbidity and low mortality.

celebratory feasts has also been reported to have increased on migration²⁰ and serving sizes of most foods, especially animal foods, has increased by more than 30%.^{20,22}

Low mortality hypothesis

Which foods or aspects of diet may have contributed to low mortality? Greek migrants appear to have retained high intakes of vegetables, especially those high in antioxidants, such as, leafy greens¹⁸ tomato, capsicum, onions, garlic and herbs. Even though elderly Anglo-Celts had similar total vegetable intakes to GA, they had higher intakes of potatoes.^{10,20} Greek-born Australians also appear to have retained high intakes of legumes and fish and the mode of cooking is still identifiably Greek.^{1,9,15} This is especially true when it came to the vegetables. Vegetables are usually well-cooked and stewed in olive oil, tomato, onion, garlic and herbs. There is evidence that the fat-soluble antioxidants (carotenoids, some polyphenols) in well-cooked vegetables especially when cooked in fat are more bio-available com-

pared with vegetables that are minimally cooked without fat.^{23,24} Cooking probably breaks plant cells open so antioxidants and other plant chemicals can be better absorbed. Adding fat allows fat-soluble phytochemicals to be better absorbed. Theoretically, the Greek cuisine has potential to result in higher blood levels of antioxidants. Research on a subsample of Greek migrants in the Health 2000 study (Anti-Cancer Council, Melbourne) has indeed found that they have over double the circulating concentrations of antioxidant carotenoids, especially lutein, compared with Australians of Anglo-Celtic ancestry.¹⁷ It is now being suggested that this may explain why Greek migrants appear to be ‘getting away’ with CVD risk factors.¹⁸

Another factor that has probably contributed to the mortality advantage of ageing Greek migrants is the observation that they return to a more traditional Greek food pattern (TGFP) in old age (defined as being high in plant food, low in animal food, high in monounsaturated fat, low in saturated fat). A greater percentage of GA (80%) had food

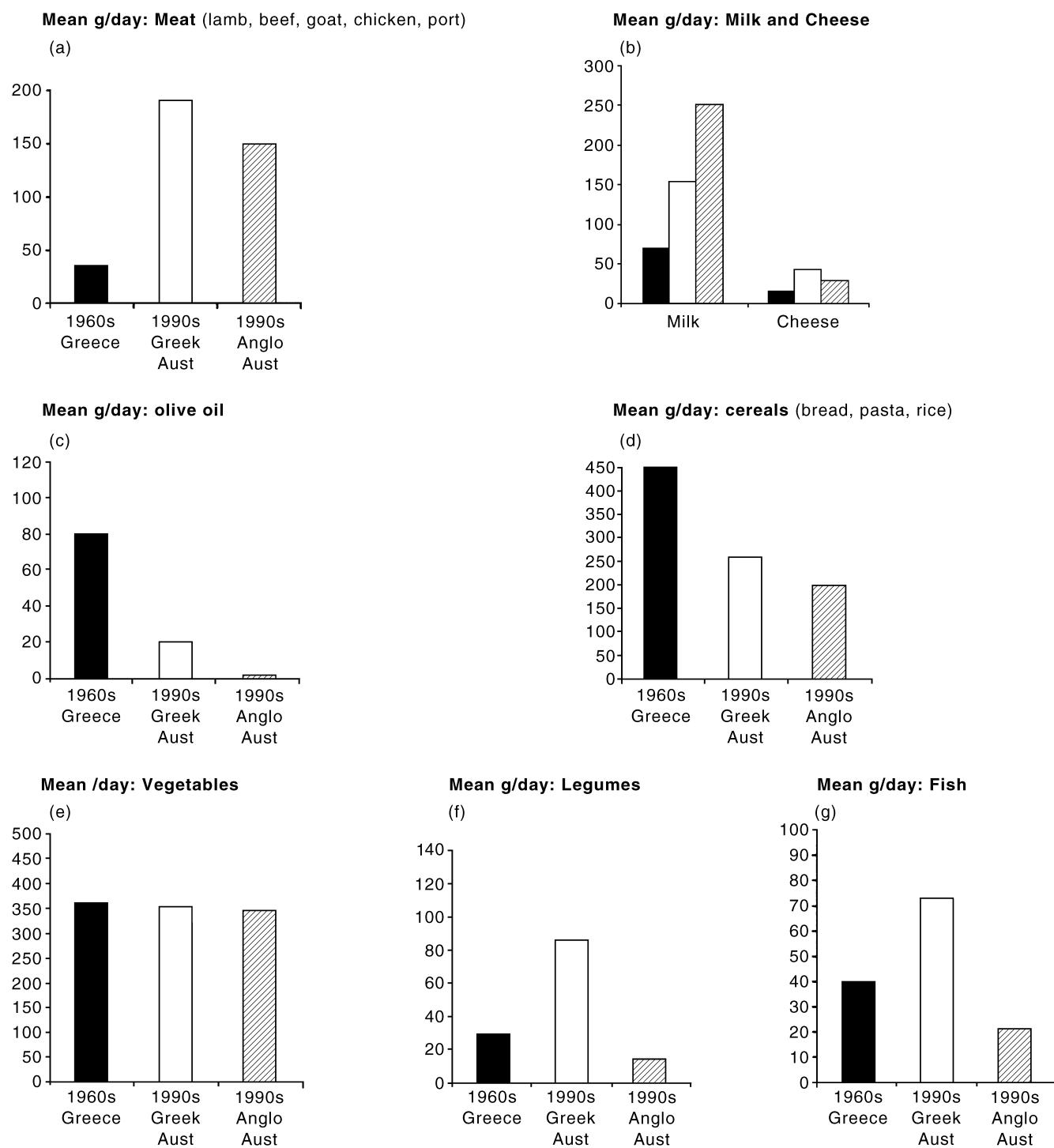


Figure 6. Comparison of mean intakes (g/day) of foods consumed by middle-aged Greeks in Greece in the 1960s²⁰ and elderly Greeks and Anglo-Celts in Melbourne in the 1990s.^{1,9,10} (a) Meat (lamb, beef, goat, chicken, pork); (b) milk and cheese; (c) olive oil; (d) cereals (bread, pasta, rice); (e) vegetables; (f) legumes; (g) fish.

patterns that were more traditional than Greeks in Greece (60%). Anglo-Celts, as expected, were less likely to have food patterns found in Greece in the 1960s (28%). The TGFP was also found to be predictive of survival in GA when mortality data were collected after 5 years; subjects with food patterns similar to the TGFP of the 1960s had a reduced risk of death by 28%.^{16,25}

Implications for other/recent migrant groups

The morbidity mortality paradox of 1st generation Greek migrants may represent another paradigm shift in our understanding of CVD risk factors. It suggests that CVD risk factors can, to some extent, be made less harmful if one ensures that their diet contains a variety of putatively protective foods. The paradox also has implications for other migrant groups in

Australia. What has been witnessed in one ethnic group may be prevented in another. A study on Somalian refugees in Australia found that after 2–4 years in Australia there was a significant decrease in physical activity in conjunction with increased intakes of energy dense foods and animal foods. The authors concluded that this recent migrant group was at high risk of developing obesity.²⁶ Australia currently has dietary guidelines for adults, older adults and children. Dietary guidelines for recent migrants are also needed. They would need to cover the following issues:

1. Retention of 'healthy' dishes/foods from their traditional diet, watching the intake of energy dense festive foods and the potential to change the energy density of traditional plant-based dishes.
2. Inclusion of 'healthy' dishes/foods from the mainstream food culture – this has potential to improve the variety of foods consumed, but serving sizes of energy dense foods requires attention and animal foods need not be eaten at the expense of plant foods.

References

1. Kouris-Blazos A, Wahlqvist M, Wattanapenpaiboon N. 'Morbidity mortality paradox' of Greek-born Australians: possible dietary contributors. *Aust J Nutr Diet* 1999; 56 (2): 97–107.
2. Young C. Selection and Survival: immigrant mortality in Australia. *Studies in Adult Migrant Education*. Canberra: Department of Immigration and Ethnic Affairs. Australian Government Printing Services, 1986.
3. Young C. Mortality, the ultimate indicator of survival: the differential experience between birthplace groups. In: Donovan J, d'Espagnet EM, Merton C, van Ommergen A, eds. *Immigrants in Australia: A Health Profile*. Canberra: Australian Government Publishing Service, 1992; 34–70.
4. Mathers C. Health Patterns of Immigrants in Australia. *People Place* 1996; 4 (1): 8–18.
5. Australian Bureau of Statistics. Deaths, Australia 1997. Canberra: Australian Government Publishing Service, 1998; 21.
6. Bennett SA. Inequalities in risk factors and cardiovascular mortality among Australia's immigrants. *Aust J Public Health* 1993; 17: 251–261.
7. Australian Bureau of Statistics. National Health Survey, Summary of Results 1989–90. ABS category no. 4364.0. Canberra: Australian Government Publishing Service, 1991.
8. Australian Bureau of Statistics. National Health Survey. Summary Results, Australian States and Territories 1995. ABS category no. 4368.0. Canberra: Australian Government Publishing Service, 1995.
9. Kouris-Blazos A, Wahlqvist ML, Trichopoulou A, Polychronopoulos E, Trichopoulos D. Health and nutritional status of elderly Greek migrants to Melbourne, Australia. *Age Ageing* 1996; 25: 177–189.
10. Kouris-Blazos A, Gnardellis C, Wahlqvist ML, Trichopoulos D, Lukito W, Trichopoulou A. Are the advantages of the Mediterranean diet transferable to other populations? A cohort study in Melbourne, Australia. *Br J Nutr* 1999; 82: 57–61.
11. Darmadi-Blackberry I. Survival amongst longevity cultures: social, physical activity and nutritional determinants. PhD Thesis. Monash University, Melbourne, Australia, 2001.
12. Australian Council on the Ageing & Department of Community Services. *Older People at Home. A Report of a 1981 Joint Survey Conducted in Melbourne and Adelaide*. Canberra: Australian Government Printing Services, 1986.
13. Australian Institute of Multicultural Affairs. *Community and Institutional Care for Aged Migrants in Australia – Research Findings*. Melbourne: AIMA, 1986.
14. Giles GG. The Melbourne Study of Diet and Cancer. In: Proceedings of the Nutrition Society of Australia 14th Annual Scientific Meeting. Adelaide: Nutrition Society of Australia, 1990; 94–103.
15. Powles JW, Ktenas D, Sutherland C, Hage B. Food habits in southern-European migrants: a case study of migrants from the Greek island of Levkada. In: Truswell S, Wahlqvist ML, eds. *Food Habits in Australia*. Australia: Rene Gordon, 1988; 201–223.
16. Trichopoulou A, Kouris-Blazos A, Wahlqvist ML, Gnardellis Ch, Lagiou P, Polychronopoulos E, Vassilakou T, Lipworth L, Trichopoulos D. Diet and overall survival in elderly people. *Br Med J* 1995; 311 (7018): 1457–1460.
17. Itsipoulos C, Cameron M, Fowler C, Kaimakamis M, Best J, O'Dea K. Is Diabetes less of a coronary heart disease risk factor in Greek migrants? *Proceedings of the Australian Diabetes Society, 1–3 October 1997 Canberra*; 71.
18. Su Q, Rowley KG, Itsipoulos C, Odea K. Identification and quantification of major carotenoids in selected components of the Mediterranean diet: green leafy vegetables, figs and olive oil. *Eur J Clin Nutr* 2002; 56: 1149–1154.
19. Wahlqvist ML, Kouris-Blazos A, Trichopoulou A, Polychronopoulos E. The wisdom of the Greek cuisine and way of life: comparison of the food and health beliefs of elderly Greeks in Greece and Australia. *Age Nutr* 1991; 2 (3): 163–173.
20. Kouris-Blazos A. Elderly Greeks in Sparta, Greece and Melbourne, Australia: food habits, health and lifestyle. PhD Thesis. Monash University, Melbourne, Australia, 1994.
21. Kromhout D, Keys A, Aravanis C, Buzina R, Fidanza F, Giampaoli S, Jansen A, Menotti A, Nedeljkovic S, Pekkarinen M, Bozidar S, Toshima H. Food consumption patterns in the 1960s in seven countries. *Am J Clin Nutr* 1989; 49: 889–894.
22. Ireland P, Jolley D, Giles G, O'Dea K, Powles J, Rutishauser I, Wahlqvist ML, Williams J. Development of the Melbourne FFQ: a food frequency questionnaire for use in an Australian prospective study involving an ethnically diverse cohort. *Asia Pac J Clin Nutr* 1994; 3: 19–31.
23. Talcott ST, Howard R, Brenes CH. Antioxidant changes and sensory properties of carrot puree processed with and without periderm tissue. *J Agric Food Chem* 2000; 48 (4): 1315–1321.
24. Khachik F, Goll MB, Beecher GR, Holden J, Lusby WR, Tenorio MD, Barrera MR. Effect of food preparation on qualitative and quantitative distribution of major carotenoid constituents of tomatoes and several green vegetables. *J Agric Food Chem* 1992; 40: 390–390.
25. Kouris-Blazos A, Wahlqvist ML. The traditional Greek food pattern and overall survival of elderly people. *Aust J Nutr Diet* 1998; 4 (Suppl.): 20–23.
26. Burns C, Salmon J, Mohamed A. Refugees from sub-Saharan Africa – a high risk population for obesity. *Proceedings to the Australian Society for the Study of Obesity, Annual Conference, Gold Coast, September 2001*.