Table 4. **Reconstruction of the traditional Greek food pattern circa 1960 by elderly Greek-born Australians (n = 189) in the 1990s using a qualitative anthropological approach** (22)[(a)]

Daily	
Fetta cheese (sheep's milk)	
Milk (sheep or goat) seasonal, reserved for children	
Bread (whole wheat, corn, barley), 8 slices	
Tomatoes (fresh or paste)	
Onions, garlic (especially in spring)	
Olives	
Olive oil (mainly unrefined) added at the end of cooking or directly on food on plate: 40–60 mL	
Grapes, figs (summer)	
Citrus (mainly lemons added to salads, fish)	
Peach, apricot, cherries (summer)	
Herbs (oregano, mint, rosemary)	
Wine (mainly red or white wine with pine resins—retsina): men, 4 glasses; women, <2 glasses	
Once or twice a week	
Fish (e.g. sardines, cod, herring)	
Yoghurt (sheeps milk) seasonal	
Eggs	
Pasta dish	
Ladera[(b)], rice and vegetable dishes, and vegetable casserole	
Legume dishes (mainly winter) lentils, haricot, black eye, lima, broad, split peas, chick peas; soya beans and products not eaten or unavailable	
Nuts, seeds (almonds, walnuts, pumpkin and sunflower seeds, roasted chickpeas, tahini)	
Dried fruit (sultanas, figs, dates, prunes)	
Wild greens[(c)] mainly as boiled salads	
Cabbage (winter)	
Lettuce (summer)	
Potatoes	
Melons (summer)	
Herb tea (sage, camomile, *sideritis sp*, e.g. mountain tea) (winter)	
Twice a month	
Chicken, pork	
Shellfish (octopus, squid, sea urchin)	
Filo pies (filo pastry, leafy greens, herbs, pumpkin, leeks, cheese, eggs, olive oil)	
Once a month	
Red meat (mainly lean lamb, goat)	
Milk (sheep or goat) seasonal, adults	
Butter (mainly used in sweets)	
Cakes, biscuits, sweets	

(a) Rapid assessment procedures were used to obtain information on distant past food intake (21).

(b) Ladera (Greek = made with oil) vegetarian-style dishes commonly consumed in summer; comprised of a tomato, onion, garlic, herb, oil-based sauce into which vegetables, rice and sometimes legumes are cooked.

(c) Wild greens (Greek = *horta*) include wild chicory, (*Cichorium intybus*; Greek = radikia), dandelion leaves (*Tanacetum vulgare*), stinging nettle (*Urtica dioica*; Greek = tsouknida), rocket (*Eruca sativa*; Greek = roka), watercress (*Nasturtium officinale*; Greek = cardamo), amaranth (*Amaranthus retroflexus*; Greek = vlita), thistle (*Carduus benedictus*), purslane (*Portulaca oleracea*; Greek = glystrida).

Major dietary differences between elderly Greek-born and Anglo-Celtic Australians in the IUNS study

Food intake in the first 20 years in Australia (1950s to 1970s)

According to the accounts given by the elderly GA in the IUNS study (22) and from other studies (13,14,16), the major changes to the diets of GA occurred in the first 20 years in Australia. These changes were associated with the lack of familiar foods in the new environment and more importantly, the status ascribed to meat (and other animal foods) and sweet foods as a sign of affluence, and legumes as a sign of poverty. Meat was introduced into their diets almost on a daily basis. The most consistent description from all study subjects was the recall of the smell of meat being barbecued on most days in suburbs where Greeks were located. Meat was relatively cheap in Australia and was a sign that they were doing well in their new country. The most notable changes in these early years described by the elderly subjects included (22):

- increased intakes of beef, lamb, chicken, lard, butter, margarine, polyunsaturated vegetable oils, cream, milk, yellow cheeses, white bread, ice cream, sweets, beer and tea; and,
- decreased intakes of goat, fish, eggs, fetta cheese, yoghurt, unrefined olive oil, olives, legumes, wine, pickled or salty foods, barley or corn bread, pasta, wild leafy greens and herb teas.

However, the elderly subjects indicated that they continued to eat most of their traditional dishes (including legumes) and that serving sizes tended to be larger than serves consumed prior to migration. These larger serving sizes of animal and plant foods appear to have been retained with increasing duration of residence, reported in the IUNS study (18) and in the Melbourne collaborative cohort study (17). Most foods or dishes were prepared and cooked according to traditional methods but there was a shift from the traditional casseroles to more roasts, grills and barbecues with the increased frequency of celebratory feasts (18,22). Overall, the increase in meat consumption occurred against a background of continued high intakes of fruits, vegetables, legumes, cereals, olive oil and fish, in a cuisine that was still identifiably Greek (5,22).

Food intake in the 1970s to 1990s

Data from the IUNS study showed that in the past 10 to 20 years this first generation of migrants appears to have begun to return to or to prefer their TGFP into old age. Intakes of meat and butter appear to have decreased and intakes of traditional foods, such as fish, legumes, leafy greens, pasta, yoghurt, olives and the less expensive refined olive oil, to have increased. However, premigration levels have not been re-established (22). New foods, such as margarine, vegetable oils, biscuits, fruit juices, canned fruit, certain types of fruit (tropical) and vegetables (broccoli), cow's milk, beer and soft drinks, have been retained. The intake of pickled, salted or cured foods remained low, possibly explaining the reduced stroke and stomach cancer rates on migration (5,33).

Data from the IUNS study showed that there were significant dietary differences between the GA, GG and AA participants. These are summarised in Tables 5, 6 and 7.

The olive oil consumed by GG was unrefined extra virgin and locally produced, and contributed most of their MUFA intake. GA tended to consume the less expensive 'pure' refined olive oil and other vegetable oils, and significantly more of their MUFA intake was derived from animal foods (10,18). The higher intakes and variety of plant foods consumed by GA are partly attributed to the greater availability of vegetables and fruit in Australia all year round. Apart from these changes in food intakes, changes also appear to have occurred to the meal pattern and the habit of taking a siesta after lunch. More than two-thirds of the elderly GA compared with less than half of the GG reported to have their main meal for dinner. Less than 50% of the GA and 90% of the GG had a siesta after lunch (27).

Compared to AA, GA had higher intakes of fish, vegetables, legumes, wine, olive oil and MUFA, and lower intakes of meat, milk, margarine, butter and beer. AA had high intakes of vegetables and fruits, but the types consumed were different (i.e. more root vegetables and less leafy greens, grapes, stone and citrus fruits (see Table 7).

Possible dietary contributors to the paradox and their mechanisms

High intakes of plant foods have been shown to be protective against cancer and CVD (34), and this protection does not appear to be related solely to their nutrient content (35). Other biologically active compounds (phytochemicals) distributed widely in plant foods, such as lycopene and flavonoids, are now thought to play a more important role (36–38). Growing scientific evidence also supports the role that n-3 and n-9 fatty acids have in the prevention and treatment of chronic diseases (39–41). The TGFP provides a variety of phytochemicals (Table 8) due to the variety of plant foods used in the cuisine (34). It is also high in n-3 and n-9 fatty acids due to the high intake of leafy greens, figs, pulses, nuts, seafood and olive oil (25,30) (Table 8). Changes in the intakes of these compounds due to changes in the types of foods consumed on migration may help to explain the paradox. The intakes by GA and AA of phytochemicals and n-3 fats could not be calculated from the Australian food composition tables (42), but a qualitative assessment could be made by identifying intakes of foods which are good sources of these compounds (35–37,41,43–46) (Table 8). This information was used, along with the quantitative food intake data for the past year of GG, GA, and AA and qualitative food intake data for the distant past of GA (food intake before migration and in the first 20 years after migration), to develop a diet-related hypothesis which explores possible reasons for the paradox which are summarised in Figure 2. Further studies are needed to substantiate the hypothesis; therefore only some examples of possible mechanisms have been outlined.

Many of the GA who migrated to Australia were born in time of privation (such as during wars and economic depression) and probably had low birth weights. This may have been a factor in the development of obesity, diabetes, and CVD when exposed to food abundance in the new country (47). Other contributors to the high morbidity levels may have been due to the changes that occurred in the food patterns of GA in the first 20 years in Australia, with the introduction of more animal foods, saturated fats, beer, sugar products, butter and margarine (Figure 2). These changes are not as marked in the 1990s because there appears to be a trend towards returning to the TGFP in old age. For example, 80% of the elderly GA compared with 30% of the AA were found to be adhering to a more TGFP which was associated with a 50% reduction in overall mortality in GA after five years follow-up, despite unfavourable CVD risk factors (10,20). The larger serving sizes of both plant and animal foods of GA have resulted in plant to animal food ratios that are higher than comparable ratios for AA (as well as a higher total energy intake, see Tables 5 and 7), but lower than before migration (6,25). A high plant to animal food ratio, along with adherence to the TGFP in old age, may be the keys to the continued mortality advantages of GA (32). However, such large food servings, especially of energy dense foods, may have contributed to the development of obesity, dyslipidaemia, hypertension and diabetes in an environment where physical activity was no longer such a large part of daily activities.

An increased intake of animal fats and a decreased intake of olive oil may have increased the tendency for central obesity, since a high intake of MUFA from olive oil has been reported to protect against central obesity (48). There is also evidence from the Normative Ageing Study (49) that dietary saturated fat may increase insulin resistance independently of its effect on adiposity. It has also been postulated that deficiency of MUFAs in the diet contributes to diabetes and CVD (40). Olive oil, as a source of MUFAs, may be a key protective ingredient. However, population studies of these diseases indicate that oleic acid intake can be associated with increased adiposity and insulin resistance (40). Inconsistencies between the various population-based studies and short-term dietary interventions using oleic acid may reflect the background diet. In non-Mediterranean populations the association of oleic acid with dairy and meat intakes may account for the deleterious effect of mono-unsaturates (40). One argument in favour of mono-unsaturates is based on the hypothesis that n-6 fats are pro-inflammatory due to the production of the eicosanoid 2-series. It is suggested that the use of mono-unsaturates in preference to n-6 fats would result in a lower ratio of n-6 to n-3 polyunsaturates in the diet and a less inflammatory state. However, more evidence is required to support this hypothesis (39–41). Another argument in favour of mono-unsaturates is that LDL cholesterol enriched with n-9 fatty acids resists oxidation compared to LDL enriched in poly-unsaturates. If the oxidation theory of atherosclerosis is correct, this should lead to less atherosclerosis on a mono-unsaturated fat enriched diet. However, animal studies do not support this hypothesis and more studies are required in humans (39).

The continued high intake of fish, leafy vegetables and pulses suggests that the intake of the n-3 fats may have been maintained following migration and could be protecting against premature death by preventing heart arrhythmia, blood clotting and arterial wall spasm (29,30). The continued high intake of MUFA and polyphenols from olive oil may be protecting LDL cholesterol from oxidation (50–52) and facilitating the conversion of n-3 fats to the anti-inflammatory and anti-thrombogenic eicosanoid 3 series. Phenolic compounds may also inhibit eicosanoid 2 series metabolism, have antiplatelet and vasodilatory effects and inhibit ischaemic and re-

Table 5. The percentage of daily total food intake and amount (g/day) from food groups for rural Greeks (GG), Greek-born (GA) and Anglo-Celtic (AA) Australians aged 70 and over (10,11,18)[(a)]

	Rural Greeks n =104		*Greek-born Australians n =189*		*Anglo-Celtic Australians n =140*	
Total intake[(b)]	1181 ± 341g[(c,d)]		1443 ± 404g[(c)]		1398 ± 505g[(d)]	
	% total intake	*g/day*	*% total intake*	*g/day*	*% total intake*	*g/day*
Plant[(e)]	68 ± 11[(c)]	802 ± 264[(c,d)]	66 ± 10[(d)]	955 ± 289[(c)]	64 ± 13[(c,d)]	900 ± 390[(d)]
Vegetables, nuts	25 ± 9[(c)]	304 ± 153[(c,d)]	29 ± 9[(c)]	415 ± 172[(c)]	27 ± 11	378 ± 208[(d)]
Legumes	4 ± 3[(c)]	49 ± 35[(c)]	5 ± 3[(c)]	80 ± 57[(c)]	1 ± 1[(c)]	8 ± 13[(c)]
Cereal[(f)]	23 ± 10[(c,d)]	270 ± 129	17 ± 6[(c)]	244 ± 97	18 ± 9[(d)]	254 ± 152
Fruit	15 ± 10[(c)]	181 ± 116[(c)]	15 ± 7[5]	221 ± 127[(c)]	18 ± 10[(c,d)]	260 ± 188[(c)]
Animal[(g)]	32 ± 11[(c)]	380 ± 173[(c,d)]	34 ± 10[(d)]	488 ± 233[(c)]	36 ± 13[(c,d)]	498 ± 235[(d)]
Meat[(h)]	8 ± 4[(c)]	90 ± 55[(c)]	9 ± 4[(d)]	130 ± 63[(c)]	13 ± 9[(c,d)]	172 ± 120[(c)]
Fish	5 ± 4[(c)]	60 ± 44[(c)]	5 ± 3[(d)]	69 ± 51[(d)]	1 ± 1[(c,d)]	17 ± 16[(c,d)]
Dairy products	16 ± 9[(c)]	184 ± 130[(c)]	16 ± 10[(c)]	232 ± 187[(c)]	22 ± 12[(c)]	309 ± 202[(c)]
Milk		101 ± 107[(c)]		154 ± 175[(c)]		251 ± 185[(c)]
Cheese		43 ± 34[(c)]		43 ± 29[(d)]		29 ± 39[(c,d)]
Yogurt		33 ± 39		26 ± 38		29 ± 97
Eggs	0.8 ± 1[(c)]	10 ± 14[(c)]	0.8 ± 1[(d)]	11 ± 18[(d)]	1.34 ± 1[(c,d)]	17 ± 16[(c,d)]
Plant:animal ratio		2.7 ± 1.7[(c)]		2.7 ± 1.4[(d)]		2.3 ± 2[(c,d)]
Plant variety score[(i)]		26 ± 9[(c)]		35 ± 9[(c)]		-
Animal variety score[(i)]		10 ± 3[(c)]		12 ± 3[(c)]		-
Other						
Margarine		0.2 ± 0.9[(c)]		2.8 ± 4.4[(c)]		13.6 ± 11.6[(c)]
Butter		0.1 ± 1[(c)]		0.8 ± 3[(d)]		4.1 ± 7.2[(c,d)]
Olive oil		30.7 ± 12[(c)]		18.1 ± 13.3[(c)]		1.2 ± 3.7[(c)]
Beer[(j)]		14 ± 73[(c)]		48 ± 97[(c)]		232 ± 366[(c)]
Wine[(j)]		169 ± 171[(c)]		73 ± 119[(c)]		24 ± 58[(c)]
Sugar products[(k)]		49 ± 85[(c)]		101 ± 137[(c)]		152 ± 142[(c)]

(a) Mean ± SD; food intake data collected with quantitative food frequency questionnaire for past 12 months.
(b) Total intake = daily intake of plant + animal foods. Fats, alcohol, sugar products, water not used to calculate total food intake.
(c,d) Means sharing a common superscript are significantly different ($P < 0.05$) using the Wilcoxon rank sums test.
(e) Plant food includes vegetables, legumes, cereal and fruit; vegetables includes nuts. Nut intake in GG, GA, AA was <10 g/day .
(f) Cereals includes biscuits and cakes. GG and GA consumed about 15 g/day of biscuits and cakes compared with about 45 g/day for AA. GG and GA consumed about 25 g/day of rice and 50 g/day of pasta compared with 10 g/day and 15 g/day respectively for AA; bread and breakfast cereals 165 g/day and 5 g/day GG, 125 g/day and 40 g/day GA and AA.
(g) Animal food includes meat, fish, dairy products and eggs.
(h) Meat includes red meat (lamb, beef, etc) and white meat (chicken, pork, etc).
(i) Plant and animal variety scores = number of different plant or animal foods consumed at least once a month.
(j) Beer and wine values apply to men only (GG n = 51, GA n = 94, AA n = 70); women consumed 15–26 g wine/day and 2–17 g beer/day.
(k) Sugar products includes soft drinks, fruit juice, jams, sweets and sugar.

perfusion arrhythmias (51). The high intake of MUFA by GA with diabetes may help reduce hyperglycaemia and dyslipidaemia (53), the complications associated with these and their associated mortality. Bonanome et al. (39) reported that a high polyunsaturated n-6 linoleic acid to MUFA ratio predisposes to oxidation of LDL cholesterol in diabetes, increasing the tendency to atherogenesis. In contrast, mortality follow-up studies have shown that a high mono-unsaturated to saturated fat ratio is negatively associated with death rates from coronary heart disease (6) and with overall mortality (20,26,32). Compared with AA, the GA had greater intakes of foods which are good sources of lycopene (37,43), polyphenols (flavonoids and phytoestrogens) (44,45) and salicylates (36) and may in part be responsible for the mortality advantage of GA. Traditional risk factors for CVD such as obesity, dyslipidaemia and diabetes may be more 'benign' if there is adequate intake of certain anti-oxidant phytochemicals which inhibit tissue damage. For example, chronic garlic intake has been reported to attenuate age-related increases in aortic stiffness, therefore garlic may protect against CVD other than through blood lipids or blood pressure (54). In other studies, lycopene (37) and flavonoid (38) intakes were inversely associated with mortality from coronary heart disease. Itsiopoulos et al. (23) are currently testing the hypothesis that the traditional Greek diet, by being a rich source of a wide range of anti-oxidant phytochemicals as a result of the high intake of plant foods and olive oil, could inhibit the process of atherosclerosis by inhibiting LDL oxidation.

There is growing awareness that distribution of food throughout the day, combined with the cooking technique or eating practice, may contribute to the expression of chronic diseases. For example, having a light snack for lunch and a larger main meal for dinner was associated with higher body fatness and abdominal obesity in the elderly GA compared with GG who were having their main meal for lunch (27). Also, the cooking technique used to prepare meat appears to have changed on migration from boiling, casseroling and spit roast to the more popular barbecue and grilling methods. Consumption of charred or burnt meat and grilling in direct flames have been linked with cancer due to the formation of carcinogenic compounds (33). The practice of eating plant foods with oil probably also helped to increase the bio-availability of the fat-soluble phytochemicals (e.g. lycopene) (37). Taking a nap or siesta during the day has been customary in the Greek culture. However, this behaviour was reported by only half of the GA compared with almost all of the GG. The significance of this change in sleeping pattern on morbidity and mortality requires further investigation, since napping has been associated with reduced coronary mortality (55). A full understanding of the paradox will depend on a more detailed knowledge of mechanisms by which death occurs and how food intake and other psycho-social variables might influence these.

Table 6. Total energy intake (MJ/day) from macronutrients for both sexes for rural Greeks (GG), Greek-born (GA) and Anglo-Celtic (AA) Australians aged 70 years and over (10,11,18)[a]

	GG *n = 104* *Mean ± SD* %	*GA* *n = 189* *Mean ± SD* %	*AA* *n = 140* *Mean ± SD* %
Energy (MJ/day)	8.1 ± 2.1[b]	8.8 ± 2.2[b]	7.4 ± 2.2[b]
Percentage of total energy intake			
Protein[d]	16 ± 3[b]	19 ± 3[b,c]	16 ± 4[c]
Carbohydrate	39 ± 7[b]	36 ± 6[b]	51 ± 8[b]
Unrefined	27 ± 8[b]	22 ± 5[b,c]	26 ± 7[c]
Refined	12 ± 5[b]	14 ± 5[b]	25 ± 8[b]
Fat	42 ± 7[b]	42 ± 6[c]	30 ± 7[b,c]
Saturated	12 ± 3[b]	12 ± 2[c]	11 ± 3[b,c]
Polyunsaturated	5 ± 1[b,c]	6 ± 2[b]	6 ± 3[c]
Mono-unsaturated[e]	22 ± 5[b]	21 ± 4[b]	10 ± 3[b]
Alcohol[f]	5 ± 5[b]	3 ± 4[b]	4 ± 6
Fibre (g/day)	19 ± 6[b]	26 ± 9[b]	29 ± 12[b]
Cholesterol (mg/day)	242 ± 117[b]	321 ± 129[b]	152 ± 83[b]

(a) Mean ± SD. Nutrient intake data based on quantitative food frequency questionnaire for past 12 months.
(b,c) Means sharing a common superscript are significantly different ($P < 0.05$) using the Wilcoxon rank sums test.
(d) For GG the main source of mono-unsaturated fat is olive oil; GA olive oil intake has decreased so mono-unsaturated fat is obtained from other sources, namely animal foods.
(e) Percentage values apply to men only; women consumed <1% energy intake from alcohol.

Conclusion

In the 1990s, Greek-born Australians (GA) continue to have one of the lowest levels of all-cause mortality and about 30% lower mortality from cardiovascular diseases (CVD) than the Australian-born. However, this mortality advantage has occurred in the face of a high prevalence of identified risk factors for CVD. A clear explanation for this phenomenon is unknown. This paper has examined differences in food patterns and lifestyle habits of elderly Greeks in rural Greece, Greek-born Australians, and Anglo-Celtic Australians to formulate a hypothesis for the morbidity mortality paradox. According to the accounts given by the elderly Greeks, changes to the diets of Greek migrants occurred in the first 20 years in Australia. These

Table 7. Significant differences ($P < 0.05$, Wilcoxon rank sums test) in the consumption of specific foods and dishes among rural Greeks, Greek-born and Anglo-Celtic Australians (18)[a]

Compared with Rural Greeks, Greek-born Australians had:

a lower intake of (g/day):	*a greater intake of (g/day):*	*the same intake of (g/day):*
Goat, pasta, bread, feta cheese, potatoes, cabbage, egg plant, artichokes, figs, peaches, apricots, cherries, wild greens, water, wine, salty or pickled foods, olive oil, herb tea, Greek coffee	Beef, chicken, milk, breakfast cereals, yellow cheese, carrot, capsicum, lettuce, cauliflower, broccoli, leeks, spinach, silverbeet[b], legumes, pumpkin green beans, 'ladera dishes'[c], pies (spinach, cheese, pasta) bananas, tropical fruit, apples, citrus fruit, fruit juice, ice cream sugar products, instant coffee, black tea, beer, margarine, polyunsaturated oils, herbs (e.g. oregano)	Lamb, rabbit, yoghurt, fish, eggs, nuts, rice, pasta, watermelon, cantaloupe, cucumber, tomatoes, zucchini, onion, garlic, chicory, okra, olives

Compared with Anglo-Celtic Australians, Greek-born Australians had:

a lower intake of (g/day):	*a greater intake of (g/day):*	*the same intake or approaching the same intake of (g/day):*
Eggs, carrots, pumpkin, turnips, brussel sprouts, tropical fruit, cakes, beer, apples, pears	Fish, yoghurt, cheese, capsicum, leafy greens, spinach, tomato, onions, leeks, okra, artichokes, eggplant, green beans, legumes pasta, rice, figs, lemons, oranges grapes, watermelon, cantaloupe, olive oil, wine, herbs (e.g. oregano)	Potato, broccoli, cabbage, cauliflower, nuts, breakfast cereals, bread, meat, milk, sugar products, instant coffee, black tea

(a) Food intake data obtained with validated food frequency questionnaire (10).
(b) Silverbeet or seakale *(Beta vulgaris)*.
(c) Ladera dishes, see Table 4.

Table 8. Potential candidates and their possible physiological actions for the protective effects of the Greek version of the traditional Mediterranean diet (22,37–39,41,43–46)

Dietary constituents	*Food sources*
Fats	
Linolenic acid (n-3) (anti-inflammatory, anti-coagulation, anti-arrhythmic, improved insulin sensitivity)	Legumes, leafy greens (e.g. purslane), nuts (e.g. walnuts), figs, olive oil[(a)]
EPA[(b)], DHA[(c)] (n-3) (anti-inflammatory, anti-coagulation, anti-arrhythmic, improved insulin sensitivity)	Cod, herring, sardines, pilchards, fish roe
Oleic acid (n-9), (may prevent oxidation of LDL cholesterol and reduce inflammation, improved insulin sensitivity)	Olive oil (low intake of linoleic acid and high intake of oleic acid) may allow linolenic acid to be metabolised to EPA and DHA and their anti-inflammatory products.
Phytochemicals[(d)]	
Carotenoids, e.g. lycopene, (anti-oxidant, anticarcinogen, immunoenhancement)	Tomatoes, watermelon, apricots, spinach, wild greens
Phytoestrogens or compounds with oestrogenic or anti-oestrogenic activity, e.g. isoflavones, lignans, (anti-tumour, hypocholesterolaemic, increases bone density)	Legumes (chickpeas, lentils), almonds, sesame seeds, cracked wheat, barley, sage, aniseed
Salicylates, (anti-tumour in colon, anti-coagulation)	Zucchini, capsicum, eggplant, green beans, grapes, sultanas, apples, oranges, cherries, apricots, rockmelon, thyme, oregano, peppermint
Polyphenols, anthocyanins, and flavonoids, (potent anti-oxidants, antibacterial, reduce urinary tract infection)	Red wine, grapes, cherries, apples, lemon, oregano, basil, oregano, thyme, sage, parsley, rosemary, wild greens, endive, celery, red capsicum, tomato, eggplant, garlic, onions, unrefined olive oil
β-sitosterol (may be an anticarcinogen)	Pumpkin seeds
Monoterpenes (anti-tumour)	Lemons, oranges
Saponins, (anti-tumour, hypocholesterolaemic)	Nuts, chickpeas, sage tea
Allyl thiosulphinates, (hypocholesterolaemic, hypoglycaemic, hypotensive, anticancer, antibacterial)	Garlic, onions, leeks
Non-digestible oligosaccharides, e.g. inulin (hypoglycaemic, hypercholesterolaemic)	Artichoke, garlic

(a) Olive oil is not a rich source of linolenic acid (0.5–1.5%), but when consumed in large quantities (as in the TGFP), it becomes a significant source of this fatty acid.
(b) Eicosapentaenoic acid.
(c) Docosahexaenoic acid.
(d) Phytochemicals are plant compounds which are not usually considered to be vitamins in the classical sense, but are biologically active, e.g. can act as anti-oxidants, or can be weakly oestrogenic or anti-oestrogenic, can enhance immunity, inhibit promotion phase of carcinogenesis and angiogenesis, and can have anti-microbial activity.

changes were due to the lack of familiar foods in the new environment and more importantly, the status ascribed to energy dense foods (fatty meat, animal foods, sweets) which were not frequently consumed prior to migration—these foods were a sign that they were doing well in the new country. Meal and sleep patterns changed and serving sizes of both plant and animal foods increased in an environment which did not require as much physical activity. Overall, the increase in energy dense foods occurred against a background of a continued high intake of phytochemicals and n-3 fatty acids from fish, vegetables, legumes, fruit, cereals and olive oil, in a cuisine that was still identifiably Greek. This paper raises the question of whether it is possible to develop a more benign form of diabetes or obesity or whether it is possible to counteract other CVD risk factors depending upon the kind of foods consumed. It was not the intention of this paper to give a detailed account of the possible mechanisms that may be involved since further studies are needed to substantiate the paradox hypothesis formulated. However, what is now being witnessed in one ethnic group may be prevented in another, especially the more recent arrivals to Australia. This questions whether specific dietary guidelines need to be developed for first and second generation migrants to Australia, encouraging them to retain the best of their traditional cultures and include the best of the mainstream culture.

References

1. Young C. Selection and survival: immigrant mortality in Australia. Studies in adult migrant education. Department of Immigration and Ethnic Affairs. Canberra: Australian Government Printing Services; 1986.
2. Mathers C. Health patterns of immigrants in Australia. People Place 1996;4(1):8–18.
3. Australian Bureau of Statistics. National health survey, summary of results 1989–90. ABS cat.no.4364.0. Canberra: Australian Government Publishing Service; 1991.
4. Young C. Mortality, the ultimate indicator of survival: the differential experience between birthplace groups. In: Donovan J, d'Espaignet EM, Merton C, van Ommergen M, editors. Immigrants in Australia: a health profile. Canberra: Australian Government Publishing Service; 1992. p. 34–70.
5. Powles JW. Best of both worlds? Attempting to explain the persisting low mortality of Greek migrants to Australia. In: Caldwell JC, editor. Health transition: cultural, social and behavioural determinants of health: what is the evidence? Proceedings of a workshop, 1989 May 15–19; Canberra, Australia. Canberra: Australian National University; 1990.

Figure 2. Possible dietary and lifestyle contributors to the morbidity mortality paradox of Greek-born Australians after migration

High morbidity possibly due to:

1. Food, nutrients

⇑[(a)] energy dense foods, especially in the first 20 years in Australia

⇑ saturated, mono-unsaturated, *trans* fatty acids from animal foods, butter, lard, margarine

⇑ refined and high glycaemic index carbohydrates (sugar products, white bread)

2. Meal patterns, cooking methods

⇑ serving sizes of both plant and animal foods

Main meal consumed in the evening as opposed to the middle of the day (27)

⇑ barbeques, grills, ⇓[(b)] casseroled, boiled meat (33)

⇑ celebratory feasts

3. Lifestyle, other

⇓ physically active but ⇑ energy intake

⇓ naps, siesta (55)

Stress of migration (56)

Low birth weight due to wars, economic depression and socioeconomic adversity through malnutrition and inadequate care (47)

Low mortality possibly due to:

1. Food, nutrients

↔[(c)] high plant to animal food ratio (but increased intake of both food groups)

⇑ food variety, especially from plant food

↔ high intake of fish, legumes, chicory, endives, leafy greens, wine along with the n-3 fatty acids and other phytochemicals (phytoestrogens, polyphenols) they contain

↔ high intake of onions, garlic, olives, cucumber, zucchini, grapes, melons, tomatoes and phytochemicals they contain (allyl thiosulphinates, salicylates, lycopene)

↔ high intake of herbs, especially oregano, dill, parsley and mint

⇑ intake of certain plant foods (carrots, capsicum, pumpkin, cauliflower, apples, citrus fruits) and introduction of new foods (such as tea, tropical fruits, broccoli, silverbeet) and their phytochemicals (e.g. catechins, carotenoids, indoles, monoterpenes, polyphenols)

↔ high intake of mono-unsaturated fats, with the majority being derived from olive oil

⇓ intake of foods preserved in salt, e.g. pickled vegetables, salted fish or meat, some cheeses

Return to the traditional Greek food pattern in old age

2. Cooking, eating practices

↔ high intake of tomato, onion, garlic, oil-based casseroles (ladera) and therefore lycopene, flavonoids and other phytochemicals

↔ plant food consumed or cooked with oil may have increased the bio-availability of certain fat-soluble phytochemicals (e.g. lycopene)

3. Lifestyle, other

Strong social support networks and activities (18, 57)

(a) ⇑, increased.
(b) ⇓, decreased.
(c) ↔, retained.

6. Keys A, editor. Seven countries: a multivariate analysis of death and coronary heart diseases. Cambridge, Mass: Harvard University Press; 1980.

7. Australian Council on the Ageing and Department of Community Services. Older people at home. A report of a 1981 joint survey conducted in Melbourne and Adelaide. Canberra: Australian Government Printing Service; 1986.

8. Australian Institute of Multicultural Affairs. Community and institutional care for aged migrants in Australia—research findings. Melbourne: AIMA; 1986.

9. Bennett SA. Inequalities in risk factors and cardiovascular mortality among Australia's immigrants. Aust J Public Health 1993;17:251–61.

10. 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;25:177–89.

11. Wahlqvist ML, Hsu-Hage BH-H, Kouris-Blazos A, Lukito W, editors. Food habits in later life: a cross-cultural study [CD Rom]. Melbourne: Asia Pac J Clin Nutr and United Nations University Press; 1995.

12. Wahlqvist ML, Hsu-Hage B, Kouris-Blazos A, Lukito W. Food habits in later life—an overview of key findings. Asia Pac J Clin Nutr 1995;4(2):1–11.

13. Kosmidis G, Rutishauser I, Wahlqvist ML, McMichael A. Food intake patterns among Greek migrants in Melbourne. Proc Nutr Soc Aust 1980;5:165.

14. Rutishauser I, Wahlqvist ML. Food intake patterns of Greek migrants to Melbourne in relation to duration of stay. Proc Nutr Soc Aust 1983;8:49–55.

15. Department of Community Services and Health. National dietary survey of adults, 1983. Canberra: Australian Government Publishing Service; 1987.

16. 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, editors. Food habits in Australia. Sydney: Rene Gordon; 1988. p. 201–23.

17. Ireland P, Jolley D, Giles G, O'Dea K, Powles J, Rutishauser I, et al. 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.

18. Kouris-Blazos A. Elderly Greeks in Spata, Greece and Melbourne, Australia: food habits, health and lifestyle [thesis]. Melbourne: Monash University; 1994.

19. Trichopoulou A, Katsouyanni K, Gnardellis C. The traditional Greek diet. Eur J Clin Nutr 1993;47 Suppl 1:76–81.

20. 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. In press 1999.

21. Scrimshaw S, Hurtado E. Rapid assessment procedures for nutrition and primary health care. Los Angeles, California: UCLA Latin American Centre Publications; 1987.

22. 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;2:163–73.

23. Itsiopoulos 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 [Abstract]. Proceedings of the annual scientific meeting of the Australian Diabetes Society and Australian Diabetes Educators Association; 1997 Oct 1–3; Canberra. Sydney: Australian Diabetes Society; 1997. p. 71.

24. Australian Bureau of Statistics. National health survey: summary results, Australian States and Territories 1995. ABS cat.no.4368.0. Canberra: Australian Government Publishing Service; 1995.

25. Willett WC, Sacks F, Trichopoulou A, Drescher G, Ferro-Luzzi A, Helsing E, et al. Mediterranean diet pyramid: a cultural model for healthy eating. Am J Clin Nutr 1995;61 Suppl:1402–6.

26. Trichopoulou A, Kouris-Blazos A, Wahlqvist ML, Gnardellis C, Lagiou P, Polychronopoulos E, et al. Diet and overall survival in elderly people. Br Med J 1995;311:1457–60.

27. Wahlqvist ML, Kouris-Blazos A, Wattanapenpaiboon N. The significance of eating patterns: an elderly Greek case study. Appetite 1998;32:1–10.

28. Profiles in nutrition: the mediterranean diet for the new millennium. Aust J Nutr Diet 1998;55(4 Suppl):4–35.

29. de Lorgeril M, Salen P. Mediterranean diet in secondary prevention of coronary heart disease. Aust J Nutr Diet 1998;55(4 Suppl):16–20.

30. de Lorgeril M, Salen P, Martin JL, Mamelle N, Monjaud I, Touboul P, et al. Effect of a Mediterranean type diet on the rate of cardiovascular complications in patients with coronary artery disease. Insights into the cardioprotective effect of certain nutriments. J Am Coll Cardiol 1996;28:1103–8.

31. Osler M, Schroll M. Diet and mortality in a cohort of elderly people in a north European community. Int J Epidemiol 1997;26(1):155–9.

32. Kouris-Blazos A, Wahlqvist ML. The traditional Greek food pattern and overall survival of elderly people. Aust J Nutr Diet 1998;55(4 Suppl):20–3.

33. World Cancer Research Fund, American Institute for Cancer Research. Food, nutrition and the prevention of cancer: a global perspective. Washington. DC: American Institute for Cancer Research; 1997. p. 252–87.

34. Kushi LH, Lenart EB, Willett WC. Health implications of Mediterranean diets in light of contemporary knowledge. 1. Plant foods and dairy products. Am J Clin Nutr 1996;61 Suppl:1407–15.

35. Ferro-Luzzi A, Serafini M. Polyphenols in our diet: do they matter? [editorial] Nutrition 1995:11:399–400.

36. Wahlqvist M, Wattanapenpaiboon N, Kannar D, Dalais F, Kouris-Blazos A. Phytochemical deficiency disorders: inadequate intake of protective foods. Curr Ther 1998;July:53–60.

37. Clinton S. Lycopene: chemistry, biology and implications for human health and disease. Nutr Rev 1998:56:35–51.

38. Hertog MGL, Kromhout D, Aravanis C, Blackburn H, Buzina R, Fidanza F, et al. Flavonoid intake and long-term risk of coronary heart disease and cancer in the seven countries study. Arch Intern Med 1995;155:381–6.

39. Bonanome A, Pagnan A, Biffanti S, Opportuno A, Sorgato F, Dorella M, et al. Effect of dietary monounsaturated and polyunsaturated fatty acids on the susceptibility of low density lipoproteins to oxidative modification. Arterioscler Thromb 1992;12:529–33.

40. Peterson DB. Long-chain fatty acids and cardiovascular disease risk in non-insulin-dependent diabetes. Nutrition 1998;14:316–7.

41. Sinclair AJ. The good oil: omega 3 polyunsaturated fatty acids. Today's Life Sciences 1991;8:18–27.

42. Commonwealth Department of Community Services and Health. NUTTAB91. Nutrient data table for use in Australia (nutrient data on diskette). Canberra: Australian Government Publishing Service, 1991.

43. Mangels AR, Holden JM, Beecher GR, Forman MR, Lanza E. Carotenoid content of fruits and vegetables: an evaluation of analytic data. J Am Diet Assoc 1993;93:284–96.

44. Hertog MGL, Hollman PCH, Katan MB. Content of potentially anticarcinogenic flavonoids of 28 vegetables and 9 fruits commonly consumed in The Netherlands. J Agric Food Chem 1992;40:2379–83.

45. Mazur WM, Duke JA, Wahala K, Rasku S, Adlercreutz H. Isoflavonoids and lignans in legumes—nutritional and health aspects in humans. J Nutr Biochem 1998;9:193–200.

46. Duke JA. Handbook of medicinal herbs. Florida: CRC Press; 1989.

47. Barker DJ. Maternal nutrition and cardiovascular disease. Nutr Health 1993;9:99–106.

48. Walker K, O'Dea K, Johnson L, Sinclair A, Piers L, Nicholson GC, et al. Body fat distribution and non-insulin dependent diabetes: comparison of a fiber-rich, high-carbohydrate, low fat (23%) diet and a 35% fat diet high in monounsaturated fat. Am J Clin Nutr 1996;63:254–60.

49. Parker DR, Weiss ST, Troisi R, Cassano PA, Vokonas PS, Landsberg L. Relationship of dietary saturated fatty acids and body habits to serum insulin concentration: the normative ageing study. Am J Clin Nutr 1993;58:129–36.

50. Visioli F, Gallii C. The effect of minor constituents of olive oil on Cardiovascular disease: new findings. Nutr Rev 1998;56:142–7.

51. Colquhoun DM, Hicks BJ, Reed AW. Polyphenolic content of olive oil is reduced in extraction and refining. Asia Pac J Clin Nutr 1996;5:105–7.

52. Manna C, Galletti P, Cucciolla V, Moltedo O, Leone A, Zappia V. The protective effect of the olive oil polyphenol (3,4-dihydroxyphenyl)-ethanol counteracts reactive oxygen metabolite-induced cytotoxicity in Caco-2 cells. J Nutr 1997:127:286–92.

53. Shah M, Garg A. High-fat and high carbohydrate diets and energy balance. Diabetes Care 1996;19:1142–52.

54. Breithaupt-Grogler K, Ling M, Boudoulas H, Belz G. Protective effect of chronic garlic intake on elastic properties of aorta in the elderly. Circulation 1997;96:2649–55.

55. Trichopoulos D, Tzonou A, Christopoulos C, Havatzoglou S, Trichopoulou A. Does a siesta protect from coronary heart disease. Lancet 1987; August 1:269–70.

56. Piperoglou MV. The stress of change. The Greek migrant experience. Aust Fam Physician 1988:17;453–6.

57. Welin LG, Tibblin G, Svärdsudd K, Tibblin B, Ander-Peciva S, Larsson B, et al. Prospective study of social influences on mortality. Lancet 1985;1:915–8.