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Migrant Health

Evidence of divergence with duration of residence in circulatory disease mortality in migrants to Australia

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Background: Very little is known about how acculturation affects health in different societal settings. Using duration of residence, this study investigates acculturation and circulatory disease mortality among migrants in Australia. **Methods:** Data from death records, 1998–2002, and from 2001 Census data were extracted for seven migrant groups [New Zealand; United Kingdom (UK)/Ireland; Germany; Greece; Italy; China/Singapore/Malaysia/Vietnam (East Asia); and India/Sri Lanka (South Asia)] aged 45–64 years. Poisson regression models were fitted to estimate the duration of residence effect (categorized in 5-year bands and also as having arrived 2–16, 17–31 and 32 years ago or more), adjusted for sex, 5-year age group and year of death, then additionally for occupational class and marital status (SES) on relative risks (RR) of CVD mortality. **Results:** Compared with the Australia-born population, CVD mortality was generally lower in each migrant group. Decreasing mortality with increasing duration of residence was observed for migrants from New Zealand (RR 0.95, 95% Confidence Interval 0.92–0.98, $P < 0.01$, per 5-year increase), Greece (0.90, 0.86–0.94, $P < 0.01$), Italy (0.94, 0.91–0.97, $P < 0.01$) and South Asia (0.95, 0.91–0.99, $P < 0.01$), mainly in older age groups. Trends remained after SES adjustment and also when broader categories of duration of residence were used. CVD mortality among migrants from the UK/Ireland appeared to converge towards those of the Australian-born. **Conclusions:** These results show divergence in CVD mortality compared with the Australian rate for New Zealanders, Greeks, Italians and South Asians. Sustained cardio-protective behavioural practices in the Australian setting is a potential explanation.

Keywords: Australia, circulatory disease mortality, duration of residence, Migrants

Introduction

With over two centuries of migration, Australia provides an interesting context for migrant studies. Forced (penal) migration from Britain and the British Empire between 1788 and 1868 coincided with free immigrants arriving from the early 1790s. The 'White Australia Policy' introduced in the early 1900s was used to deter non-European migration after the influx of Chinese from the Gold rush era of the 1850s and of Pacific islanders who worked on the sugar plantations in Queensland. In the post-war period up to the late 1960s, this policy was gradually abandoned, but the emphasis remained on encouraging European immigration through the assisted passage schemes. During this period six million European migrants arrived in Australia. From the 1970s there has been a general broadening of immigration policies that ended the restrictions on non-European migrants but increased restrictions according to skill and humanitarian needs. In the 2001 Census nearly one in four Australians were born abroad, from about 200 countries.[1] The British/Irish, New Zealanders, Germans, Italians, Greeks and Asians make up the largest foreign-born groups.

The Australian censuses and death records contain information on year of arrival in Australia, providing a unique opportunity to examine the impact of duration of residence on mortality of migrants. Duration of residence is often used as a proxy measure of the extent of exposure of migrant populations to the habits of the host population over time. Acculturation of health-related norms, that is a change over time, and consequent health changes are expected.[2,3] Previous studies used cross sectional data from the 1961, 1966,[4,5] 1971,[5,6] 1981[7] and 1986[7] censuses and from death records[8] around those periods, mainly focussing on cancer mortality,[5–8] with the exception of one on circulatory disease mortality based around the 1966 census.[4] Most of these studies[4–6,8] only included migrants from European countries. A pattern of general convergence of mortality of migrants towards that of the Australian mortality rates, suggested adaptation of health habits towards those of the Australian-born population. Most of these studies focussed on all cause and cancer mortality. We are aware of only three studies that examined circulatory disease mortality and these were conducted more than a decade ago[4,9,10] and did not explore the potential confounding effect of socio-economic circumstances. This study uses the most recently available data on the large migrant groups to examine the relationship between duration of residence and CVD mortality, and whether occupational class and marital status modify the relationship.

Methods

The Australian Bureau of Statistics provided anonymized individual death records for the period 1998–2002 and tabulated data from the 2001 Census. The number of deaths and populations-at-risk were derived by country of birth, year of arrival, 5-year age categories, sex, occupational and marital status. These analyses are based on people aged 45–64 years since there were too few deaths under the age 45 years and data on occupations over the age of 65 years were incomplete. Seven country of birth groupings were selected on the basis of at least 25 deaths in each of the 10-year age categories for both

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sexes: (1) New Zealand; (2) United Kingdom; (UK)/Ireland; (3) Germany; (4) Greece; (5) Italy; (6) China/Singapore/Malaysia/Vietnam and (7) India/Sri Lanka. Migrants from India and Sri Lanka are referred to as South Asians, and those from China, Singapore, Malaysia and Vietnam as East Asians. The term 'Asian' in the text refers to both Asian groups. Population and deaths for those born in Australia were also extracted for overall comparison purposes.

Year of arrival in Australia was provided in categories from the Census to prevent potential disclosure of identity. Duration of residence was categorized in 5-year bands. Duration of residence was also considered in 2–16, 17–31 and 32 years and more groupings, providing a scheme with roughly equal durations. The former two categories were combined where number of deaths was low. Sub-analyses with these broader categories of duration of residence were necessary as there was evidence of departure from linearity of the relationship with mortality for some age groups. Deaths among migrants who had been in Australia for <2 years were excluded for two reasons. Whereas mortality of sick migrants seeking health care may lead to an upward bias, the healthy migrant effect associated with a lowering of death rates could be expected, given that migrant tend to healthier than those left behind.[2] Occupational classes were classified as manual, non-manual and non-classifiable (including unemployed, retired, independent means, missing or inadequately described occupations) based on the Australian Standard Classification of Occupations Second Edition.[11] Marital status was classified as married and not married (never married, divorced, separated or widowed). Deaths due to circulatory diseases (ICD10 I00-I99) and diabetes (ICD10 E10-E14) were identified.

Of a total of 21,587 circulatory disease and diabetes deaths in 45–64-year olds [17,080 (79%) among those born in Australia and 4507 (21%) among those from the seven countries of birth groupings], 20,751 (96%) [16,563 (97%) and 4188 (93%), respectively] could be classified by information at the census. Among migrants, duration of residence was known for 3815 (91%) of these deaths and the proportions of unknown duration of residence differed by country of birth ($P<0.01$), age ($P<0.01$), sex ($P<0.01$), occupational class ($P<0.01$) and marital status ($P<0.01$). Based on the counts of deaths among the population at risk, the census population, multivariable Poisson regression[12] was used to quantify the effect of duration of residence on relative risks (RR) for circulatory disease and diabetes mortality, adjusted for the confounding effects of sex, 5-year age group and year of death, and then additionally for occupational group and marital status. Interactions between duration of residence and confounders were examined, and stratified models were run if the number of deaths was reasonable. Increasing duration of residence can be positively correlated with age, so that older people have longer residence.[2] They are also more likely to die than younger people so that an increase in mortality with duration of residence could reflect the effect of ageing rather than duration of residence. We thus stratified the analyses by 10-year age groups to examine the impact of age on the RRs. All analyses were conducted using STATA (STATA Version 8.1; College Station, TX) statistical procedures on a Windows platform.

Results

Compared with mortality of the Australia-born population in 1998–2002, the risk of circulatory disease and diabetes mortality was generally lower, though not always statistically significantly so, among migrants (table 1). Germans aged 45–54 years were a notable exception, as circulatory disease and diabetes mortality was significantly higher by 21%. The largest deficit was observed for East Asians, consistently lower by ~60% in each age group.

There were distinct differences in the proportions in a manual occupation and proportions that were not married at the 2001 Census by duration of residence (table 2). With a few exceptions, migrants who had been resident for 32 years or more were less likely to be in a manual class and more likely to be unmarried than those who were resident for a shorter time. The exceptions were Germans, who were more likely to be in a manual class, and older Greeks and Italians, who were less likely to be unmarried with longer duration of residence. Compared with the Australia-born population, longer residing migrants were generally less likely to be in manual occupations. Regardless of length of residence, migrants were generally more likely to be married than those Australian-born.

Table 3 shows the effect of 5-year increases in duration of residence in Australia on circulatory disease and diabetes mortality, partially adjusted for age and sex, and further adjusted for occupational class and marital status. For New Zealand, Greek, Italian and South Asian migrants, the age, sex and year of death adjusted RRs for all ages combined (45–64 years) showed an inverse relationship, with decreasing mortality with increasing duration of residence. Further adjustment for occupational class and marital status generally strengthened this trend. The divergence was consistent across both age groups for New Zealanders but only for the older age groups for Greeks, Italians and South Asians. Although not significant at the 5% level, it is noteworthy that the all age RRs for UK/Irish migrants suggested that mortality increased with increasing duration of residence.

Table 4 shows RRs adjusted for all confounders, by broad categories of duration of residence. The trends are consistent with those shown in table 3. Longer residence was associated with lower mortality among the New Zealand, Greek, Italian and South Asian groups, and with higher mortality among the UK/Irish migrants (now significant for the latter group). It was difficult to examine the impact of age in these sub-analyses due to small number of deaths in some of the cells of the younger age groups but the trends in the older group (55–64 years) were consistent with those seen in table 3.

Table 1 Relative risk (RR) of circulatory disease and diabetes mortality among migrants, 1998–2002, relative to Australian-born individuals by age adjusted for age and sex

Country	Age (years)	Population at risk	Deaths	RR (95% CI)
Australia	45–54	8,290,205	5514	1.00
	55–64	5,393,060	11,049	1.00
	All	13,683,265	16,563	1.00
New Zealand	45–54	296,675	155	0.79 (0.68–0.93)
	55–64	146,475	218	0.74 (0.65–0.85)
	All	443,150	373	0.76 (0.69–0.85)
UK and Ireland	45–54	1,090,520	525	0.70 (0.64–0.76)
	55–64	971,955	1420	0.71 (0.67–0.75)
	All	2,062,475	1945	0.70 (0.67–0.74)
Germany	45–54	135,310	122	1.21 (1.01–1.45)
	55–64	125,015	196	0.77 (0.66–0.88)
	All	260,325	318	0.89 (0.79–0.99)
Greece	45–54	112,530	67	0.84 (0.66–1.08)
	55–64	173,445	262	0.70 (0.62–0.79)
	All	285,975	329	0.73 (0.65–0.81)
Italy	45–54	214,015	110	0.72 (0.59–0.87)
	55–64	250,250	377	0.69 (0.62–0.76)
	All	464,265	487	0.69 (0.63–0.76)
East Asia	45–54	351,095	83	0.37 (0.30–0.46)
	55–64	154,625	130	0.41 (0.34–0.48)
	All	505,720	213	0.39 (0.34–0.45)
South Asia	45–54	129,865	35	0.41 (0.29–0.57)
	55–64	79,540	115	0.72 (0.60–0.87)
	All	209,405	150	0.61 (0.52–0.72)

Note: RR, relative risk; 95% CI, 95% confidence interval

Table 2 Distribution of socio-economic circumstances by duration of residence in Australia

Country	Age (years)	Manual occupation Duration of residence (years)		Not married Duration of residence (years)	
		<32	≥32	<32	≥32
New Zealand	45–54	25.9	19.8*	37.5	38.6*
	55–64	19.7	14.5*	34.2	34.6
	All	24.3	16.6*	36.6	36.2*
UK and Ireland	45–54	19.2	18.4*	25.8	32.0*
	55–64	15.4	13.1*	23.1	27.6*
	All	17.7	15.6*	24.7	29.7*
Germany	45–54	18.6	20.1*	32.8	33.6*
	55–64	14.3	17.4*	29.3	31.9*
	All	16.7	18.8*	31.3	32.8*
Greece	45–54	34.7	24.5*	16.2	18.7*
	55–64	20.1	17.3*	18.2	14.9*
	All	30.3	19.7*	16.8	16.1*
Italy	45–54	34.6	25.6*	16.5	18.9*
	55–64	20.7	20.3*	22.1	16.6*
	All	29.2	22.6*	18.7	17.6*
East Asia	45–54	23.8	11.9*	20.8	27.2*
	55–64	10.6	8.7*	20.2	24.4*
	All	20.1	10.2*	20.6	25.7*
South Asia	45–54	16.4	12.5*	13.8	29.0*
	55–64	10.2	9.4*	19.8	27.8*
	All	14.4	10.7*	15.8	28.3*

*Significantly different from proportion for <32 years at the 5% level. Corresponding figures for Australia—manual: 24.9, 21.9 and 22.8%; not married: 41.1, 33.6 and 39.7%; for 45–54, 55–64 years and all ages, respectively

Table 3 Effect of 5-year increase in duration of residence on circulatory disease and diabetes mortality, 1998–2002, by country of birth and age

	Age (years)	RR[a]	95% CI	RR[b]	95% CI
New Zealand	45–54	0.86	0.79–0.93‡	0.86	0.79–0.93‡
	55–64	0.92	0.87–0.97‡	0.92	0.87–0.97‡
	All	0.95	0.92–0.98‡	0.90	0.86–0.94‡
UK and Ireland	45–54	1.03	0.99–1.06	1.02	0.98–1.06
	55–64	1.00	0.97–1.02	1.00	0.97–1.02
	All	1.01	1.00–1.02	1.00	0.98–1.03
Germany	45–54	1.05	0.97–1.14	1.05	0.96–1.14
	55–64	0.99	0.92–1.06	0.99	0.92–1.06
	All	1.03	0.99–1.07	1.01	0.96–1.06
Greece	45–54	0.92	0.79–1.07	0.88	0.76–1.03
	55–64	0.90	0.81–1.00	0.85	0.77–0.93‡
	All	0.90	0.86–0.94‡	0.85	0.79–0.93‡
Italy	45–54	0.94	0.85–1.05	0.95	0.85–1.06
	55–64	0.95	0.89–1.02	0.91	0.85–0.98†
	All	0.94	0.91–0.97‡	0.91	0.86–0.97‡
East Asia	45–54	0.99	0.88–1.12	0.99	0.87–1.11
	55–64	1.06	0.99–1.12	1.01	0.95–1.08
	All	1.01	0.98–1.04	1.01	0.96–1.07
South Asia	45–54	0.98	0.85–1.15	0.96	0.82–1.12
	55–64	0.92	0.85–0.99†	0.90	0.83–0.97‡
	All	0.95	0.91–0.99‡	0.92	0.86–0.98†

Note: RR, relative risk; 95% CI, 95% confidence interval
Significance levels: †$0.01 \leq P < 0.05$; ‡$P < 0.01$
a: Relative-risk adjusting for 5-year age group, sex and year of death
b: Further adjustment by occupation group and marital status

Significant interactions between gender and duration of residence were observed for South Asians. Males aged 45–54 years had non-significant decreasing mortality (RR 0.85, 95% Confidence Interval 0.70 to 1.02, $P = 0.09$) with increasing duration of residence while females had significant increasing mortality (RR = 1.36, 1.02 to 1.82, $P = 0.04$). This could explain the non-significance of the results for 45–54-year old South Asians in table 3.

Table 4 Effect of duration of residence in broad categories on circulatory disease and diabetes mortality, 1998–2002, by country of birth adjusted for age, sex and year of death, occupation group and marital status.

Country	Age (years)	Period of residence (v. baseline)	RR	95% CI
New Zealand	45–54[a]	17–31 y (v. <17 y)	0.86	0.61–1.20
	55–64	17–31 y (v. <17 y)	1.13	0.83–1.54
		≥32 y (v. <17 y)	0.58	0.40–0.84‡
	All	17–31 y (v. <17 y)	0.99	0.79–1.25
		≥32 y v. (v. <17 y)	0.51	0.37–0.71‡
UK and Ireland	45–54	17–31 y (v. <17 y)	1.20	0.88–1.64
		≥32 y (v. <17 y)	1.27	0.94–1.71
	55–64	17–31 y (v. <17 y)	1.44	1.10–1.89‡
		≥32 y (v. <17 y)	1.29	0.99–1.68
	All	17–31 y (v. <17 y)	1.34	1.10–1.64‡
		≥32 y (v. <17 y)	1.28	1.05–1.55†
Germany[c]	55–64[b]	≥32 y (v. <32)	1.06	0.73–1.56
	All[b]	≥32 y (v. <32)	1.26	0.93–1.72
Greece[c]	55–64[b]	≥32 y (v. <32)	0.52	0.38–0.73‡
	All[b]	≥32 y (v. <32)	0.53	0.40–0.71‡
Italy[c]	55–64[b]	≥32 y (v. <32)	0.63	0.46–0.87‡
	All[b]	≥32 y (v. <32)	0.65	0.50–0.86‡
East Asia	45–54[a]	17–31 y (v. <17 y)	1.52	0.95–2.42
	55–64	17–31 y (v. <17 y)	0.94	0.62–1.42
		≥32 y v. (v. <17 y)	1.20	0.77–1.88
	All	17–31 y (v. <17 y)	1.17	0.86–1.59
		≥32 y v. (v. <17 y)	1.36	0.93–1.99
South Asia[c]	55–64	17–31 y (v. <17 y)	0.84	0.54–1.31
		≥32 y v. (v. <17 y)	0.53	0.31–0.89†
	All	17–31 y (v. <17 y)	0.87	0.59–1.27
		≥32 y v. (v. <17 y)	0.61	0.38–0.96†

Note: RR, relative risk; 95% CI, 95% confidence interval
Significance levels: †$0.01 \leq P < 0.05$; ‡$P < 0.01$
a: Numbers of deaths in 32 and over category were below 25, hence omitted
b: Numbers of deaths for 2–16 years categories were below 25, hence 2–31 years used as baseline category
c: Numbers of deaths for 2–31 years categories were below 25 for 45–54-year old group hence omitted

Discussion

There are two important points to bear in mind in interpreting these findings—first, Australia has evolved through migration and migrants make up ~25% of the population, and secondly, it has relatively low circulatory disease mortality compared with other developed countries.[13,14]

Health advantages among migrant populations have been frequently observed, and attributed to selective migration (migrants being relatively healthier with better socio-economic circumstances than those left behind in home countries) or to origin cultures that foster positive health practices. Over time, a shift in disease patterns towards that of the host country is expected, based on the supposition that migrants adopt the lifestyles and health-related behaviours of the host population.[3] There is, however, increasing evidence challenging this convergence hypothesis.[15–17] In Australia, where large critical masses of specific migrant populations occur, cultural traditions may thrive more easily than in countries such as the UK, where migrants make up a relatively small proportion of the total population. Ethnic clusters in Australian cities such as the Southern Europeans in Sydney and Melbourne, are well known[18] and it is plausible that this may also encourage the continuity of cultural habits, such as adherence to traditional Mediterranean dietary patterns,[19] which are known to be associated with protection from circulatory disease.[20] In addition, family centred migration, which Australia actively promoted, could be expected to reduce the disruption of lifestyles and foster the retention of health promoting behaviours. The stronger effects among older age cohorts are in line with findings from a previous study, which

suggested that Greek migrants in Australia tend to return to traditional diets with advancing years.[21] Paradoxically, residents of Greek origin experience low levels of circulatory disease but elevated levels of obesity, hypertension and hyperlipidaemia.[21] To some extent this parallels observations in African-origin populations in the UK.[22,23] The prevalence of conventional risk factors, such as obesity and hypertension, in these groups is high, but LDL cholesterol levels, and CHD mortality rates are relatively low, with (in contrast to results reported here) duration of residence having little effect.[24,25]

Our findings are not consistent with all previous findings.[4,10] Stenhouse and McCall (1970)[4] found that circulatory disease mortality among Italian migrants aged 40–79 years, during the period 1961–1966, generally increased with increasing residence. The inconsistency could be influenced by trends in the different waves of migration. Italian migration peaked in the 1930s and was almost minimal by the 1960s, when stricter immigration controls were implemented. If healthier cohorts arrived during the dramatic decline in migration in the 1960s, then positive selection could have contributed to the results observed by Stenhouse and McCall.[4] Relative to Australia-born, Italians appear to have low levels of LDL cholesterol, but high levels of physical inactivity and smoking (men), complicating the interpretation of their relatively low circulatory disease mortality.[2]

We are not aware of any previous studies that focussed on circulatory disease mortality among South Asians in relation to duration of residence in Australia; they were aggregated with other Asian groups in previous mortality studies.[7,9,10] In our findings for South Asians, circulatory disease mortality was lower relative to the Australia-born rates and declined with increasing duration of residence. These findings are in stark contrast to those reported in the UK. Circulatory disease mortality rates, mainly attributable to CHD, among South Asians in the UK are high compared with national rates[26–28] and appear to increase with increasing duration of residence in the UK.[29] The cause of excess of CHD among South Asians in the UK remains a mystery, though it has been linked to higher prevalence of metabolic syndrome and physical inactivity. The ethnic variation in adaptation of circulatory disease risk in the different countries highlights the complexity of the aetiology of the disease even in an era where so much is known about the multiplicity of risk factors. While the UK environment appears to adversely influence circulatory disease risk among South Asians,[29] the Australian environment appears to support a cardio-protective life style for these migrants. Alternatively, these results could reflect temporal changes in exposures in the Indian subcontinent where circulatory disease has been increasing[30,31] as in other developing countries.[32] Migrants who arrived before the 1970s could have been exposed to a lower circulatory disease risk in India than those who arrived later.

The convergence of circulatory disease[4,10] and cancer[5,6,33] mortality of British/Irish migrants towards the Australia-born rates has been reported before. The aggregation of this group could have masked differences between Scottish, Irish, English and Welsh migrants as circulatory disease risk factor prevalence[9] and cancer mortality[5] vary. Levels of smoking, for example, are higher among Scottish and Irish migrants but not among English migrants relative to those born in Australia. Among developed countries, both the UK and Ireland are among the top five countries with the highest circulatory disease mortality rates, whereas Australia is among the lowest two.[14] If circulatory disease mortality in Australia continues to fall[14] and that of UK/Irish migrants continue to shift towards that of the national rate with increasing duration of residence, then one could expect a crossover in the mortality rates in the future.

There are important limitations to this study. Selection (on the basis of more favourable socio-economic position or on the basis of good health) and ageing of the cohort (older people have longer duration of residence) are the main problematic issues in this area of research. Longer-term residents were more likely to be more economically advantaged than shorter-term residents, which could have contributed to the decline of mortality among New Zealanders, Italians, Greeks and South Asians. We adjusted for occupational class but this measure may not adequately reflect socio-economic circumstances among recent arrivals given the disruption to labour market chances on migration.[34] A younger age at migration may be associated with quicker behavioural adaptation and a different patterning of circulatory disease risk for the same duration of residence. We could not investigate the interaction between age at migration and duration of residence, as age at migration could not be accurately derived from the publicly available data. This analysis was based on mortality data and it is plausible that the findings reflect differences in survival by duration of residence rather than prevalence of circulatory disease and diabetes or risk factors. For example, if longer established Greeks, Italians, South Asians and New Zealanders had better access to quality health care than recent arrivals, the decline could be expected.

In summary, whereas circulatory disease and diabetes mortality of UK/Irish migrants converged towards that of the Australian-born population with increasing duration of residence, mortality of New Zealanders, Greeks, Italians and South Asians diverged. As with any analyses of cross-sectional data, we cannot rule out a potential cohort effect contributing to the divergence. An alternative explanation, however, particularly for the oldest age group, is sustained cardio-protective behaviours despite longstanding migration. For policy and aetiological reasons, it would be useful for future research to investigate if and how the cardio-protection among migrant communities diffuses to the general population and contributes to Australia's international advantage of low circulatory disease and diabetes rates.

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Key points

- In contrast to the conventional wisdom of convergence, in Australia some groups, such as older migrants from Mediterranean countries and New Zealand experience divergence, with increasing length of residence associated with lower circulatory disease and diabetes mortality.
- Surprisingly, this is also the case for South Asians, which contrasts with findings for South Asians in the United Kingdom.
- This study suggests that the Australian environment may be protective of circulatory disease and diabetes risk of these migrant groups, and that there may be a synergistic effect on the host population from the cardio-protective lifestyles of some cultures.
- Future research could investigate if and how the cardio-protection among migrant communities diffuses to the general population and contributes to Australia's international advantage of low circulatory disease and diabetes.

References

1 2001 Census Basic Community Profiles and Snapshots. Australian Bureau of Statistics..

2 Harding S, Balarajan R. Mortality data on migrant groups living in England and Wales: issues of adequacy and of interpretation of death rates. In: Haskey J, editor. *Population projections by ethnic group: a feasibility study*. London: The Stationary Office, 2002:115–27.

3 Haenszel W, Kurihara M. Studies of Japanese migrants. I. Mortality from cancer and other diseases among Japanese in the United States. *J Natl Cancer Inst* 1968;40(1):43–68.

4 Stenhouse NS, McCall MG. Differenital mortality from cardiovascular disease in migrants from England and Wales, Scotland and Italy, and native-born Australians. *J Chronic Dis* 1970;23(5):423–31.

5 McMichael AJ, McCall MG, Hartshorne JM, Woodings TL. Patterns of gastro-intestinal cancer in European migrants to Australia: the role of dietary change. *Int J Cancer* 1980;25(4):431–7.

6 McMichael AJ, Bonett A. Cancer profiles of British and southern-European Migrants. Exploring South Australia's cancer registry data. *Med J Aust* 1981;1(5):229–32.

7 Giles GG. *Cancer mortality in migrants to Australia 1979-1988*. Canberra: Australian Institute of Health and Welfare, 1995.

8 McCredie M, Williams S, Coates M. Cancer mortality in migrants from the British Isles and continental Europe to New South Wales, Australia, 1975–1995. *Int J Cancer* 1999;83(2):179–85.

9 Bennett S. Inequalities in risk factors and cardiovascular mortality among Australia's immigrants. *Aust J Public Health* 1993;17(3):251–61.

10 Young CM. Causes of death by birthplace age and period of residence. *In: Selection and survival: immigrant mortality in Australia*. Canberra: Australian Government Publishing Service, 1986.

11 Australian Standard Classification of Occupations, Second Edition. Canberra: Australian Bureau of Statistics, 1997.

12 Coleman JS. *Introduction to mathematical sociology*. New York: Free Press, 1964.

13 Mortality database. In http://www3.who.int/whosis/mort/table1.cfm?path=whosis,mort,mort_table1&language=english%20ed: World Health Organization; 2001, last accessed 10/11/2006.

14 Reutens R, Garden AA, Somerford P, Codde JP. National and international comparisons of selected health measures for Western Australians: Health Information Centre, Department of Health, Western Australia 2004.

15 Harding S, Balarajan R. Mortality of third generation Irish people living in England and Wales: longitudinal study. *BrMedJ* 2001;322(7284):466–7.

16 Harding S, Balarajan R. Patterns of mortality in second generation Irish living in England and Wales: longitudinal study. *BrMedJ* 1996;312(7043):1389–92.

17 Collins JWJ, Wu SY, David RJ. Differing intergenerational birth weights among the descendants of US-born and foreign-born Whites and African Americans in Illinois. *Am J Epidemiol* 2002;155(3):210–6.

18 Grimes S. Residential segregation in Australian cities - a literature-review. *Int Migration Rev* 1993;27(1):103–20.

19 Kouris-Blazos A, Gnardellis C, Wahlqvist M, et al. Are the advantages of the Mediterranean diet transferable to other populations? A cohort study in Melbourne, Australia. *Br J Nutr* 1999;82(1):57–61.

20 Schroder H, Marrugat J, Vila J, et al. Adherence to the traditional Mediterranean diet is inversely associated with body mass index and obesity in a Spanish population. *J Nutr* 2004;134(12):3355–61.

21 Kouris-Blazos A, Wahlqvist ML, Wattanapenpaiboon N. 'Morbidity mortality paradox' of Greek-born Australians: possible dietary contributors. *Aust J Nutr Diet* 1999;56(2):97–107.

22 Cruickshank JK, Mbanya JC, Wilks R, et al. Hypertension in four African-origin populations: current 'Rule of Halves', quality of blood pressure control and attributable risk of cardiovascular disease. *J Hypertens* 2001;19(1):41–6.

23 Whitty CJ, Brunner EJ, Shipley MJ, et al. Differences in biological risk factors for cardiovascular disease between three ethnic groups in the Whitehall II study. *Atherosclerosis* 1999;142(2):279–86.

24 Harding S. Mortality of migrants from the Caribbean to England and Wales: effect of duration of residence. *Int J Epidemiol* 2004;33(2):382–6.

25 Abbotts J, Harding S, Cruickshank K. Cardiovascular risk profiles in UK-born Caribbeans and Irish living in England and Wales. *Atherosclerosis* 2004;175(2):295–303.

26 Harding S. Examining the contributon of social class to high cardiovascular mortality among Indian, Pakistani and Bangladeshi male migrants living in England and Wales. *Health Stat Q* 2000;5:26–8.

27 Balarajan R, Bulusu L, Adelstein AM, Shukla V. Patterns of mortality among migrants to England and Wales from the Indian subcontinent. *Br Med J* 1984;289(6453):1185–7.

28 Wild S, Mckeigue P. Cross sectional analysis of mortality by country of birth in england and wales, 1970-92. *Br Med J* 1997;314:705.

29 Harding S. Mortality of migrants from the Indian subcontinent to England and Wales: effect of duration of residence. *Epidemiology* 2003;14(3):287–92.

30 Rastogi T, Vaz M, Spiegelman D, et al. Physical activity and risk of coronary heart disease in India. *Int J Epidemiol* 2004;33:759–67.

31 Wannamethee SG. Commentary: prevention of coronary heart disease in South Asia—containing the physical inactivity epidemic. *Int J Epidemiol* 2004;33:767–8.

32 Reddy KS, Yusuf S. Emerging epidemic of cardiovascular disease in developing countries. *Circulation* 1998;97(6):596–601.

33 McMichael AJ, Bonett A, Roder D. Cancer incidence among migrant populations in South Australia. *Med J Aust* 1989;150(8):417–20.

34 Heath R. Social mobility of ethnic minorities. *J Biosoc Sci* 1983;S8:169–84.

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