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Health Assimilation Patterns Amongst Australian Immigrants*

NICHOLAS BIDDLE
Australian Bureau of Statistics and Centre for Aboriginal Economic Policy Research, Australian National University, Canberra, ACT, Australia

STEVEN KENNEDY
Australian Treasury and Economics Department, Research School of Social Sciences, Australian National University, Canberra, ACT, Australia

JAMES TED MCDONALD
Department of Economics, University of New Brunswick, Fredericton, New Brunswick, Canada

This paper compares the health of Australian immigrants with that of the Australian-born population and examines the extent to which differences vary with time since migration. Health is measured using self-reports of chronic diseases from three national health surveys. Probit models are used to estimate the health effects of immigrant arrival cohorts, years since migration and country of birth. We find that the health of Australian immigrants is better than the Australian-born population, but the longer immigrants spend in Australia, the closer their health approximates that of the Australian-born population. There are variations for different immigrant groups and for particular chronic diseases.

I Introduction

Immigrants make up 23 per cent of the total Australian population according to the 2001 census, and about 27 per cent of the population of working age (25–64 years). Understanding the determinants of health in this population of Australians is important for many reasons including promoting the overall health and welfare of the population, understanding the economic consequences of poor health among population subgroups, and obtaining insights into how exposure to the Australian social, cultural and physical environment might be associated with health.

This paper focuses on how Australian immigrants' health changes with the number of years since migration. By comparing the health of immigrants who have been in Australia for different periods of time with the health of the Australian-born, we can examine whether immigrant health upon arrival in Australia is different from Australian-born health, and if such a difference exists, whether the effect persists. Health is measured in this paper using self-reports of chronic disease. Chronic disease is a well-known measure of health that focuses on physical impairment.

We find that immigrants from some countries, particularly immigrants from non-English-speaking countries, do have a lower incidence of chronic disease upon arrival than the Australian-born population, but the gap tends to narrow with time in Australia. That is, there is a process of assimilation

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Correspondence: Nicholas Biddle, Centre for Aboriginal Economic Policy Research, Australian National University, Canberra, ACT 0200, Australia. Email: nicholas.biddle@anu.edu.au

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in the health of immigrants to Australia. However, for most immigrant groups the incidence of chronic disease still does not attain the incidence in the Australian-born population. In addition, there are significant variations in the assimilation profiles of particular chronic diseases such as heart disease, asthma and diabetes.

This pattern in the health profiles of immigrants (where it is commonly observed that immigrants to a country are healthier than the native-born population) is typically referred to as the 'healthy immigrant effect'. This effect has been well documented for immigrants in the USA and Canada (see, for example, Chen *et al*., 1996a,b; Strong *et al*., 1998; Perez, 2002; Jasso *et al*., 2004; McDonald and Kennedy, 2004; Antecol and Bedard, 2005).[1] Perez (2002) and McDonald and Kennedy (2004) found that there are health assimilation patterns in Canadian immigrants, with the incidence of chronic disease being lower for immigrants upon arrival, but that for most immigrant groups the incidence of chronic disease approaches native-born levels with the length of time in Canada. Jasso *et al*. (2004) found that for immigrants to the USA, the incidence of chronic disease is lower for immigrants who have recently arrived and, while the health differentials fall, the incidence remains consistently below the levels of the native-born. While not all studies find unambiguous evidence of healthy immigrant effects (see, for example, Laroche, 2000, for Canada) in the main, the existence of a healthy immigrant effect is now well accepted in the literature.

In Australia, the nature of any healthy immigrant effect is less well understood. Differences in morbidity between the Australian-born population and immigrants have been found using hospital separations (Kliewer and Butler, 1995) and survey data (Young and Coles, 1992), as well as in mortality statistics (Strong *et al*., 1998; Australian Institute of Health and Welfare, 2002). The present study differs from these studies in that we not only document the health differential between the Australian- and overseas-born populations, but also show how this changes with time in Australia (health assimilation).

One source of the healthy immigrant effect is thought to be immigrant selection processes, which may in part reflect the health requirements of countries' immigration policies.[2] However, selection effects might also reflect the particular observed and unobserved characteristics of people who apply to migrate. For example, it may only be the healthier members of a country that are willing to apply to migrate and are able to migrate.

Another explanation for the healthy immigrant effect is disease under-reporting by immigrants. Jasso *et al*. (2004) illustrate this explanation in their US study when they note that there are no differences between immigrants and the native-born in self-assessed health status, but that there are differences for specific chronic diseases. In contrast, McDonald and Kennedy (2004) found that under-reporting does not appear to be a major factor in explaining immigrant and native-born differences in health.

Many studies of the health profiles of immigrants after arrival in their new country refer to the notion of acculturation as an important driver of changes in health.[3] Essentially, this means that exposure of immigrants to a new culture and adoption of some of the new culture's health habits leads to immigrant health steadily approximating native-born health with time in the new country. Thus, acculturation appears to be shorthand for a range of issues including diet, physical environment, stress, and health behaviours such as exercise.[4]

Studies of subgroups of immigrants to the USA have found evidence that the health of immigrant

[1] The Australian Institute of Health and Welfare (2002) found that 'generally overseas-born persons experience an all-case death rate 10–15 per cent lower than for Australian-born persons'. This healthy migrant effect does not necessarily apply to all categories of immigrants in particular; humanitarian immigrants may have worse health than other immigrants and the native-born population.

[2] In Australia, health requirements must be satisfied for all immigrants except for some close family members or for humanitarian applicants where the Department of Immigration and Multicultural and Indigenous Affairs may waive the requirements when the person does not represent a risk to public health.

[3] See Salant and Lauderdale (2003) for a recent review of acculturation and health in Asian immigrant populations.

[4] There are many methodological difficulties in identifying the extent to which the health profile of immigrants after arrival represents the effects on health of these new country influences or whether the health profile of immigrants merely represents the health profile of healthy persons from the country of origin. To answer this question we need to consider the health of people in the immigrants' country of birth as well as that of immigrants and the native-born. These issues are the subject of ongoing work by the authors.

subgroups approximates the health of the native-born as the degree of integration into the new country's culture increases. Perhaps the most influential of these studies is Marmot and Syme's (1976) study of heart disease in Japanese immigrants to Hawaii and California. These authors examined differences in the prevalence of chronic heart disease (CHD) for men living in Japan and Japanese men who had migrated to Hawaii and California. They found that the prevalence of CHD was highest in Californian Japanese male immigrants followed by those in Hawaii and Japan. Their analysis suggested that Japanese male immigrants who retained more of their traditional cultural practices had better health outcomes in terms of CHD compared with those that retained less.

In this paper, we do not directly address the methodological questions related to the causation of differences in health among immigrants and the native-born. Instead, we focus on carefully describing the health profiles of immigrants to Australia, and how these profiles vary by region of origin and year of arrival. In describing immigrant health profiles, we allow for differences across immigrants from different countries of birth and across arrival cohorts.[5] By allowing for differences across countries of birth, we capture health differentials that might be specific to countries. Differences across arrival cohorts allow us to control for, at least in part, differences in the composition of visa categories over time and other cohort-specific characteristics. Controlling for visa composition is an important issue as skilled, unskilled and humanitarian migrants are likely to exhibit different health profiles. In addition, over time the proportions of immigrants from different visa categories have changed.

II Data

The data underlying this study come from three national health surveys conducted by the Australian Bureau of Statistics (ABS) in 1989/90, 1995 and 2001. Each survey was run over a 12-month period. After excluding those who did not reply to key questions on the three surveys, there was a combined sample of 66 641 persons aged 20–64 years. Of the sample, 18 328 persons (or 27.5 per cent) were immigrants to Australia. For a discussion of the comparability of data from the 1995 and 2001 national health surveys, see ABS (2003).

(i) Chronic Disease

We follow Walker and Abello's (2000) application of the ABS definition of long-term diseases in defining chronic disease.[6] However, some conditions, which are thought of as long-term conditions, seem less relevant to our discussion of differences in chronic disease in immigrant and native-born populations and we did vary somewhat from how previous researchers have defined chronic conditions. The definition of chronic disease we use, and a correspondence of the coding of diseases across various health surveys, is available in Biddle *et al*. (2003) or from the authors on request.[7]

Some of the issues that can arise in the self-reporting of health are discussed in ABS (2003). In the context of measures of health such as self-assessed health status, most studies find that while there can be considerable error in reporting health it remains a good predictor of morbidity and mortality (see Crossley and Kennedy, 2002, for further discussion). Reports of chronic disease, while a more direct measure of morbidity than self-assessed health status, are likely to suffer from similar issues to self-assessed health status in that there is likely to be error in responses and there is the potential for this error to be non-random.

In addition to models that utilise a composite measure of chronic health, we also present models of immigrant health assimilation profiles for three specific chronic diseases: heart disease, asthma

[5] Jasso *et al*. (2004) pointed out that in identifying the effect of a new culture or environment, immigrant health might be best compared to the health of people in the immigrant's country of origin. Although the comparison suggested by Jasso *et al*. (2004) would obviously be of great interest, the comparisons we use in this paper still shed light on the immigrant experience.

[6] We also considered analysing differences in responses to a self-assessed health status question as well as differences in chronic disease. However, there were difficulties in comparing responses to self assessed health status questions across health surveys as the question changed. Despite these issues, we undertook a preliminary analysis of self-assessed health status differences and found that the results varied from those presented in this paper for chronic disease in a way that was consistent with literature from other countries. We plan to examine these issues more closely in future papers.

[7] To establish whether results were robust to our definition of chronic disease, we undertook the analysis presented in this paper using Walker and Abello's (2000) definition of serious long-term conditions. The results from these sensitivity tests are virtually identical to those presented in the paper.

and diabetes.[8] We focus on these diseases for three reasons. First, they are 'chronic diseases of significant health burden', as identified in Australia's National Health Priority Areas. Second, these are diseases likely to be influenced by environmental and dietary factors. Lastly, these are diseases often examined in the immigrant population because of their unique health patterns (as explained in the Results section). Examining specific diseases also allows us to explore how heterogenous health outcomes are within our composite measure of chronic disease.

(ii) Cohort Variables, Country of Birth and Years since Migration

We follow the immigrant earnings literature and adopt a cohort and years since migration specification to capture immigrant health profiles. For immigrants to Australia we define four arrival cohorts: those who arrived prior to 1971, those who arrived between 1971 and 1980 inclusive, those who arrived between 1981 and 1990 inclusive, and those who arrived after 1990.[9] We also include a years-since-migration variable, which is measured in single years, and its square.

We use three categories of country of birth for immigrants: English-speaking countries including Canada, Ireland, New Zealand, the UK, and the USA; other parts of Europe including non-English-speaking European countries; and other overseas born including all other countries (primarily the Middle East and Asia). Country of birth is defined at this broad level to ensure that we have appropriate sample sizes in various cells in the cohort analysis.

In addition to controlling for the set of immigrant characteristics described above, we also included a variable that indicated if the immigrant arrived in Australia before the age of 14 years. This simple specification can be interpreted as allowing immigrants who arrived as children to have different health profiles from those that arrived as adults.

(iii) Socioeconomic Variables

We use a number of variables to control for differences in health associated with the socioeconomic characteristics of immigrants to Australia and the Australian-born population with the definitions and correspondence of variables across surveys presented in Appendix I. Age and gender are two important determinants of health. We control for age through a very flexible specification of age effects discussed in Section III. We control for gender by estimating models separately for males and females.

Ideally, we would have also included in our models a measure of educational attainment. However, information on educational attainment was only collected from half of the sample in the 1995 Health Survey.[10] To capture some of the possible differences in human capital or education, we augmented our labour force status variable and divided the employed category into those in professional or managerial occupations and those in other occupations.

We include labour force status and household income quintiles to capture socioeconomic characteristics that may affect health. In a number of studies, labour force status has been shown to be related to health, as has income, although there are difficulties in identifying a causal relationship with health for both variables.[11] We also include a dummy variable for whether the person was an Indigenous Australian. In Australia, Indigenous status has been shown in a number of studies to be closely related to poor health outcomes (see, for example, Gray *et al*., 2002).

The Australian State in which people live is included as a set of dummy variables to control for a combination of factors including state-specific policies that might affect the health of immigrants and others. Given that state variables reflect a number of factors, their association with immigrant health is difficult to interpret. However, their inclusion should

[8] Diabetes refers to both type 1 and type 2 diabetes. Although the profiles of the two diseases are likely to vary, it was not possible to distinguish between the two in the 1989 health survey.

[9] Sample size considerations do not allow us to define arrival cohorts at a finer level; for example, 5-year cohorts.

[10] To check the robustness of our results to the inclusion of education variables, we estimated our models using a reduced sample where education was recorded. We found that the results and overall conclusions using this sample did not vary from those from the complete dataset.

[11] For a discussion of the relationship between income and health, see Ettner (1996). It is extremely difficult to find a suitable set of instruments through which to capture the effects of labour force status and income on health while circumventing endogeneity concerns. This tends to be the case because of the difficulty in finding variables that are correlated with the variables of interest but that do not directly affect health. We ran models with and without the employment variables. There were no qualitative differences in conclusions across the two specifications (results available from the authors on request).

allow for other influences to be more accurately estimated than if state variables were excluded.[12]

The year of the survey is included as an explanatory variable to capture possible survey effects; for example, differences in the survey instruments leading to different responses and genuine through-time effects in the reporting of chronic diseases. These could possibly reflect increased awareness of particular diseases or an increased incidence of the disease.

III Econometric Methods

To motivate our analysis, we first estimate a simple probit model where a latent (poor) health variable is expressed against socioeconomic and demographic characteristics, country of birth and years since migration variables. That is,

$$h_i^* = Z_i\delta + \alpha_1 age_i + \alpha_2 age_i^2 + \sum_{j=1}^{j-1}\gamma_{1j}A_{ij}age_i + \sum_{j=1}^{j-1}\gamma_{2j}A_{ij}age_i^2 + \phi AoA_i + \sum_{k=1}^{k}\beta_{2k}CB_{ik} + \beta_4 YSM_i + \beta_5 YSM_i^2 \quad (1)$$

In Equation 1, we do not observe h_i^*. Instead we observe h_i, which indicates the presence of chronic disease. The probability of having a chronic disease is assumed to be a function of Z_i, which is a vector of socioeconomic characteristics including labour force status, State, equivalised household income quintile, gender, survey year, and Indigenous status; A_{ij}, 10-year age dummy variables; *AOA*, which is whether the immigrant arrived in Australia before age of 14 years; CB_k, country of birth dummy variables; and *YSM* representing years since migration. Estimation is through a probit model that has a zero–one dependent variable where in this case one represents the self-report of a chronic disease, and zero represents no self-report of chronic disease. We present marginal effects of variables from this equation to establish the broad patterns of health status among Australian migrants.

To identify more accurately health assimilation profiles, and how they differ by different countries of birth and arrival cohorts, we include in our main (preferred) equation an additional set of interaction terms. Our preferred equation is similar to the specification developed by Borjas (1985) for examining earnings assimilation in the immigrant population and which has been applied to the Australian population by McDonald and Worswick (1999).[13] A similar specification has also been applied to health assimilation among Canadian migrants in McDonald and Kennedy (2004).

$$h_i^* = Z_i\delta + \alpha_1 age_i + \alpha_2 age_i^2 + \sum_{j=1}^{j-1}\gamma_{1j}A_{ij}age_i + \sum_{j=1}^{j-1}\gamma_{2j}A_{ij}age_i^2 + \phi AoA_i + \sum_{l=1}^{l}\beta_{1l}C_{il} + \sum_{l=1,k=1}^{l,k-1}\beta_{2lk}C_{il}CB_{ik} + \sum_{k=1}^{k-1}\beta_{3k}CB_{ik}YSM_i + \beta_4 YSM_i + \beta_5 YSM_i^2 \quad (2)$$

The inclusion of country of birth variables interacted with cohort variables allows for cohort or year of arrival effects to vary across country of birth. Country of birth variables should capture some (although not all) of the visa category variation.[14]

[12] Vega and Rumbaut (1991) found that in the period after arrival in a new country, an immigrant's support network is an important aspect of their mental health. Unfortunately, the level of geographical region used in this paper is too coarse to capture effectively differences in immigrant support networks.

[13] By estimating both Equations 1 and 2, we follow Miller and Neo (2003) who used a similar methodology in estimating labour market adjustment. They argue that given the potential sensitivity of the results to the choice of survey years, it is preferable to estimate the assimilation profiles with and without cohort effects. While we would argue that the business cycle effects that call into question some of the assumptions around a pooled-cohort approach in labour market estimations are less likely to be present for health data, we do concede that there may be survey effects leading to biases in our estimates.

[14] Data obtained from the ABS 2004 Labour Force and Other Characteristics of Migrants Survey showed that, of the permanent migrants whose status is known, since 1980 no migrants from Oceania and North-West Europe (roughly equivalent to our English-speaking country category) entered on humanitarian or refugee visas and 16.0 per cent entered under the various family streams. For Southern and Eastern Europe (which is equivalent to our other non-English-speaking European countries category), 15.0 per cent entered under humanitarian and refugee visas and 32.5 per cent under the family stream. For those from the rest of the world (equivalent to our other non-English-speaking category), 6.2 per cent entered under humanitarian and refugee visas and 33.6 per cent entered under the family stream. Although the proportion of the population entering as refugees or on humanitarian visas stayed constant through time, those entering under the family stream did not. The proportion from Oceania and North-West Europe as well as Southern and Eastern Europe was higher in the 1980s compared to the 1990s. For the rest of the world, the proportion increased.

By specifying age effects through a quadratic in age and the interaction of this quadratic with a set of age dummy variables that represent a series of 10-year age groups, we have flexibly captured age effects. That is, age varies non-linearly across age groups and through a quadratic specification within age groups. Formal tests show that these variables are significant for all the models estimated.[15]

The specification of a years-since-migration quadratic variable allows us to capture a possible non-linear relationship across years since migration, although this is constrained to have the same effect across all cohorts.

To show differences between the sexes in a simple way, Equation 1 is estimated for males and females together. However, to take into account possible differences in patterns of assimilation, in our preferred Equation 2 we estimate models separately for males and females.

IV Results

(i) Descriptive Statistics

In Table 1 we present variable means and the incidence of chronic conditions for females and males by these variables. For all females and males aged 20–64 years in the pooled sample (all three health surveys), the incidence of chronic disease is 37.8 and 33.2 per cent, respectively. The incidence of chronic disease rises with age, although more quickly for males than for females. The incidence falls with equivalised household income and is higher for the unemployed and those not in the labour force compared to those who are employed. For those born overseas in non-European non-English-speaking countries, the incidence is lower compared to both other immigrants and the Australian-born population. This probably reflects, at least in part, the age distribution of this group of immigrants, with immigrants from these countries being on average younger than other immigrants and the Australian-born population.

(ii) Regression Results

We report both regression coefficients and marginal effects for Equation 1 in Table 2. The negative marginal effects for the three country-of-birth variables show that all else being equal, those born overseas have a lower incidence of chronic disease than those born in Australia (albeit with some variation across the three country of birth groupings). However, the positive coefficient and marginal effect for the years-since-migration variable shows that the longer a person has spent in Australia, the higher the chance of having a chronic disease.

In Equation 2, because of the additional complexity of interacted dummy variables, presenting results as marginal effects makes interpretation difficult. Instead, we construct a series of particular cases that represent immigrant groups and compare these with the Australian-born population. The regression coefficients that are used to construct these cases are presented in Table 3.[16] These cases represent different migrant cohorts for different countries of birth across the number of years they have been in Australia. Using these cases, we show how the probability of reporting chronic disease changes with years since migration across the three countries of birth groups and four arrival cohorts.

In Figure 1, we show the results for males and females. The results are for the following base case: age 45 years, non-Indigenous, employed professional, in income quintiles 2–4, arrived in Australia after age 14 years (for those born overseas) and lives in New South Wales. Male and female immigrants who were born in a non-English-speaking country and arrived in Australia since 1991 report a significantly lower incidence of chronic disease than both Australian-born persons and immigrants who were born in English-speaking countries. This suggests either that factors common to residents of non-English-speaking countries lie behind the differences in the incidence of chronic disease or the migrant selection/decision process is working differently for this group.

All immigrant groups and cohorts tend to report a higher incidence of chronic disease with the number of years since migration. This is reflected in the positive slope of the lines representing immigrant groups in Figure 1. Thus, there is evidence of a health assimilation profile for immigrants with the incidence of chronic disease beginning to approximate that of the Australian-born with the number of years since migration. However, immigrants who were born in a non-English-speaking European country, and who

[15] The formal tests are available from the authors on request.

[16] Controls for socioeconomic and demographic factors that we include are related to the incidence of chronic disease in the expected way. The incidence of chronic disease increases with age, declines with income, is higher for those unemployed and out of the labour force compared to the employed, and is higher for Indigenous Australians.

TABLE 1
Descriptive Statistics for the 1989, 1994–1995 and 2001 Health Surveys

	Females		Males	
	Proportion/mean of variable	Incidence of chronic disease	Proportion/mean of variable	Incidence of chronic disease
Indigenous	0.014	0.460	0.010	0.343
Non-Indigenous	0.986	0.377	0.990	0.331
2001	0.201	0.392	0.185	0.346
1995	0.411	0.411	0.410	0.359
1989	0.388	0.337	0.405	0.297
Age	39.00	NA	39.28	NA
Age 25–29	0.264	0.259	0.258	0.185
Age 30–39	0.283	0.297	0.276	0.261
Age 40–49	0.233	0.392	0.237	0.346
Age 50–59	0.151	0.578	0.163	0.532
Age 60–64	0.069	0.692	0.066	0.652
New South Wales	0.215	0.374	0.215	0.334
Victoria	0.256	0.354	0.252	0.311
Queensland	0.140	0.408	0.141	0.363
South Australia	0.125	0.407	0.129	0.341
Western Australia	0.105	0.379	0.107	0.334
Tasmania	0.062	0.383	0.060	0.329
Northern Territory	0.032	0.344	0.034	0.294
ACT	0.065	0.381	0.063	0.337
Metropolitan	0.690	0.371	0.688	0.318
Non-metropolitan	0.310	0.395	0.312	0.363
Arrived 1991 or after	0.023	0.225	0.021	0.188
Arrived 1981–1990	0.069	0.267	0.067	0.219
Arrived 1971–1980	0.059	0.333	0.059	0.302
Arrived 1970 or before	0.119	0.461	0.133	0.409
Born in Australia	0.730	0.384	0.719	0.334
Born overseas in an English-speaking country	0.111	0.406	0.119	0.333
Born overseas in a non-English-speaking country in Europe	0.076	0.408	0.087	0.372
Born overseas in a non-European non-English-speaking country	0.082	0.266	0.075	0.254
Income Quintile 1	0.181	0.412	0.169	0.348
Income Quintiles 2–4	0.608	0.380	0.586	0.333
Income Quintile 5	0.211	0.346	0.246	0.317
Employed other occupation	0.423	0.327	0.518	0.290
Employed management or professional	0.199	0.331	0.312	0.310
Unemployed	0.043	0.376	0.057	0.316
Not in labour force	0.196	0.501	0.073	0.593
Asthma	0.100		0.073	
Heart disease	0.108		0.093	
Diabetes	0.036		0.026	
Sample		0.378		0.332

NA, not applicable.

TABLE 2
Equation 1 Estimates – Incidence of Chronic Disease (Age 25–64 Years)

	Coefficient	*Z*-statistic	Marginal effect
Female	0.113	10.75	0.042
Indigenous	0.146	3.10	0.055
1995	0.119	8.29	0.044
1989	–0.032	–2.13	–0.012
Age	–0.060	–1.40	–0.022
Age squared	0.001	1.92	0.004×10^{-1}
Age 25–29 * Age	–0.012	–0.70	–0.005
Age 25–29 * Age squared	0.004×10^{-1}	0.60	0.001×10^{-1}
Age 40–49 * Age	0.002	0.18	0.007×10^{-1}
Age 40–49 * Age squared	-0.008×10^{-2}	–0.28	-0.003×10^{-2}
Age 50–59 * Age	0.018	1.09	0.007
Age 50–59 * Age squared	-0.004×10^{-1}	–1.03	-0.001×10^{-1}
Age 60–64 * Age	0.032	1.34	0.012
Age 60–64 * Age squared	-0.007×10^{-1}	–1.34	–0.002
Victoria	–0.063	–4.09	–0.023
Queensland	0.056	3.12	0.021
South Australia	–0.005	–0.28	–0.002
Western Australia	0.004	0.20	0.001
Tasmania	–0.051	–2.15	–0.019
Northern Territory	–0.086	–2.72	–0.031
ACT	0.004	0.16	0.001
Non-metropolitan	0.007	0.60	0.003
Arrived before age 14	0.036	1.41	0.014
Born overseas in an English-speaking country	–0.387	–11.52	–0.132
Born overseas in a non-English-speaking country in Europe	–0.528	–13.88	–0.173
Born overseas in a non-European non-English-speaking country	–0.555	–17.61	–0.180
Year since migration	0.024	8.69	0.009
Year since migration (squared)	-0.004×10^{-1}	–6.54	-0.001×10^{-1}
Income Quintile 1	0.058	3.97	0.021
Income Quintile 5	–0.055	–4.16	–0.020
Employed other occupation	–0.047	–3.87	–0.017
Unemployed	0.082	3.20	0.031
Not in labour force	0.218	11.85	0.083
Constant	0.004		
Observations	66 641		
Log likelihood	–39 773.473		
Pseudo R^2	0.0829		

Omitted variables: male, non-Indigenous, 2001 health survey, age 31–40 years, NSW, metropolitan, Australian-born, Income quintiles 2–4, employed management or professional.

arrived before 1970, continue to have a significantly lower incidence of chronic disease than either those born in Australia or other immigrant groups. The differences across arrival cohorts possibly reflects the visa-category-composition issues discussed earlier in the paper, but it is notable that certain immigrants retain their apparent health advantages, even after many years in Australia.

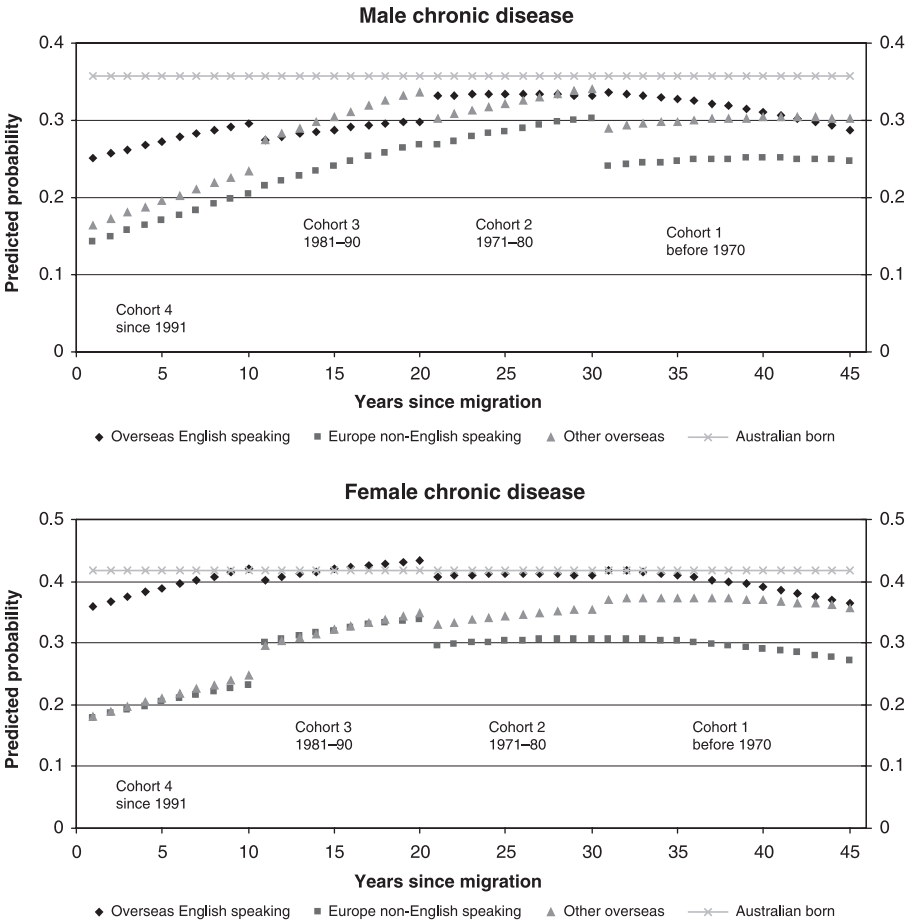
In the regressions we also include a variable that captures whether an immigrant arrived in Australia prior to the age of 14 years. This variable is included to capture the possibility that cohort arrival differences would be smaller for persons who arrived in Australian as children. That is, if health differences are largely a result of childhood experiences, then those immigrants who spent a portion of their childhood in Australia would be more similar to the Australian-born than those immigrants who did not. In all regressions this variable was insignificant, indicating that childhood arrival was not a key factor associated with immigrant health. That is, immigrants who arrived

TABLE 3
Equation 2 Estimates – Incidence of Chronic Disease (Age 25–64 Years)

	Persons		Females		Males	
	Coefficient	*Z*-statistic	Coefficient	*Z*-statistic	Coefficient	*Z*-statistic
Female	0.114	10.76				
Indigenous	0.145	3.08	0.216	3.58	0.035	0.46
1995	0.118	8.14	0.115	5.76	0.130	6.06
1989	–0.034	–2.14	–0.056	–2.55	–0.001	–0.36
Age	–0.059	–1.38	–0.028	–0.49	–0.093	–1.47
Age squared	0.001	1.90	0.001	0.73	0.002	1.95
Age 25–29 * Age	–0.012	–0.67	0.001	0.06	–0.031	–1.15
Age 25–29 * Age squared	0.004×10^{-1}	0.58	-0.001×10^{-1}	–0.14	0.001	1.10
Age 40–49 * Age	0.002	0.16	–0.020	–1.34	0.024	1.53
Age 40–49 * Age squared	-0.001×10^{-1}	–0.27	0.005×10^{-1}	1.29	–0.001	–1.63
Age 50–59 * Age	0.018	1.08	0.004	0.16	0.034	1.41
Age 50–59 * Age squared	-0.004×10^{-1}	–1.02	-0.001×10^{-3}	–0.00	–0.001	–1.47
Age 60–64 * Age	0.031	1.32	0.031	0.95	0.034	0.98
Age 60–64 * Age squared	–0.001	–1.32	-0.005×10^{-1}	–0.69	–0.001	–1.23
Victoria	–0.063	–4.08	–0.066	–3.07	–0.059	–2.66
Queensland	0.055	3.08	0.059	2.37	0.050	1.93
South Australia	–0.005	–0.26	0.014	0.55	–0.024	–0.89
Western Australia	0.002	0.12	–0.005	–0.18	0.010	0.36
Tasmania	–0.051	–2.13	–0.027	–0.82	–0.075	–2.15
Northern Territory	–0.086	–2.72	–0.072	–1.63	–0.106	–2.34
ACT	0.005	0.22	–0.001	–0.04	0.007	0.22
Non-metropolitan	0.007	0.62	–0.023	–1.41	0.041	2.39
Arrived before age 14	0.044	1.69	0.044	1.22	0.046	1.23
Arrived 1991 or after	–0.246	–3.68	–0.174	–1.87	–0.325	–3.36
Arrived 1981–1990	–0.306	–6.25	–0.231	–3.38	–0.401	–5.66
Arrived 1971–1980	–0.299	–3.89	–0.302	–2.81	–0.312	–2.84
Arrived 1970 or before	–0.275	–2.86	–0.276	–2.04	–0.297	–2.16
Arrived 1991 or after * Other Europe	–0.474	–3.82	–0.562	–3.29	–0.407	–2.24
Arrived 1981–1990 * Other Europe	–0.305	–4.02	–0.305	–2.93	–0.314	–2.82
Arrived 1971–1980 * Other Europe	–0.386	–4.25	–0.362	–2.80	–0.419	–3.27
Arrived 1970 or before * Other Europe	–0.301	–2.56	–0.168	–1.00	–0.436	–2.61
Arrived 1991 or after * Other overseas-born	–0.442	–5.16	–0.558	–4.76	–0.315	–2.49
Arrived 1981–1990 * Other overseas-born	–0.262	–4.51	–0.373	–4.64	–0.133	–1.57
Arrived 1971–1980 * Other overseas-born	–0.348	–3.73	–0.367	–2.82	–0.334	–2.49
Arrived 1970 or before * Other overseas-born	–0.419	–2.92	–0.356	–1.78	–0.500	–2.42
Other Europe * Year since migration	0.007	2.01	0.003	0.56	0.011	2.27
Other Overseas * Year since migration	0.009	2.23	0.007	1.23	0.012	1.94
Year since migration	0.020	3.94	0.022	3.08	0.020	2.71
Year since migration (squared)	-0.004×10^{-1}	–4.89	-0.004×10^{-1}	–3.78	-0.004×10^{-1}	–3.40
Income Quintile 1	0.059	4.04	0.061	3.15	0.056	2.55
Income Quintile 5	–0.055	–4.19	–0.067	–3.59	–0.042	–2.24
Employed other occupation	–0.047	–3.87	–0.046	–2.66	–0.043	–2.52
Unemployed	0.083	3.25	0.170	4.59	0.022	0.60
Not in labour force	0.221	11.96	0.155	6.62	0.395	12.07
Constant	–0.014	–0.02	–0.276	–0.28	0.416	0.38
Observations	66 641		33 987		32 654	
Log likelihood	–39 758.003		–20 805.553		–18 878.337	
Pseudo R^2	0.0832		0.0770		0.0900	

Omitted variables: male, non-Indigenous, 2001 health survey, age 31–40 years, NSW, metropolitan, Australian-born, Income quintiles 2–4, employed management or professional.

FIGURE 1
Male/Female Chronic Disease



in Australia as children do not appear to have different health profiles to those immigrants who arrived as adults (although it is difficult to precisely estimate this effect given the likely interaction with years since arrival, country of birth and cohort effects).

A large number of specific chronic diseases make up our composite measure of chronic disease. Some specific chronic diseases are more likely to reflect genetic predispositions whereas others might be more influenced by environmental conditions or cultural factors. Furthermore, diseases that primarily reflect genetic factors are not directly relevant to assimilation or acculturation hypotheses. We examine three specific diseases that might better reflect the effects of environment or diet on health – heart disease, diabetes and asthma – and estimate Equation 2 for each of these conditions.[17]

[17] Immigrants from some countries may derive positive health benefits from aspects of their diet. For example, researchers have found that the 'Mediterranean diet' can lower mortality due to heart disease and cancer (see Hu, 2003; Trichopoulou *et al*., 2003). In the context of this paper, we might expect immigrants from 'other European countries' to have a lower incidence of heart disease than their native-born compatriots.

Similar to Figure 1, we plot a health trajectory for these three specific diseases in Figure 2.[18]

For diabetes and heart disease, the differences between immigrants and the Australian-born population are small. For diabetes, the set of coefficients on cohort variables and those on years-since-migration variables are not jointly significantly different from zero.[19] For heart disease, the cohort variables are significant at the 1 per cent level, although not years since migration. This indicates that the incidence of heart disease varies across some immigrant groups, with immigrants from non-English-speaking countries tending to report lower levels, particularly for more recent arrival cohorts.

Australia has one of the highest rates of asthma in the world (Beasley *et al*., 1998) and the health assimilation results for asthma are somewhat different to heart disease and diabetes. Immigrant arrival cohorts and years-since-migration variables are all significantly different from zero, with much lower rates of asthma in immigrants from non-English-speaking countries, particularly those from non-English-speaking Europe. There are also clear assimilation profiles for asthma. The results for asthma are more similar to the results for the composite measure of chronic disease compared with heart disease and diabetes. This hints at a more complex story than can be obtained by examining only composite measures of chronic disease.

Our results are broadly similar to those for Canadian immigrants presented in Perez (2002) and McDonald and Kennedy (2004). Upon arrival in Australia, immigrants tend to be healthier than the native-born, but over time this difference tends to dissipate. Perez also found that these differences are not present for diabetes, a result that we find and that other Australian studies have found (see, for example, Australian Institute of Health and Welfare, 2002). Our results for the incidence of heart disease and diabetes among immigrants differ from those presented in Jasso *et al*. (2004) for immigrants to the USA. Jasso *et al*. (2004) found that the incidence of heart disease and diabetes is lower for immigrants and remains lower with years since migration. These differences could represent differences in the source countries of immigrants between Australia and the USA. Our results for asthma are consistent with other Australian studies such as Leung *et al*. (1994), who found that the prevalence of asthma and hay fever is associated with the length of stay in Australian for Asian-born immigrants.

V Discussion

We find that immigrants arrive in Australia in better health than their Australian-born counterparts. Furthermore, immigrants from non-English-speaking Europe or other non-European countries report better health upon arrival than those from English-speaking countries whose health is more similar to the Australian-born population.

We find that, relative to that of the Australian-born, immigrants' health declines with time in Australia. The probability of reporting a chronic condition increases quite quickly in the first 10–20 years in Australia, and then tends to plateau at a level below that of the Australian-born population, but with significant variation by region of origin.

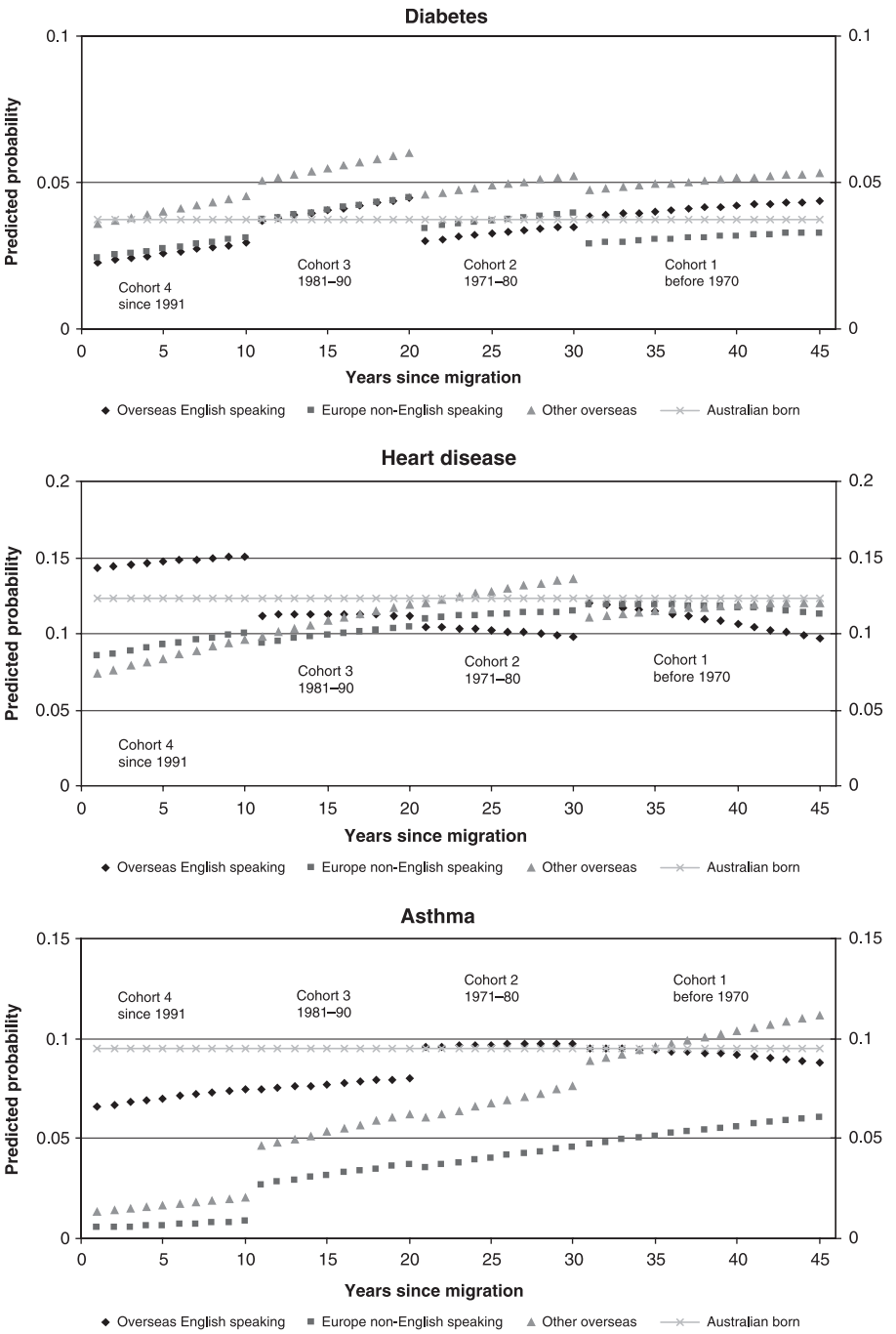
We also examined differences in the health assimilation profiles of immigrants across three specific chronic diseases: asthma, diabetes, and heart disease. The incidence of asthma is relatively low for immigrants upon arrival, but begins to approach that of the Australian-born population with time in Australia. This occurs slowly for those born in Europe or in English-speaking countries, but at a greater rate for those born in other overseas countries. The incidence of diabetes in immigrants is more similar to that of the Australian-born population than for other disease types. For some immigrant groups becomes higher than that for the Australian-born population with time in Australia. The incidence of heart disease is not very different between immigrants and the Australian-born population, and it changes little with time in Australia.

Our results suggest that there are a number of ways that time in a new country may affect the health of immigrants. For example, country-specific dietary influences are likely to affect the incidence of diabetes and heart disease, while exposure to influences more specific to the physical environment (e.g. allergens) might be influencing the incidence of asthma in immigrants.

[18] Full regression model results are available from the authors on request.

[19] The Australian Institute of Health and Welfare (2002) found that diabetes was a cause of greater mortality for persons born overseas compared with the Australian-born population, in particular, for people born in Europe, Pacific Islands and Asia. We found that the incidence of diabetes in immigrants from other Europe and other overseas is higher than the native-born, but that the difference in not statistically significant. The level of disaggregation of the overseas born population in this paper may be too coarse to reflect the variation reported by other studies.

FIGURE 2
Diabetes



Alternatively, rather than reflecting the effects of the environment or country-specific effects, the health assimilation profiles identified in this paper in the composite measure of chronic disease could simply reflect a combination of the health selection aspects of migration and a process of reversion to the mean. This would imply that the health selection effects are for the most part transitory in nature rather than permanent and as such have no clear implications for policy-makers. A simple health model of a reversion to the mean process is developed in Appendix II.

Although it is difficult to separate a reversion to the mean effect from other acculturation or environmental effects, our results do shed some light on this issue. Where we considered cohorts of immigrants from three different groups of country of birth, we would expect reversion to the mean effects to operate similarly across the three groups. The differences we identified in health profiles between immigrants from English-speaking and non-English-speaking countries are more suggestive of health being affected by culture and environment. Furthermore, most immigrant groups converge to levels of health below the native-born levels suggesting that there are some permanent factors at work beyond those explained by the usual set of socioeconomic factors.

There are other pathways through which immigrant health might be affected by migration and decline with time in a new country. For example, Newbold and Danforth (2003) suggest that inferior immigrant access to health services might be a reason that immigrant health trajectories are worse than the health trajectories of the native-born. Such an effect might explain some of the differences identified in this paper between immigrants from English-speaking countries and non-English-speaking countries. This would be the case if language were a significant barrier to obtaining health services.[20]

Until such time that the pathways through which immigrant health are more carefully identified, it is difficult to derive strong policy conclusions from the identification of the immigrant health assimilation profiles presented in this paper. However, confirming the presence of immigrant health differences and describing the evolution of immigrant health after arrival in Australia is useful for understanding how immigrant healthcare needs are likely to change over time and contributes to our understanding of the socioeconomic determinants of physical health.

[20] An extension to this argument is that non-English-speaking immigrants have difficulty answering health questions and this leads them to initially under-report poor health, but that this factor declines over time as their English-speaking ability improves. The national health surveys are personal interview-based surveys and interpreters are used when respondents cannot speak English. However, it is possible that the health-reporting effect persists and in particular, persists for immigrants who do not use interpreters and whose English is not as good as that of native-born Australians.

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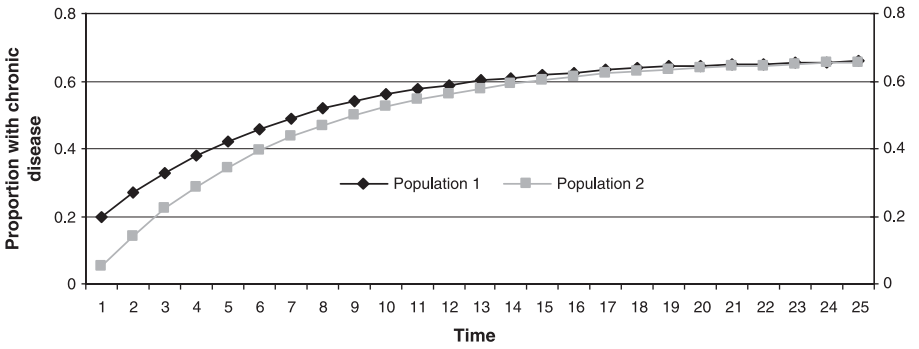
Appendix I

Variable Definition and Correspondence between Health Surveys

Variable	Variable description
Indigenous	Whether an Aboriginal or Torres Strait islander.
Age	Measured in single years. Linear and quadratic term interacted with age cohort dummies (20–29, 30–39, 40–49, 50–59, 60–64).
Child on arrival	Age 14 years or less on arrival.
Country of birth	There are four countries of birth groups: Australian-born; Other English-speaking country (the UK and Ireland, New Zealand, Canada and the USA); Other European non-English-speaking country; and Other non-English-speaking countries.
Year of arrival	Continuous variable and 10-year arrival cohorts: 1991 or after, 1981–1990, 1971–1980, and 1970 or before.
Income	Income summed across households then equivalised using the 'modified' OECD scale (see De Vos and Zaidi, 1997, for a discussion of the modified OECD scale). Dummy variables then created for first and fifth quintile based on the equivalised income distribution for individual surveys. In the 2001 survey, individuals were given a list of possible sources of income rather than just a single catch-all question, as was asked in the other surveys.
Employed	A distinction is made between whether a person's main or usual job is non-managerial or non-professional compared to whether it is. For those not employed, dummy variable created for whether they were unemployed or not in the labour force.
Unemployed	Whether a person is unemployed. There are a number of minor changes to the activity tests in measuring unemployment across surveys.
Not in the labour force	Whether a person is not employed or actively seeking work, see unemployed.
Australian State	The State a person usually resides in.
Metropolitan and non-metropolitan	If the persons usually resides in a metropolitan or non-metropolitan area.

FIGURE A1
Chronic Disease Reversion to the Mean



Appendix II

A Simple Model of Mean Reversion and Immigrant Health Assimilation[21]

In this appendix, we describe a simple model of a chronic disease process, which leads to a stable equilibrium with a constant proportion of the population having a chronic disease. We begin by defining two transition probabilities where π_1 is the probability of contracting a chronic disease and π_2 the probability of recovering from the chronic disease; p_{it} is the proportion of the ith population who have the chronic disease at time t; and q_{it} the proportion without chronic disease, where $q_{it} = 1 - p_{it}$. The following equations describe the evolution of chronic disease in the population over time.

$$p_{it} = \pi_1 q_{it-1} + (1 - \pi_2) p_{it-1} \quad \text{(A1)}$$

$$q_{it} = (1 - \pi_1) q_{it-1} + \pi_2 p_{it-1} \quad \text{(A2)}$$

When $(\pi_1 + \pi_2) < 1$ and $\pi_1 > \pi_2$ this system has a stable equilibrium, with the proportion of people with chronic disease in the population steadily approximating an equilibrium value over time. The conditions set out above seem reasonable in the context of chronic disease prevalence rates where we would expect the probability of contracting chronic disease at any particular time to be reasonably low and that the probability of recovering from a chronic disease is lower still.

As $t \to \infty$, the level of chronic disease in the ith population will approximate $p_i = \pi_1/(\pi_1 + \pi_2)$.

In Figure A1, we show the evolution of the proportion of people in two populations with chronic disease, both populations have the same probability of contracting a disease of $\pi_1 = 0.1$ and once contracting a chronic disease, a probability of recovering of $\pi_2 = 0.05$. Importantly, the population starting points are different with population 1 having a pre-existing proportion of the population with chronic disease of 0.2 and population 2 of 0.05.

[21] We wish to thank Dr Jim Thompson (Australian Treasury) for discussing and developing this model with us.