Investigating the Dynamics of Migration and Health in Australia: A Longitudinal Study

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Abstract There have been few longitudinal studies investigating the immigrant health and changes in their health with longer residency in the host country. Additionally, the pathways and mechanisms by which transition of health over time occurs are poorly understood, limiting the ability to implement policies that will result in improved health for all, including immigrants. We assessed differences in health outcomes among foreign-born people from English speaking countries and non-English speaking countries relative to native-born Australians over a 10-year period using a large representative longitudinal dataset. We also explored English language proficiency, socio-economic factors and health behaviour factors as possible mechanisms through which health outcomes change over time post-migration. Conventional multilevel mixed and hybrid regression models were used to evaluate health outcomes in 9558 native-born and 3067 foreign-born people from the Household, Income and Labour Dynamics in Australia survey. There were clear differences in physical health, mental health and self-assessed health between foreign-born subgroups in comparison with native-born Australians. Foreign-born people from English speaking countries typically had a health advantage relative to native-born people, and foreign-born people from non-English speaking countries had a health disadvantage with respect to native-born people for all health outcomes. There was no evidence that these differences changed by duration of residence except for self-assessed health amongst foreign-born people from non-

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English speaking countries when duration of residence exceeded 20 years. English language proficiency mediated the relationship between duration of residence and health for foreign-born people from non-English speaking countries.

Keywords Australia · Migrant health · Longitudinal · Duration of residence · Multilevel mixed models · Hybrid models

1 Background

Observational studies often suggest a health and mortality advantage among foreign-born (FB) people as compared with the native-born (NB), even of the same ethnicity. While the exact nature of the association between nativity and health varies from study to study as a result of different samples and the specific morbidity measures used; in general, this literature from North America and Canada (Gushulak 2007; Hummer et al. 1999; Hyman 2001; Jasso et al. 2004, 2005; Markides and Eschbach 2005; McDonald and Kennedy 2004; Morales et al. 2002; Newbold 2005; Newbold and Danforth 2003; Ng et al. 2005; Singh and Siahpush 2001), Europe (Anson 2004; Deboosere and Gadeyne 2005; Domnich et al. 2012; Ladin and Reinhold 2013; Rivera et al. 2015, 2016; Wallace and Kulu 2014a, b; Williams et al. 1997) and Australia (Jatrana et al. 2014; Kouris-Blazos 2002; Strong et al. 1998; Taylor et al. 1998) has shown that immigrants to a new country have an advantage over the native-born population on most indicators of health, including mortality, morbidity, disability and mental disorder, often despite lower socio-economic status that might suggest poorer health profiles. This phenomenon is generally referred to as the “immigrant health paradox” or “Hispanic paradox” as it was found only among Hispanics in the USA. Over time, however, the health advantage of immigrants declines below that of new migrants or to the level of their native-born counterparts (Cho et al. 2004; Gushulak 2007; Hyman 2007; Markides and Eschbach 2005; Morales et al. 2002; Rivera et al. 2016). However, the heterogeneity in morbidity and mortality among ethnic/migrant populations upon arrival and over time in the host country has been acknowledged and documented (Reynolds et al. 2016; Singh and Siahpush 2001, 2002). There are both diversity and similarity in health outcomes across world regions, both on arrival and over time (Reynolds et al. 2016).

Much of the recent international literature on immigrant health has used single or repeated cross-sectional datasets (Abraido-Lanza et al. 2006; Biddle et al. 2007; McDonald and Kennedy 2004; McKay et al. 2006). However, many factors that influence health may change over time in individuals, particularly among immigrants. Additionally, processes such as migration are dynamic and may require several years to fully impact health. The effect of migration on health will therefore be more difficult to determine from purely cross-sectional data.

Moreover, the pathways and mechanisms by which transition of health over time occurs are poorly understood, limiting the ability to implement policies that will result in improved health for all, including immigrants. Most of these explanations

are speculative. This arises partly from a lack of reliable data linking health outcomes to migration status, and the background and experiences of migrants.

The present study advances the migrant health literature by (1) using a nationally representative longitudinal data with 10 years of follow-up to investigate the association between migration and health in Australia, (2) using multiple health indicators to represent various dimensions of health and (3) exploring possible mechanisms through which health outcomes change over time post-migration.

We address the following specific questions:

1. Does health differ by nativity status [native-born, foreign-born groups from English speaking (ES), and non-English speaking (NES) countries of birth (CoB)]?
2. Does health vary by nativity, country of birth and duration of residence (DoR)?
3. Is the association between nativity and duration of residence mediated by English language proficiency, and socio-economic status and health behaviour factors?

Based on previous research, we hypothesise that (1) foreign-born people have better health as compared to native-born people, (2) longer stay in Australia is associated with a decline in health and (3) English language proficiency, socio-economic status and health behaviour factors mediate the association between nativity, duration of residence and health.

1.1 Nativity, Duration of Residence and Health: Theoretical Context

There are several mechanisms that could impact the health of immigrants as they stay longer in the host country. Researchers have often focussed on acculturation as a possible explanation for any decline in health with years in the host country (Ryder et al. 2000). The process of acculturation is likely to be influenced by factors including diversity in the host society, pressure towards assimilation, and public perception of immigrants, as well as individual factors including English language skills, education and family and social networks (Kasl and Berkman 1983). In this study, we use Duration of residence (DoR) as a measure of acculturation and English language proficiency as a path/mechanism through which acculturation/DoR affects health. We also explore socio-economic status and health behaviour as other paths/mechanisms that might mediate the relationship between nativity, country of birth, DoR and health.

A conceptual framework of the causal relationship between acculturation/duration of residence and health is presented in Fig. 1 as a directed acyclic graph (DAG). Such graphs summarise hypothesised causal relations amongst variables (Greenland et al. 1999; Gunasekara et al. 2013; VanderWeele and Robins 2007), and Fig. 1 posits that acculturation could impact health through four main causal pathways. This framework also provides the basis upon which modelling decisions were made. The first set of DoR–health paths pass first through English language proficiency, i.e., $a + b$, $a + e + d$, $a + e + h + g$ using the path labels from Fig. 1. The second set of paths pass first through socio-economic factors (income, employment

Fig. 1 Directed acyclic graph (DAG) of the relationship between duration of residence and health. *Note* *DoR* duration of residence, *ELP* English language proficiency, *SES* socio-economic status (level of education, marital status, household equivalised income and employment status), health [physical health (PH), mental health (MH) and self-assessed health (SAH)], *UM* unknown mediator(s), *HB* health behaviours (smoking, drinking and physical activity)

and education), i.e. $c + d$, $c + h + g$. The third causal path passes first through health behaviour, i.e. $f + g$. The fourth set of causal paths pass through unmeasured mediators (such as discrimination/racism), i.e. $i + j$. To simplify the DAG, node UM includes the null (no) mediator, i.e. the direct path from duration of residence to health is a subset of $i + j$. The DAG makes explicit an assumption of no confounding of the association between DoR and health.

1.2 The English Language Proficiency Pathway

Given the importance of English in accessing health care and securing a job in Australia, we expect English language proficiency to play an important role in determining immigrant health status. The pathway by which language proficiency relates to health is complex and may operate through several mechanisms, e.g. individuals with limited English proficiency, particularly those from non-English speaking countries, may face communication and cultural barriers to accessing healthcare services (Stronks et al. 2001; Kandula et al. 2004). Difficulty with linguistic communication is among the most frequently cited barriers to accessing health and auxiliary health services by immigrants (Bauder 2003; Pottie et al. 2008). Alternatively, low English proficiency may affect the relationship between nativity and health via SES (employment, income). On the other hand, longer duration of residence could lead to improved English language proficiency, which in turn could improve employment opportunities with higher and more stable income.

1.3 The SES Pathway

Regarding the SES pathway ($c + d$), many studies have provided reasonably good evidence that higher SES is generally associated with better health status (McDonough et al. 2010, Richardson et al. 2010). However, the relationship between SES and health is complex, and the causal direction has been vigorously debated (Gunasekara et al. 2011). Finding employment is a critical part of the settling-down process for migrants (Valtonen 2001), and we expect employment to causally affect health, making employment a potential mediator between duration of

residence and health. Alternatively, SES may affect the association between duration of residence and health via the health behaviours (path $c + h + g$).

1.4 The Health Behaviour Pathway

Theories of acculturation suggest that as DoR increases immigrants are more likely to replace healthier home country foods for fast foods, do less physical activity and adopt other risky health behaviours, leading to the eventual loss of any initial health advantage (Abraido-Lanza et al. 2005; Lara et al. 2005; Gerber et al. 2012). Over time these rates are thought to converge to host country levels (Hyman 2001). While the theory of acculturation provides an important framework within which the nativity gap in health between immigrants and native-born people can be considered, it may provide a simplistic view of the complexity of mechanisms by which immigrants health change over time. The theory of acculturation requires careful scrutiny because of its inherent assumptions. For example, acculturation research assumes that the country of origin has better health behaviours than the country migrated to and that migration to Western countries is accompanied by negative behavioural changes. We return to this point later in the Discussion section.

Regarding the relationship between DoR and these pathways (English language proficiency, SES and health behaviour), there may be various distinct processes occurring simultaneously: (1) increasing DoR also leads to improvement in English language proficiency, which results in immigrants particularly from non-English speaking countries rating their health more positively ($a + b$); (2) increasing DoR leads to improved SES and resultant better health either directly or via English language proficiency ($c + d$ or $a + e + d$); (3) increasing DoR leads immigrants to rate their health worse due to adoption of negative behaviours prevalent in Australia ($f + g$ or $c + h + g$); and (4) increasing DoR may impact on health through unknown mediators such as discrimination/racism ($i + j$).

2 Data and Methods

2.1 Data

This paper utilises data from the Household, Income and Labour Dynamics in Australia (HILDA) survey, which is a nationally representative panel survey of Australian people occupying private dwellings. The survey commenced in 2001 with a large sample of 7682 households having at least one eligible person aged 15 years and above. Information is collected using face-to-face interviews and self-completion questionnaires (see Watson and Wooden 2012). This study used data on all 12,625 individuals who responded in wave 1 and in at least one wave between waves 2 and 10 (i.e. an unbalanced panel). Of these, 9558 (75.7%) were native-born, 1359 (10.8%) were born in English speaking countries and the remaining 1708 (13.5%) were born in non-English speaking countries. The number of responses between waves 1–10 from the native-born, the foreign-born from English speaking countries and the foreign-born from non-English speaking countries was,

respectively, 79,886, 11,132 and 13,063. The average number of times a person responded between waves 1–10 was greater for native-born people (8.36) than for foreign-born people from English speaking or non-English speaking countries (8.19 and 7.65, respectively). Using an unbalanced panel makes better use of the information collected and provides a method to check for health selection bias.

2.2 Variables and Measures

For the nativity analysis, the main exposure variable was nativity status (foreign-born or native-born), with the foreign-born level further divided by country of birth, broadly categorised as English speaking or non-English speaking countries. Immigrants from the UK, USA, New Zealand, Canada, Ireland and South Africa made up the English speaking group, and other immigrants comprised the non-English speaking group. For the DoR analysis, DoR at wave 1 was used to investigate how exposure to the social, cultural and physical environment of the host population might be associated with the health of the migrant population. Duration of residence was categorised into <10 years, 10–19 years and greater than or equal 20 years in Australia, and combined with the nativity status variable described above. The main exposure variable for the DoR analysis therefore had levels: “English speaking; DoR < 10 years”, “English speaking; DoR 10–19 years”, “English speaking; DoR $\geq$ 20 years”, “non-English speaking; DoR < 10 years”, “non-English speaking; DoR 10–19 years”, “non-English speaking; DoR $\geq$ 20 years” and “native-born”. The cut points for DoR were chosen to: (1) reflect empirical evidence, suggesting that after 10 years an initial health advantage is lost (Goel et al. 2004); (2) ensure sufficient statistical power and allow reasonable estimates of uncertainty; (3) allow time for adoption of lifestyle and diet of the host country to affect health. Out of 12,625 respondents, 9558 (76%) were native-born, 1359 (11%) were born in English speaking countries and 1708 (14%) were born in non-English speaking countries. Amongst foreign-born people, about 19% had been resident in Australia for <10 years, 25% for 10–19 years and 56% for 20 years or more (see Table 1 for baseline (wave 1) characteristics of the study population).

The three health outcome measures used in this study are: self-assessed health (SAH), physical health (PH) and mental health (MH). Physical and mental health were measured by constructing physical component summary scores (PCS) and mental component summary scores (MCS). All three health measures considered in this study were obtained using the SF-36 questionnaire, part of the HILDA self-completion questionnaire. The SF-36 is one of the most widely used self-completion measures of health status (Coons et al. 2000), has been validated for the detection of changes in health over time (Hemingway et al. 1997) and is considered to be reliable for use in the Australian population (McCallum 1995). For this study, SAH was coded to have values between 1 (poor health) and 5 (excellent health) and modelled as a continuous variable for analyses. The PCS and MCS were derived from eight SF-36 health domains using correlated factor analysis. Both PCS and MCS vary between 0 (worst health) and 100 (best health) with a mean score of 50 and were modelled as continuous outcomes in regression analyses. A score of 100 in physical

Table 1 Wave 1 characteristics (number (N) and percent (%) / mean) of the study respondents by country of birth

Characteristics	All		FB		NB		FB country of birth				p value*
	N	%	N	%	N	%	ES		NES		
							N	%	N	%	
Sex											
Male	5962	47.2	1486	48.5	4476	46.8	695	51.1	791	46.3	<0.001
Female	6663	52.8	1581	51.5	5082	53.2	664	48.9	917	53.7	
Age group											
15–29	3008	23.8	476	15.5	2532	26.5	150	11.0	326	19.1	
30–44	4064	32.2	962	31.4	3102	32.5	419	30.8	543	31.8	<0.001
45–59	3016	23.9	881	28.7	2135	22.3	414	30.5	467	27.3	
60+ years	2536	20.1	748	24.4	1788	18.7	376	27.7	372	21.8	
(Mean age)	43.6		47.1	42.4		49.4		45.3			<0.001
Duration of residence											
<10 years	580	4.6	580	19.0			167	12.3	413	24.2	
10–19 years	751	6.0	751	24.5			280	20.7	471	27.6	<0.001
≥ 20 years	1729	13.7	1729	56.5			908	67.0	821	48.2	
English proficiency											
Proficient	11,199	88.7	1890	61.6	9309	97.4	1323	97.4	567	33.2	
Good	1221	9.7	977	31.9	244	2.6	36	2.6	941	55.1	<0.001
Not good	202	1.6	200	6.5	2	0.0	0	0.0	200	11.7	
Level of education											
<12 years of schooling	5035	39.9	1004	32.7	4031	42.2	456	33.6	548	32.1	
Exactly 12 year of schooling	1824	14.4	518	16.9	1306	13.7	173	12.7	345	20.2	
Diploma	3466	27.5	853	27.8	2613	27.3	443	32.6	410	24.0	<0.001
Had university education	2296	18.2	691	22.5	1605	16.8	287	21.1	404	23.7	

Table 1 continued

Characteristics	All		FB		NB		FB country of birth				<i>p</i> value*
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	ES		NES		
							<i>N</i>	%	<i>N</i>	%	
Current marital status											
Married/in de facto	8074	64.0	2198	71.7	5876	61.5	1002	73.7	1196	70.0	
Separated/widowed	1703	13.5	430	14.0	1273	13.3	203	14.9	227	13.3	<0.001
Never married/never in de facto relation	2839	22.5	439	14.3	2400	25.1	154	11.3	285	16.7	
Employment status											
Employed	7685	60.9	1685	54.9	6000	62.8	800	58.9	885	51.8	
Unemployed	462	3.7	121	3.9	341	3.6	50	3.7	71	4.2	<0.001
Not in labour force	4478	35.5	1261	41.1	3217	33.7	509	37.5	752	44.0	
Household equivalised income											
≤20,000	4830	38.3	1312	42.8	3518	36.8	498	36.6	814	47.7	
(20,000–40,000]	5608	44.4	1220	39.8	4388	45.9	570	41.9	650	38.1	
(40,000–60,000]	1696	13.4	394	12.8	1302	13.6	205	15.1	189	11.1	<0.001
>60,000	491	3.9	141	4.6	350	3.7	86	6.3	55	3.2	
(Average household equivalised income)	27,472		27,061		27,603		30,265		24,512		<0.001
Smoking											
Never smoked	5982	50.4	1372	49.2	4610	50.8	537	41.7	835	55.6	
Former smoker	3164	26.7	890	31.9	2274	25.1	489	38.0	401	26.7	<0.001
Current smoker	2718	22.9	527	18.9	2191	24.1	262	20.3	265	17.7	
Drinking											
Never drunk	1119	9.4	372	13.4	747	8.2	42	3.3	330	22.0	
Former drinker	628	5.3	174	6.2	454	5.0	77	6.0	97	6.5	<0.001
Current drinker	10,129	85.3	2239	80.4	7890	86.8	1168	90.8	1071	71.5	

Table 1 continued

Characteristics	All	FB		NB		FB country of birth		<i>p</i> value*		
						NES				
						ES				
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
Physical activity										
Not at all	1417	11.9	402	14.4	1015	11.2	163	12.6	239	16.0
<3 times per week	4472	37.6	1070	38.4	3402	37.4	458	35.5	612	40.9
≥ 3 times per week	5994	50.4	1314	47.2	4680	51.4	668	51.8	646	43.2
Mean level of PH	50.6			50.1		50.7		50.8	49.5	<0.001
Mean level of MH	50.3			50.1		50.3		51.0	49.3	<0.001
Mean level of SAH	3.48			3.45		3.49		3.53	3.38	<0.001
Sample size	12,625	100.0	3067	24.3	9558	75.7	1359	10.8	1708	13.5

Country of birth is defined as NB (native-born) and FB (foreign-born) from English speaking (ES) and non-English speaking (NES) countries

The sum of row counts with respect to each characteristic need not be equal to corresponding sample size because of missing values

* Chi-square tests in case of categorical variables and analysis of variance (ANOVA) tests in case of continuous variables were performed in order to test whether there is a statistical difference by country of birth in the considered characteristics. Test results were provided in the form of *p* values

functioning indicates an ability to perform all activities without limitations due to health, whereas a score of 100 in mental health indicates an ability to function without personal or emotional problems.

Age at wave 1 (henceforth age) and sex were the main time-invariant control variables since they were considered to be effect modifiers of the exposure–health relationship. Time-varying covariates used in analyses included English language proficiency and aspects of socio-economic status (SES) such as marital status, highest education level, employment status and household equivalised income. Overall temporal effects such as any general decline in the health of the sample were controlled by including wave as a linear covariate, and exposure-specific differences in such temporal effects were modelled by interacting exposure variables (nativity/country of birth, DoR) with wave. Consequently, the exposure estimates presented below are relevant to exposure groups at the start of the survey. Additionally, the number of times a respondent responded out of waves 1–10 was also used in the regression analysis to check for health selection bias.

2.3 Methods

We used mixed and “hybrid” regression models (Allison 2005) to investigate the longitudinal association between nativity and health and between nativity, duration of residence and health.

The following mixed (Eq. 1) and hybrid (multilevel group-mean-centred mixed: Eq. 2) models were used in this study to investigate the association between immigrant status and duration of residence with physical health, mental health and self-assessed health:

$$Y_{it} = \alpha_i + \eta Z_i + \varepsilon_{it} \quad (1)$$

$$Y_{it} = \alpha_i + \beta_1(X_{it} - \bar{X}_i) + \beta_2\bar{X}_i + \gamma Z_i + \varepsilon_{it} \quad (2)$$

where Y_{it} denotes PCS_{it} , MCS_{it} , or SAH_{it} . The outcome Y_{it} is the health score for the i th respondent ($i = 1-n$, where n is sample size) in the t th wave ($t = 1-10$). In each of the above regression models, α_i represents a random effect to account for clustering at the individual level, $X_{it} - \bar{X}_i$ represents within person variability of time-varying confounder X_{it} , $\bar{X}_i$ is the corresponding person-level mean (over time) of X_{it} , Z_i is a vector of time-invariant covariates and η , β_1 , β_2 and γ are coefficient vectors to be estimated. Wave (time) effects are included in X_{it} . The terms $\bar{X}_i$ and Z_i are referred in this study as between-person variables as they only change between people, i.e. are constant within people.

Hybrid models control for cluster (individual) mean effects of all included time-varying covariates, resulting in potentially less biased estimates for the coefficients of time-varying and time-invariant variables than those obtained from conventional mixed models (Allison 2005). Such models are in fact a variant of econometric fixed effects models which, for time-varying longitudinal covariates, are typically used to remove bias from all time-invariant unmeasured confounders (Gunasekara et al.

2013). However, the main exposure variables in this study (nativity, country of birth and DoR) are time-invariant, and an important question to consider when using hybrid or conventional mixed models is whether the assumption of no unmeasured confounding of the exposure–outcome relation is valid.

Both hybrid and conventional mixed models give unbiased estimates for the effects of time-invariant exposures only when there is no unmeasured confounding. There can be no confounding of the relationship between health and nativity or country of birth since, once migration has occurred and nativity and country of birth are external to the model (exogenous). However, English language proficiency, socio-economic (SES) and health behaviour covariates such as household equivalised income, employment status, marital status, level of education, alcohol drinking, smoking and exercise are potential mediators of the relationship, as shown in the DAG in Fig. 1. We tested this by selectively adding English language proficiency, SES and health behaviour as model covariates (Baron and Kenny 1986), thereby blocking causal paths that pass through them. However, since this method is potentially biased, particularly when there are confounders of the mediator–outcome relationship (VanderWeele and Vansteelandt 2009), the method provides only a qualitative indication of whether mediation might be important. Quantification of the magnitudes of direct and indirect effects is left for future research.

While unmeasured confounding of the DoR–health relationship is conceivable, mediation by SES variables and English Language proficiency, SES, and health behaviour is a more plausible scenario and was tested as above. When known (time-varying) effect modifiers (such as age and sex) and mediators (such as English language proficiency) were included in the DoR–health model, we used hybrid models specified in the form of Eq. (2).

All analyses were performed by using Statistical Analysis System (SAS) package version 9.3. To guard against possible inconsistency in the choice of covariance structure, robust standard errors for parameters were computed using a sandwich estimator (Diggle et al. 2002; Huber 1967; Liang and Zeger 1986; White 1980) by selecting the empirical option in SAS PROC MIXED.

Contrasts were used to test several hypotheses, e.g. whether foreign-born people (combining foreign-born country of birth subgroups) had a health advantage over native-born people. Similarly, for each foreign-born country of birth subgroup (English speaking or non-English speaking countries), we tested whether the health (PH, MH and SAH) of those with <10-year DoR was (statistically) the same as those with 10- to 19-year DoR and more than 20-year DoR (i.e. whether there is any trend in health outcome by DoR).

An interaction between exposures and the number of longitudinal observations per respondent in waves 1–10 was included in the models to test for dropout effects.

We received institutional review exemption from the Deakin University Human Research Ethics Committee.

Table 2 Multilevel linear mixed (model I) and hybrid (Models II, III and IV) regression model results showing estimates and their 95% confidence intervals (CI) for nativity by (1) physical health, (2) mental health and (3) self-assessed health

Effect	Model I		Model II		Model III		Model IV	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Physical health								
Nativity								
ES	1.212**	(0.736, 1.687)	1.204**	(0.729, 1.680)	0.939**	(0.491, 1.387)	0.874**	(0.457, 1.290)
NES	-0.805**	(-1.234, -0.376)	0.369	(-0.214, 0.952)	0.372	(-0.182, 0.927)	0.390	(-0.141, 0.922)
NB (R)								
T	-0.182**	(-0.201, -0.164)	-0.182**	(-0.201, -0.164)	-0.201**	(-0.221, -0.181)	-0.186**	(-0.205, -0.166)
ES*T	-0.120**	(-0.177, -0.064)	-0.120**	(-0.177, -0.064)	-0.107**	(-0.164, -0.051)	-0.102**	(-0.156, -0.048)
NES*T	0.012	(-0.043, 0.068)	0.008	(-0.048, 0.064)	0.010	(-0.045, 0.065)	0.004	(-0.050, 0.059)
Mental health								
Nativity								
ES	0.794**	(0.306, 1.282)	0.790**	(0.302, 1.278)	0.519*	(0.043, 0.995)	0.443	(-0.005, 0.892)
NES	-1.231**	(-1.689, -0.773)	0.095	(-0.551, 0.740)	0.014	(-0.612, 0.639)	-0.012	(-0.607, 0.583)
NB (R)								
T	-0.053**	(-0.073, -0.033)	-0.053**	(-0.072, -0.033)	-0.073**	(-0.094, -0.052)	-0.060**	(-0.081, -0.039)
ES*T	-0.082**	(-0.139, -0.024)	-0.082**	(-0.139, -0.024)	-0.066*	(-0.123, -0.008)	-0.058*	(-0.113, -0.002)
NES*T	-0.023	(-0.081, 0.034)	-0.027	(-0.085, 0.030)	-0.023	(-0.080, 0.034)	-0.028	(-0.084, 0.029)
Self-assessed health								
Nativity								
ES	0.128**	(0.078, 0.178)	0.127**	(0.077, 0.177)	0.095**	(0.048, 0.143)	0.090**	(0.046, 0.134)
NES	-0.072**	(-0.118, -0.025)	0.021	(-0.044, 0.086)	0.010	(-0.053, 0.072)	0.011	(-0.049, 0.071)

Table 2 continued

Effect	Model I		Model II		Model III		Model IV	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
NB (<i>R</i>)								
<i>T</i>	-0.023**	(-0.025, -0.021)	-0.023**	(-0.025, -0.021)	-0.025**	(-0.027, -0.023)	-0.024**	(-0.026, -0.022)
ES* <i>T</i>	-0.006*	(-0.012, 0.000)	-0.006*	(-0.012, 0.000)	-0.006*	(-0.012, 0.000)	-0.006*	(-0.012, 0.000)
NES* <i>T</i>	-0.002	(-0.008, 0.004)	-0.003	(-0.008, 0.003)	-0.003	(-0.008, 0.003)	-0.003	(-0.009, 0.003)

Nativity is categorised as NB (native-born), FB (foreign-born) from English speaking (ES) and non-English speaking (NES) countries. *T* represents wave number, and its values range from 0 (for first wave) to 9 (for 10th wave)

Model I includes age, sex, wave effect and number of times a respondent responded out of the ten waves (waves 1–10) as the covariates. Model II adds English language proficiency to the covariates of Model I. Model III adds household equivalised income, marital status, level of education and labour force participation status to the covariates of Model II. Model IV adds health behaviour variables (smoking, drinking and physical activity) to the covariates of Model III

* $p < 0.05$; ** $p < 0.01$

3 Results

The first analysis reported here (Table 2) used conventional mixed (Model I) and hybrid (Models II, III and IV) longitudinal regression models to address our first two research questions. The estimated regression coefficients for Model I represent the mean differences in PH and MH scores and SAH between immigrants and native-born people after controlling for age at wave 1, gender, wave (year) and number of times an individual responded in 10 waves of HILDA.

As listed in Table 2, Model I suggests a clear difference in average PH, MH scores and SAH between foreign-born subgroups in comparison with native-born Australians. After adjusting for other covariates, and including an interaction between nativity/country of birth and wave, foreign-born people from English speaking countries had a 1.21 point (95% confidence interval (CI) 0.74–1.69) advantage in PH with respect to native-born people, while foreign-born people from non-English speaking countries were disadvantaged by 0.81 points (CI 0.38–1.23) relative to native-born people. As a result of these similar magnitudes in advantage and disadvantage, when overall foreign-born and native-born differences were tested no significant differences were found in their PH. In contrast, foreign-born people from English speaking countries had a 0.79 point (CI 0.31–1.28) advantage in MH compared with native-born people, but foreign-born people from non-English speaking countries were disadvantaged by about 1.23 points (CI 0.77–1.69). As a result of the relatively larger disadvantage faced by immigrants from non-English speaking countries, there was a significant overall disadvantage in mental health for foreign-born people compared with the native-born. Results for SAH are similar to those for PH: a health advantage for the foreign-born from English speaking countries (relative to the native-born) and a health disadvantage for the foreign-born from non-English speaking countries of magnitude such that there was no overall difference in SAH by nativity status. Hypothesis tests showed that foreign-born people from English speaking countries were significantly better off in terms of PH, MH and SAH than the foreign-born from non-English speaking countries.

In Model II, English language proficiency was added to block paths between nativity/country of birth and health through this variable. There was little impact on main effect estimates for respondents from English speaking countries for any health outcome, but all main effect estimates for people from non-English speaking countries were substantially reduced in magnitude and not statistically significant, suggesting that mediation by English language proficiency may be important for non-English speaking respondents. Socio-economic factors including household equivalised income, employment status, marital status and level of education were added in Model III to additionally block the direct path through SES (i.e. passing first through SES) between nativity/country of birth and health. In this case, nativity parameter estimate for English speaking respondents reduced slightly in magnitude relative to Model II for all health outcomes, but there was no change in statistical significance. This suggests that direct mediation of the relationship between nativity/country of birth and health (PH, MH and SAH) by SES covariates might not

be important for English speaking or non-English speaking people, but further research is required for confirmation. Model IV additionally blocks the path between nativity/country of birth and health through health behaviour variables, but there was little change between exposure estimates from Model III, suggesting that direct mediation of the nativity/country of birth–health association by these variables might not be important for both English speaking and non-English speaking groups.

There was evidence that average temporal effects over the survey varied by nativity/country of birth. For example in Model 1, PH declined by 0.30 points per year ($-0.182 - 0.120 = -0.302$) (CI 0.25–0.36) for English speaking people significantly greater than the overall decline of 0.18 points per year (CI 0.16–0.20). Similarly, MH declined significantly faster than average [0.05 points per year (CI 0.03–0.07)] by 0.13 points per year ($-0.053 - 0.082 = -0.135$) CI 0.08–0.19) for English speaking respondents as did SAH [0.03 points per wave ($-0.023 - 0.006 = -0.029$) (CI 0.02–0.03)].

In order to address our second research question, we used mixed (Table 3, Model 1) and hybrid (Table 3, Models II, III, IV) regression models in which the estimated regression coefficients for the nativity/country of birth/duration of residence exposure represent mean differences in PH, MH and SAH between immigrant subgroups and native-born people, after controlling for wave and the number of waves in which a person responded (plus their interaction with exposure), and for effect modifiers age at wave 1 and sex. As before paths through potential mediators, English language proficiency, SES and health behaviours were blocked by progressively adding these variables to the model. The results of these analyses are listed in Table 3, Models I–IV, respectively.

From Model I, when DoR was <10 years, foreign-born respondents from English speaking countries had a statistically significant advantage of 2.03 points (CI 1.04–3.02) in PH relative to the native-born, and 1.22 points (CI 0.61–1.83) for DoR >20 years. Hypothesis tests showed that there was no measureable overall trend by DoR for foreign-born people from English speaking countries. In contrast, foreign-born people from non-English speaking countries had a statistically significant disadvantage of 0.71–0.91 points in PH regardless of DoR. For this group, there was also no significant overall trend in PH by DoR.

Regression results (Table 3, Model I) for MH showed that foreign-born people from English speaking countries with DoR >20 years had an advantage of 0.90 points (CI 0.29–1.51) in their MH levels relative to the native-born. However, foreign-born people from non-English speaking countries were disadvantaged relative to native-born people by 1.31–1.57 points in their MH levels for DoR larger than 10 years. Hypothesis tests showed that there was no measureable overall trend in MH by DoR for the foreign-born from English speaking or non-English speaking countries.

Foreign-born people from English speaking countries had a significant SAH advantage of 0.10–0.23 points relative to native-born people, and there was no evidence of an overall trend in SAH by DoR from hypothesis tests (Table 3, Model I). The foreign-born from non-English speaking countries were not found to have better levels of SAH than the native-born people for DoR <20 years, but

Table 3 Multilevel linear mixed (model I) and hybrid (Models II, III and IV) regression model results showing estimates and their 95% confidence intervals (CI) for nativity/duration of residence (DoR) by (1) physical health, (2) mental health and (3) self-assessed health

Effect	Model I			Model II			Model III			Model IV		
	Estimate	95% CI		Estimate	95% CI		Estimate	95% CI		Estimate	95% CI	
Physical health												
Nativity/DoR												
ES; DoR < 10	2.030**	(1.041, 3.020)		2.074**	(1.088, 3.060)		1.412**	(0.462, 2.363)		0.972*	(0.075, 1.869)	
ES; DoR 10–19	0.710	(−0.163, 1.584)		0.738	(−0.133, 1.608)		0.261	(−0.549, 1.071)		0.227	(−0.560, 1.014)	
ES; DoR ≥ 20	1.215**	(0.605, 1.825)		1.176**	(0.566, 1.786)		1.055**	(0.481, 1.629)		1.046**	(0.517, 1.575)	
NES; DoR < 10	−0.886*	(−1.599, −0.174)		0.905*	(0.034, 1.775)		1.391**	(0.528, 2.254)		1.382**	(0.522, 2.243)	
NES; DoR 10–19	−0.906*	(−1.620, −0.192)		0.517	(−0.345, 1.379)		0.520	(−0.310, 1.349)		0.364	(−0.440, 1.169)	
NES; DoR ≥ 20	−0.709*	(−1.370, −0.048)		0.350	(−0.352, 1.052)		0.200	(−0.457, 0.859)		0.281	(−0.352, 0.914)	
NB (R)												
T	−0.182**	(−0.201, −0.164)		−0.182**	(−0.201, −0.164)		−0.200**	(−0.220, −0.180)		−0.185**	(−0.204, −0.165)	
ES; DoR < 10*T	−0.095	(−0.248, 0.057)		−0.095	(−0.247, 0.058)		−0.100	(−0.249, 0.050)		−0.092	(−0.236, 0.052)	
ES; DoR 10–19*T	0.025	(−0.081, 0.130)		0.024	(−0.081, 0.130)		0.022	(−0.082, 0.127)		0.011	(−0.090, 0.112)	
ES; DoR ≥ 20*T	−0.170**	(−0.240, −0.100)		−0.170**	(−0.240, −0.099)		−0.150**	(−0.220, −0.080)		−0.140**	(−0.207, −0.073)	
NES; DoR < 10*T	0.152**	(0.044, 0.259)		0.148**	(0.040, 0.256)		0.118*	(0.010, 0.226)		0.109*	(0.001, 0.216)	
NES; DoR 10–19*T	0.060	(−0.039, 0.158)		0.057	(−0.042, 0.155)		0.042	(−0.056, 0.139)		0.029	(−0.069, 0.126)	
NES; DoR ≥ 20*T	−0.076	(−0.154, 0.002)		−0.081*	(−0.159, −0.003)		−0.055	(−0.132, 0.022)		−0.054	(−0.131, 0.022)	
Mental health												
Nativity/DoR												
ES; DoR < 10	1.083	(−0.080, 2.245)		1.144	(−0.017, 2.305)		0.415	(−0.730, 1.561)		−0.053	(−1.096, 0.991)	
ES; DoR 10–19	0.260	(−0.681, 1.202)		0.297	(−0.643, 1.236)		−0.113	(−1.020, 0.793)		−0.167	(−1.052, 0.719)	
ES; DoR ≥ 20	0.895**	(0.285, 1.505)		0.853**	(0.243, 1.463)		0.710*	(0.116, 1.304)		0.695*	(0.137, 1.253)	
NES; DoR < 10	−0.469	(−1.288, 0.350)		1.633**	(0.632, 2.638)		2.004**	(0.996, 3.012)		1.878**	(0.888, 2.868)	

Table 3 continued

Effect	Model I		Model II		Model III		Model IV	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
NES; DoR 10–19	-1.307**	(-2.090, -0.524)	0.414	(-0.539, 1.367)	0.402	(-0.528, 1.331)	0.147	(-0.752, 1.045)
NES; DoR ≥ 20	-1.569**	(-2.247, -0.890)	-0.309	(-1.059, 0.441)	-0.543	(-1.263, 0.178)	-0.468	(-1.151, 0.214)
NB (<i>R</i>)								
<i>T</i>	-0.053**	(-0.073, -0.033)	-0.053**	(-0.072, -0.033)	-0.072**	(-0.093, -0.051)	-0.060**	(-0.080, -0.039)
ES; DoR < 10* <i>T</i>	-0.118	(-0.292, 0.055)	-0.118	(-0.292, 0.056)	-0.114	(-0.285, 0.056)	-0.100	(-0.265, 0.065)
ES; DoR 10–19* <i>T</i>	-0.004	(-0.120, 0.113)	-0.004	(-0.120, 0.113)	-0.004	(-0.118, 0.111)	-0.016	(-0.129, 0.096)
ES; DoR ≥ 20 * <i>T</i>	-0.098**	(-0.167, -0.029)	-0.098**	(-0.167, -0.029)	-0.075*	(-0.144, -0.007)	-0.063	(-0.128, 0.003)
NES; DoR < 10* <i>T</i>	0.063	(-0.066, 0.192)	0.059	(-0.070, 0.189)	0.038	(-0.091, 0.167)	0.030	(-0.099, 0.158)
NES; DoR 10–19* <i>T</i>	0.017	(-0.084, 0.117)	0.015	(-0.086, 0.115)	-0.001	(-0.100, 0.098)	-0.013	(-0.111, 0.085)
NES; DoR ≥ 20 * <i>T</i>	-0.082*	(-0.159, -0.006)	-0.087*	(-0.164, -0.011)	-0.059	(-0.135, 0.016)	-0.058	(-0.134, 0.017)
Self-assessed health								
Nativity/DoR								
ES; DoR < 10	0.230**	(0.113, 0.347)	0.234**	(0.117, 0.351)	0.154**	(0.045, 0.263)	0.106*	(0.000, 0.211)
ES; DoR 10–19	0.101*	(0.002, 0.201)	0.103*	(0.004, 0.203)	0.054	(-0.042, 0.149)	0.049	(-0.040, 0.137)
ES; DoR ≥ 20	0.115**	(0.053, 0.177)	0.111**	(0.049, 0.173)	0.095**	(0.036, 0.153)	0.096**	(0.042, 0.150)
NES; DoR < 10	0.063	(-0.022, 0.149)	0.230**	(0.128, 0.333)	0.239**	(0.135, 0.342)	0.235**	(0.132, 0.337)
NES; DoR 10–19	-0.059	(-0.141, 0.024)	0.069	(-0.029, 0.166)	0.049	(-0.047, 0.144)	0.029	(-0.065, 0.124)
NES; DoR ≥ 20	-0.144**	(-0.212, -0.077)	-0.050	(-0.124, 0.025)	-0.064	(-0.135, 0.008)	-0.055	(-0.123, 0.014)
NB (<i>R</i>)								
<i>T</i>	-0.023**	(-0.025, 0.021)	-0.023**	(-0.025, -0.021)	-0.025**	(-0.027, -0.023)	-0.024**	(-0.026, -0.022)
ES; DoR < 10* <i>T</i>	-0.002	(-0.022, 0.017)	-0.002	(-0.022, 0.017)	-0.003	(-0.023, 0.016)	-0.003	(-0.022, 0.016)
ES; DoR 10–19* <i>T</i>	0.001	(-0.012, 0.013)	0.001	(-0.012, 0.013)	0.000	(-0.012, 0.013)	-0.001	(-0.013, 0.011)
ES; DoR ≥ 20 * <i>T</i>	-0.009**	(-0.016, -0.002)	-0.009**	(-0.016, -0.002)	-0.008*	(-0.015, -0.001)	-0.008*	(-0.015, -0.001)

Table 3 continued

Effect	Model I		Model II		Model III		Model IV	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
NES; DoR < 10*T	-0.010	(-0.022, 0.003)	-0.011	(-0.023, 0.002)	-0.013	(-0.025, 0.000)	-0.013*	(-0.026, 0.000)
NES; DoR 10-19*T	-0.001	(-0.011, 0.010)	-0.001	(-0.011, 0.009)	-0.002	(-0.012, 0.008)	-0.003	(-0.013, 0.007)
NES; DoR ≥ 20*T	0.001	(-0.007, 0.008)	0.000	(-0.008, 0.008)	0.002	(-0.006, 0.009)	0.002	(-0.006, 0.009)

Nativity is categorised as NB (native-born), FB (foreign-born) from English speaking (ES) and non-English speaking (NES) countries. DoR is categorised into <10 years, 10-19 years, and greater than or equal 20 years in Australia, and combined with the nativity status variable described above. *T* represents wave number, and its values range from 0 (for first wave) to 9 (for 10th wave)

Model I includes age, sex, wave effect and number of times a respondent responded out of the ten waves (waves 1-10) as the covariates. Model II adds English language proficiency to the covariates of Model I. Model III adds household equivalised income, marital status, level of education and labour force participation status to the covariates of Model II. Model IV adds health behaviour variables (smoking, drinking and physical activity) to the covariates of Model III

* $p < 0.05$; ** $p < 0.01$

significantly disadvantaged in terms of their SAH (compared to native-born people) by about 0.14 (CI 0.08–0.21) points for DoR ≥ 20 years. Hypothesis tests showed a statistically significant trend by DoR for this group.

In Model II, paths between nativity/country of birth/DoR and health passing first through English language proficiency were blocked by adding English language proficiency to Model I, leading to significant changes in exposure parameter estimates for non-English speaking respondents for all health outcomes. This suggests that English language proficiency might play an important mediating role in the relation between nativity/country of birth/DoR and health for this group. In Model III, progressively adding SES and health behaviour covariates to Model II had little additional impact on estimates from Model II for non-English speaking or English speaking respondents for any health outcome, though magnitudes reduced more noticeably for non-English speaking respondents with DoR < 10 years. This implies that direct mediation by SES through these paths might not be important for both English speaking and non-English speaking respondents, though further research is required for confirmation. Similarly, in Model IV there was little change from Model III estimates for English speaking and non-English speaking people, suggesting that mediation by health behaviour variables may not be important for either group.

In summary, foreign-born people from English speaking countries typically had a health advantage relative to native-born people for all health outcomes, and there was no evidence of a change in any health outcome by DoR. Foreign-born people from non-English speaking countries living in Australia were typically disadvantaged with respect to native-born people for PH and MH outcomes, and there was no evidence of a change in these health outcomes by DoR. However, foreign-born people from non-English speaking countries were disadvantaged in SAH relative to the native-born after 20 years of stay in Australia, and there was a statistically significant evidence that self-assessed health changed by DoR in Australia, among this immigrant group. English language proficiency might be an important mediator of the nativity/DoR—health association for non-English speaking people, whereas SES and health behaviours might not be important for English speaking or non-English speaking groups, though confirmation of this will require further research.

Average temporal gradients within the survey period also depended significantly on nativity/country of birth/DoR. From Model I (Table 3), the decline in PH for English speaking respondents with DoR at least 20 years was significantly larger [0.35 points per year ($-0.182 - 0.170 = -0.352$) (CI 0.30–0.41)] than the overall decline [0.18 points per year (CI 0.16–0.20)]. Conversely, the decline in PH for non-English speaking respondents with DoR < 10 years was significantly smaller (0.03 points per year ($-0.182 + 0.152 = -0.03$) (CI $-0.02, 0.08$)) than the overall decline. The decline in MH for the English speaking and non-English speaking groups with DoR at least 20 years was significantly larger (0.15 points per year (CI 0.10–0.21) and 0.14 points per year (CI 0.08–0.135), respectively) than the overall decline [0.05 points per year (CI 0.03–0.07)]. For SAH, only English speaking respondents with DoR > 20 years showed a significant different decline over time [0.03 points per year (CI 0.03–0.04)] than average [0.02 points per year (CI 0.03, 0.03)].

In all cases, the interaction between exposure and number of longitudinal observations per respondent was not significant. Thus, we found no evidence that estimates of the exposure–outcome association differed significantly by the number of longitudinal observations per respondent, suggesting that dropout was not important.

4 Discussion and Conclusion

With respect to our three research questions, we found that:

1. There were no differences by (overall) nativity status in PH and SAH, but substantial differences in MH between immigrants and native-born Australians were observed. However, there were significant differences between immigrant country of birth subgroups and native-born people for all health measures.
2. Immigrants from non-English speaking countries living in Australia were typically disadvantaged with respect to native-born people for physical and mental health outcomes, and there was no evidence of a change in these health outcomes by DoR. However, foreign-born people from non-English speaking countries were disadvantaged in self-assessed health relative to the native-born after 20 years of stay in Australia, and there was evidence of a significant trend in DoR. Immigrants from English speaking countries typically had a health advantage relative to native-born people for all health outcomes, and there was no evidence of a change in any health outcome by DoR.
3. Additionally we found that English language proficiency may be an important mediator of the health–DoR relationship for non-English speaking people, but that SES and health behaviours may not be important mediators of the health–DoR relationship for both English speaking and non-English speaking groups.

The healthy immigrant effect (HIE) suggests that, on initial arrival, immigrants might be better off in terms of their health than their native-born counterparts due to voluntary positive selection among immigrants, cultural buffering by their native culture, and legal barriers against entry for those in poor health (Akresh and Frank 2008; Antecol and Bedard 2006; McDonald and Kennedy 2004; Rivera et al. 2016). Contrary to many studies mentioned in “Introduction”, which found that immigrants have better health than the native-born, we found little evidence of differences in any health outcome by overall nativity status. A potential explanation for this lack of difference was that it masked substantial heterogeneity within immigrant groups. For example, as indicated in Table 2, immigrants from English speaking countries had an additional 1.2 point advantage in PH over native-born people, while immigrants from non-English speaking were disadvantaged by a similar amount (0.8 points). As a result of these similar magnitudes of advantage and disadvantage, no significant differences in PH were found for the combined foreign-born group with respect to native-born people. Our findings support the contention that ethnic minority groups should not simply be combined when trying to estimate the healthy immigrant effect and subsequent health trajectory

(Kobayashi and Prus 2012). Failure to take into account the heterogeneity of immigrant subgroups risks masking substantial disparity and diversity of need. Moreover, we found that foreign-born people from non-English speaking countries were significantly disadvantaged with respect to the native-born people for all the health outcomes considered in this study.

Our second research question tested the extent to which the association between nativity status and health can be attributable to duration of residence. According to the healthy immigrant effect (HIE), the health advantage among new immigrants decreases as the length of residence in their adopted country increases. In our study, there was no evidence of duration of residence effects for immigrants from non-English speaking countries in physical and mental health outcomes. In contrast, immigrants from English speaking countries living in Australia were advantaged with respect to native-born people regardless of DoR for all health outcomes and also did not experience a significant health decline by DoR with respect to any outcome health measure. These results may be contrary to those of Setia et al. who found that visible minority immigrants or non-white immigrants (both males and females) were less likely to report poor psychological health than Canadian-born individuals (Setia et al. 2012). However, one recent Australian study found that men from non-English speaking background had higher odds of depression, while there was no difference between Australian-born and foreign-born individuals from English speaking backgrounds on any health measure (Straiton et al. 2014).

We found that English language proficiency might mediate the association between nativity, and health for immigrants from non-English speaking countries, while there was little convincing evidence of mediation by SES between nativity and health for immigrants from English or non-English speaking countries. Another key finding was that English language proficiency mediated the association between duration of residence and health for immigrants from non-English speaking countries. Unlike many previous studies which argued that acculturation into the host society worsens immigrant health through various mechanisms such as the adoption of unhealthy behaviours (Lara et al. 2005, Abraido-Lanza et al. 2006, Thomas 1995), we did not find convincing evidence that health behaviour mediates the DoR–health association for any immigrant group. Though we did find in our other work that DoR does affect health behaviour depending upon the specific health behaviour and the specific foreign-born group (Joshi 2017), acculturation can have a positive or a negative impact on health, depending on the style of acculturation (Berry 1990), country of origin, cultural differences between the source and destination countries, and migration circumstances and the strength of health selection for the particular migrant population (Chiswick, Lee, and Miller 2008, Frisbie, Youngtae, and Hummer 2001). The hypotheses that a decline in health among migrants is attributable to adopting native-born behaviours assume that the country of origin has better health behaviours than the country migrated to, and/or migration to Western countries is necessarily accompanied by negative changes in health behaviours. The validity of this assumption depends on the country of origin, and Australia could be more health promoting for some behaviours than the country of origin, e.g. less air pollution, more green space and more exercise facilities promoting physical activity post-migration. In other

instances, there may be no differences in the health behaviours of immigrants because of greater similarities between Australia and the country of origin. In fact, much of the early theoretical work on immigration was based on the experience of the Hispanic population in the USA after World War II, and its international application to other migrant groups and other time periods may be less valid (Salant and Lauderdale 2003).

Three arguments might explain our finding that English language proficiency may be an important contributor for a health disadvantage for immigrants from non-English speaking countries. First, poor English language proficiency be a barrier to accessing health services (Kandula et al. 2004; Stronks et al. 2001). Second, the link between English language proficiency and health may be mediated by employment (Grondin 2007). Employment is not only a social determinant of health, but can also serve as a source of social networking, social support and self-esteem. Third, English language proficiency might act via acculturative stress as well. For example, for many migrants, not speaking the language of the dominant culture may create long-term acculturative stress and adverse effects on health (Pudarcic et al. 2003). Migrant health research has long recognised that migration is a stressful life event (Hull 1979). Thus, psychological distress would be heightened if migration coincides with acculturative stress such as from lack of English language skills, lack of recognition of educational qualifications, and difficulties in dealing with new institutions and learning new social norms. Previous migrant health research has proposed that acculturation negatively affects the health of immigrants over time depending upon minority status. For example, non-European minority immigrants (a visible group) may be exposed to acculturative stress through the process of adoption and acculturation in a new society (Thomas 1995). In contrast, a health benefit might accrue to European immigrants in North America (say) because they more easily assimilate into the host country since it shares a similar cultural background (Dunn and Dyck 2000; Ng et al. 2005). Greater acculturation has been shown to be associated with increased health risks (Abraido-Lanza et al. 2006).

The role of government migration policy over the past several decades may provide another explanation for a decline in the health of immigrants. Australia's immigration policies have evolved over the years from a narrowly targeted programme designed to achieve the "populate or perish" objective after World War II, to a more open programme since the 1980s aimed primarily at meeting the labour market needs of Australian economy (Spinks 2010). Because the post-World War II focus was on increasing numbers to defend the country in the event of another war, it seems reasonable to suppose that health selection barriers for migrants were, in practice, low. It also seems reasonable to suppose that after the tightening of Australian migration policy in the 1980s, with a focus on better labour market performance of migrants to Australia, health criteria were more diligently enforced. Introduction of various policy measures in the mid-1980s, which emphasised skills, education and language proficiency, may have added indirect forms of health selection to these direct (medical screening) forms. Note that the DoR period 0–9 years, 10–19 years, and 20 years or longer correspond to arrival periods after 1996, between 1986 and 1995, and before 1986, respectively. Under these assumptions, a significant proportion of migrants with duration of residence

<20 years have been subject in practice to more intense health selection pressures than those with longer durations of residence, resulting in overall better health for those who settled in Australia after the mid-1980s compared with earlier migrants.

A full explanation for the lack of change in health of immigrants over time vis-à-vis the native-born, and specifying which of these possible explanations is most relevant to each subgroup may not be straightforward as the processes underlying these explanations may work both in competing and in complementary ways to produce divergent health outcomes. Moreover, a combination of processes operating over time may cause health to decline more rapidly among some immigrant groups. For example, while longer duration of stay (associated with better English proficiency) and improved socio-economic status (Akresh 2007; Chiswick et al. 2004) are strong predictors of good health (McKeever and Klineberg 1999), longer duration of residence (increased acculturation and contact with the dominant society) also brings with it accumulated exposure to discrimination, stressful social encounters (Vega et al. 1999) and attenuated aspirations (McKeever and Klineberg 1999), which are related to a decline in health. These positive and negative changes could lead to both beneficial and deleterious effects on health, and their net effect would depend upon relative magnitudes.

This research has produced several important findings related to the nativity health gap in Australia using nationally representative longitudinal survey data, but the present analyses were not without limitations. First, our results and conclusions for DoR assume that there is little or no unmeasured confounding of the DoR–health relation.

Second, measurement error has been ignored. For example, SAH might also be affected by foreign-born–native-born differential reporting behaviour, and one could therefore question the reliability and validity of SAH. If the reporting of health outcome among immigrants differed in some systematic way from the native-born, this might bias the results, though the magnitude and direction of such bias are unknown. While SAH is widely used in the social sciences and is a well-established and reliable instrument in cross-sectional studies (Idler and Benyamini 1997), longitudinal measurement of SAH may suffer from measurement error, e.g. from ceiling effects (Gunasekara et al. 2012).

Third, we do not focus on migrant generation status since our major research question deals with what happens as migrants stay longer in the host country. First-generation migrants (i.e. those born overseas) were treated as a foreign-born group because only they experienced the process of migration itself. Second-generation migrants (i.e. those born in Australia and having at least one foreign-born parent) were included in the native-born group. Fourth, grouping all classes of the foreign-born into one category (economic, family and refugees) ignores the heterogeneity of this group. Information on type of migration (visa category) is available only from wave 4 onwards. Since we used all those respondents who responded in wave 1 and in at least in one more wave between waves 2–10, we could not use the information on visa type. We acknowledge that migrants who came for work may show different health patterns than those coming as family migrants or refugees. Additionally, the data used in this study do not allow us to differentiate between immigrants based on their legal status. Similar remarks apply to the broad country of birth sub-categories

(English speaking and non-English speaking countries) used in this analysis. Particularly, several dimensions of NES countries immigrant diversity were not captured in our analyses. This group of migrants from non-English speaking countries is heterogeneous and come from countries, which have morbidity/mortality conditions quite distinct from those in Australia. However, other researchers have looked at “imported risk” and “health transition to the host country” (e.g. Reiss et al. 2010), but it is beyond the scope of this paper to explore these effects. Moreover, small numbers prevented the use of smaller subgroups for the foreign-born.

Fifth, as already noted it was not possible to separate start-of-survey duration of residence effects, from period/cohort effects. Similarly, within-survey temporal trends can be caused by both a decline in the health of the study sample over time through ageing, and external influences manifest in respondent health during the course of the survey (e.g. changes in health policy). One important variable in the context of migration is age at migration (Leão et al. 2009). However, migration studies are not generally able to separate out the effect of age at migration from duration of residence in the host population (Kinra 2004). We had limited power to examine the association of nativity/DoR and age at arrival with health.

Sixth, we have assumed that the direction of causal effect in Fig. 1 goes from ELP to SES. It is plausible that the causal arrow might also work at times in the other direction, e.g. being employed in a predominantly English speaking environment could improve proficiency in the English language. This would be an example of so-called reverse causation, an effect which is not amenable to the approach used in this paper (Wooldridge 2010) and would require more complex methods of causal analysis (Pearl 2009; Robins and Hernán 2009). Of course, such methods have their own limitations, one being that rich datasets are required for estimation. Given the limitations of the HILDA dataset, there is still a place for the simpler analyses used here, provided that the underlying assumptions are born in mind.

Despite these limitations, this study makes an important contribution to the migrant health literature. It used a large, original, national longitudinal survey containing a variety of health measures to examine the nativity–health association. The longitudinal design permitted following up native-born individuals and immigrants of different lengths of residence in Australia over time to directly test the rates of change among different groups. Furthermore, the use of longitudinal data and both conventional mixed models and group-mean-centred multilevel models helped us to address some of the limitations of previous research. Overall, this study contributes to an emerging evidence base on the relationship between migration and health. This study shows in the context of Australia the existence of a healthy immigrant effect for immigrants from English speaking countries but not for those migrating from non-English speaking countries. It also shows that the effect of duration of residence in Australia does not appear to be universal across all health measures and immigrant groups. Rather, it varies according to the measure of health and immigrant group under consideration.

It would be interesting to know whether lower mental health may be caused, say by acculturative stress or reason to migrate, or may be related to physical health, say

caused by worse work conditions. We could not include PH as a control in our mental health model (or for the various health outcomes) since this would violate exogeneity assumptions. Exploration of the relationship between mental and physical models would require more sophisticated causal models than used here and is thus out of scope. Future research using longitudinal data should examine the other mechanism(s) through which immigrants maintain their health advantage or disadvantage over time, why the health advantage/disadvantage is sensitive to health measures, and whether this varies within the broad categories for country of birth used here. This knowledge is particularly important for designing effective policy interventions, which will require identification of modifiable determinants of the observed long-term decline in the health of some immigrant groups in Australia. The impact of English language proficiency, socio-economic status and health behaviours on non-English speaking immigrant health also deserves closer study. The findings from this paper suggest that policies focusing on improving the health of individuals should broaden to include nativity/country of birth/duration of residence with particular attention being given initially to immigrants from non-English speaking countries to address their health disadvantage.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Appendix (Full Regression Results)

Tables 4, 5, 6, 7, 8 and 9.

Table 4 Multilevel linear mixed (model I) and hybrid (Models II, III and IV) regression model results showing estimates and their 95% confidence intervals (CI), with physical health as the outcome variable and country of birth as the main exposure variable

Effect	Model I			Model II			Model III			Model IV		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Intercept	42.369**	(41.756, 42.981)		42.544**	(41.929, 43.159)		49.067**	(48.251, 49.883)		40.524**	(39.484, 41.563)	
Nativity												
ES countries	1.212**	(0.736, 1.687)		1.204**	(0.729, 1.680)		0.939**	(0.491, 1.387)		0.874**	(0.457, 1.290)	
NES countries	-0.805**	(-1.234, -0.376)		0.369	(-0.214, 0.952)		0.372	(-0.182, 0.927)		0.390	(-0.141, 0.922)	
Australia (<i>R</i>)												
<i>T</i>	-0.182**	(-0.201, -0.164)		-0.182**	(-0.201, -0.164)		-0.201**	(-0.221, -0.181)		-0.186**	(-0.205, -0.166)	
7*ES countries	-0.120**	(-0.177, -0.064)		-0.120**	(-0.177, -0.064)		-0.107**	(-0.164, -0.051)		-0.102**	(-0.156, -0.048)	
7*NES countries	0.012	(-0.043, 0.068)		0.008	(-0.048, 0.064)		0.010	(-0.045, 0.065)		0.004	(-0.050, 0.059)	
Age group												
15–29 years	9.738**	(9.318, 10.158)		9.670**	(9.249, 10.092)		3.667**	(3.083, 4.251)		3.478**	(2.939, 4.017)	
30–44 years	8.205**	(7.779, 8.630)		8.165**	(7.739, 8.591)		1.963**	(1.391, 2.536)		2.187**	(1.670, 2.703)	
45–59 years	5.101**	(4.615, 5.588)		5.056**	(4.570, 5.542)		0.154	(-0.419, 0.727)		0.119	(-0.384, 0.622)	
≥60 years (<i>R</i>)												
Gender												
Female	-0.782**	(-1.046, -0.517)		-0.746**	(-1.009, -0.482)		0.479**	(0.222, 0.736)		0.450**	(0.215, 0.685)	
Male (<i>R</i>)												
Number of times responded	0.265**	(0.211, 0.319)		0.250**	(0.196, 0.304)		0.172**	(0.120, 0.223)		0.096**	(0.048, 0.144)	
English language proficiency												
English not good _Mean				-6.498**	(-8.011, -4.984)		-3.777**	(-5.248, -2.306)		-2.084**	(-3.577, -0.592)	
English good _Mean				-0.859**	(-1.511, -0.207)		-0.640*	(-1.266, -0.015)		-0.024	(-0.626, 0.579)	
English not good _md				-0.314	(-1.237, 0.609)		-0.273	(-1.190, 0.645)		-0.185	(-1.125, 0.754)	
English good _md				-0.160	(-0.467, 0.147)		-0.116	(-0.423, 0.190)		-0.175	(-0.481, 0.130)	
<i>Equalised income_mean</i>							0.457**	(0.383, 0.531)		0.344**	(0.280, 0.408)	

Table 4 continued

Effect	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
<i>Equivalised income_md</i>					0.069**	(0.044, 0.093)	0.057**	(0.033, 0.082)
Current employment status								
Not in labour force_mean					-6.928**	(-7.449, -6.407)	-5.598**	(-6.071, -5.126)
Unemployed_mean					-5.021**	(-6.377, -3.665)	-4.106**	(-5.378, -2.835)
Not in labour force_md					-1.215**	(-1.408, -1.022)	-1.188**	(-1.376, -1.000)
Unemployed_md					-0.858**	(-1.160, -0.555)	-0.889**	(-1.190, -0.589)
Current marital status								
Never married_mean					-0.294	(-0.680, 0.093)	-0.460*	(-0.821, -0.098)
Widowed_mean					-2.227**	(-2.696, -1.759)	-1.547**	(-1.974, -1.121)
Never married_md					-0.281*	(-0.546, -0.017)	-0.365**	(-0.626, -0.104)
Widowed_md					-0.091	(-0.382, 0.200)	-0.159	(-0.445, 0.127)
Level of education								
<12 years_mean					-0.796**	(-1.169, -0.424)	0.051	(-0.294, 0.397)
Exactly 12 years_mean					0.122	(-0.287, 0.530)	0.436*	(0.052, 0.821)
Diploma_mean					-0.591**	(-0.929, -0.252)	-0.190	(-0.504, 0.123)
<12 years_md					-0.236	(-0.735, 0.263)	-0.115	(-0.611, 0.382)
Exactly 12 years_md					-0.387*	(-0.776, 0.001)	-0.302	(-0.688, 0.084)
Diploma_md					-0.053	(-0.500, 0.394)	0.022	(-0.421, 0.464)
Smoking status								
Former smoker_mean							-0.750**	(-1.056, -0.444)
Current smoker_mean							-1.630**	(-1.960, -1.300)
Former smoker_md							-0.161	(-0.404, 0.081)
Current smoker_md							0.041	(-0.262, 0.344)

Table 4 continued

Effect	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Drinking status								
Former drinker _mean							-3.626**	(-4.546, -2.705)
Current drinker _mean							0.163	(-0.378, 0.704)
Former drinker _md							-0.401*	(-0.745, -0.057)
Current drinker _md							0.864**	(0.562, 1.166)
Physical activity status								
Insufficient physical activity _mean							8.627**	(7.893, 9.361)
Sufficient physical activity _mean							11.858**	(11.190, 12.526)
Insufficient physical activity _md							1.854**	(1.661, 2.048)
Sufficient physical activity _md							2.962**	(2.749, 3.175)

* $p < 0.05$; ** $p < 0.01$

Table 5 Multilevel linear mixed (model I) and hybrid (Models II, III and IV) regression model results showing estimates and their 95% confidence intervals (CI), with mental health as the outcome variable and country of birth as the main exposure variable

Effect	Model I			Model II			Model III			Model IV		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Intercept	47.523**	(46.917, 48.129)		47.707**	(47.098, 48.315)		52.506**	(51.660, 53.351)		45.602**	(44.521, 46.683)	
Nativity												
ES countries	0.794**	(0.306, 1.282)		0.790**	(0.302, 1.278)		0.519*	(0.043, 0.995)		0.443	(-0.005, 0.892)	
NES countries	-1.231**	(-1.689, -0.773)		0.095	(-0.551, 0.740)		0.014	(-0.612, 0.639)		-0.012	(-0.607, 0.583)	
Australia (<i>R</i>)												
7*ES countries	-0.082**	(-0.139, -0.024)		-0.082**	(-0.139, -0.024)		-0.066*	(-0.123, -0.008)		-0.058*	(-0.113, -0.002)	
7*NES countries	-0.023	(-0.081, 0.034)		-0.027	(-0.085, 0.030)		-0.023	(-0.080, 0.034)		-0.028	(-0.084, 0.029)	
Age group												
15–29 years	1.977**	(1.556, 2.397)		1.928**	(1.506, 2.350)		-2.234**	(-2.845, -1.623)		-2.061**	(-2.637, -1.485)	
30–44 years	1.718**	(1.308, 2.127)		1.691**	(1.281, 2.102)		-3.017**	(-3.594, -2.440)		-2.514**	(-3.047, -1.980)	
45–59 years	1.332**	(0.879, 1.785)		1.291**	(0.840, 1.743)		-2.493**	(-3.053, -1.932)		-2.373**	(-2.879, -1.867)	
≥60 years (<i>R</i>)												
Gender												
Female	-1.224**	(-1.500, -0.948)		-1.189**	(-1.464, -0.914)		-0.266	(-0.544, 0.012)		-0.302*	(-0.561, -0.043)	
Male (<i>R</i>)												
<i>T</i>												
Number of times responded	-0.053**	(-0.073, -0.033)		-0.053**	(-0.072, -0.033)		-0.073**	(-0.094, -0.052)		-0.060**	(-0.081, -0.039)	
English not good _Mean	0.234**	(0.177, 0.291)		0.217**	(0.160, 0.274)		0.136**	(0.080, 0.192)		0.065*	(0.012, 0.118)	
English good _Mean				-6.380**	(-7.833, -4.928)		-4.217**	(-5.673, -2.761)		-2.818**	(-4.277, -1.359)	
English not good _md				-1.173**	(-1.899, -0.447)		-0.845*	(-1.551, -0.140)		-0.318	(-0.998, 0.361)	
English good _md				-0.088	(-0.995, 0.819)		-0.056	(-0.957, 0.846)		0.038	(-0.883, 0.959)	
English good _md				-0.042	(-0.400, 0.317)		-0.001	(-0.358, 0.356)		-0.051	(-0.408, 0.306)	
<i>Equivalised income _mean</i>							0.447**	(0.372, 0.522)		0.332**	(0.266, 0.399)	

Table 5 continued

Effect	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Not in labour force _mean					-5.232**	(-5.773, -4.692)	-4.119**	(-4.617, -3.621)
Unemployed _mean					-6.711**	(-8.236, -5.186)	-5.505**	(-6.923, -4.087)
Never married _mean					-1.222**	(-1.663, -0.781)	-1.401**	(-1.816, -0.985)
Widowed _mean					-2.125**	(-2.599, -1.652)	-1.441**	(-1.882, -0.999)
<12 years _mean					-0.302	(-0.700, 0.096)	0.550**	(0.175, 0.926)
Exactly 12 years _mean					0.429	(-0.037, 0.895)	0.764**	(0.324, 1.205)
Diploma _mean					-0.091	(-0.463, 0.281)	0.349*	(0.000, 0.698)
<i>Equivalised income_md</i>					0.090**	(0.063, 0.117)	0.079**	(0.052, 0.106)
Not in labour force _md					-0.836**	(-1.041, -0.632)	-0.840**	(-1.040, -0.640)
Unemployed _md					-1.068**	(-1.421, -0.714)	-1.117**	(-1.470, -0.764)
Never married _md					-0.596**	(-0.916, -0.276)	-0.685**	(-1.004, -0.367)
Widowed _md					-1.285**	(-1.628, -0.941)	-1.340**	(-1.680, -1.001)
<12 years _md					-0.287	(-0.953, 0.379)	-0.254	(-0.919, 0.410)
Exactly 12 years _md					-0.398	(-0.930, 0.135)	-0.296	(-0.829, 0.237)
Diploma _md					-0.286	(-0.900, 0.327)	-0.241	(-0.852, 0.370)
Former smoker _md							-0.160	(-0.435, 0.116)
Current smoker _md							-0.370*	(-0.713, -0.027)
Former drinker _md							-0.401*	(-0.778, -0.025)
Current drinker _md							0.526**	(0.202, 0.849)
Insufficient physical activity _md							1.664**	(1.464, 1.864)
Sufficient physical activity _md							3.047**	(2.827, 3.268)
Former smoker _mean							-0.588**	(-0.913, -0.263)
Current smoker _mean							-2.337**	(-2.715, -1.959)
Former drinker _mean							-3.885**	(-4.843, -2.927)

Table 5 continued

Effect	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Current drinker _mean							-0.354	(-0.909, 0.202)
Insufficient physical activity _mean							6.768**	(6.008, 7.529)
Sufficient physical activity _mean							10.787**	(10.104, 11.470)

* $p < 0.05$; ** $p < 0.01$

Table 6 Multilevel linear mixed (model I) and hybrid (Models II, III and IV) regression model results showing estimates and their 95% confidence intervals (CI), with self-assessed health as the outcome variable and country of birth as the main exposure variable

Effect	Model I			Model II			Model III			Model IV		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Intercept	2.731**	(2.672, 2.790)		2.748**	(2.689, 2.807)		3.380**	(3.294, 3.466)		2.687**	(2.582, 2.792)	
Nativity												
ES countries	0.128**	(0.078, 0.178)		0.127**	(0.077, 0.177)		0.095**	(0.048, 0.143)		0.090**	(0.046, 0.134)	
NES countries	-0.072**	(-0.118, -0.025)		0.021	(-0.044, 0.086)		0.010	(-0.053, 0.072)		0.011	(-0.049, 0.071)	
Australia (R)												
7*ES countries	-0.006*	(-0.012, 0.000)		-0.006*	(-0.012, 0.000)		-0.006*	(-0.012, 0.000)		-0.006*	(-0.012, 0.000)	
7*NES countries	-0.002	(-0.008, 0.004)		-0.003	(-0.008, 0.003)		-0.003	(-0.008, 0.003)		-0.003	(-0.009, 0.003)	
Age group												
15–29 years	0.856**	(0.815, 0.897)		0.846**	(0.804, 0.887)		0.344**	(0.284, 0.403)		0.379**	(0.324, 0.435)	
30–44 years	0.643**	(0.603, 0.683)		0.636**	(0.596, 0.676)		0.112**	(0.057, 0.167)		0.183**	(0.133, 0.234)	
45–59 years	0.381**	(0.337, 0.425)		0.376**	(0.332, 0.420)		-0.039	(-0.092, 0.014)		-0.014	(-0.061, 0.034)	
≥60 years (R)												
Gender												
Female	0.002	(-0.026, 0.030)		0.006	(-0.022, 0.033)		0.102**	(0.075, 0.130)		0.098**	(0.073, 0.123)	
Male (R)												
T	-0.023**	(-0.025, -0.021)		-0.023**	(-0.025, -0.021)		-0.025**	(-0.027, -0.023)		-0.024**	(-0.026, -0.022)	
Number of times responded	0.021**	(0.015, 0.026)		0.019**	(0.014, 0.025)		0.010**	(0.004, 0.015)		0.003	(-0.002, 0.008)	
English not good _Mean				-0.679**	(-0.828, -0.531)		-0.420**	(-0.563, -0.276)		-0.289**	(-0.433, -0.144)	
English good _Mean				-0.031	(-0.103, 0.042)		-0.024	(-0.095, 0.047)		0.034	(-0.035, 0.103)	
English not good _md				-0.020	(-0.103, 0.063)		-0.016	(-0.099, 0.067)		0.003	(-0.081, 0.087)	
English good _md				0.020	(-0.018, 0.057)		0.023	(-0.014, 0.060)		0.016	(-0.022, 0.053)	
<i>Equalised income _mean</i>							0.047**	(0.037, 0.056)		0.033**	(0.025, 0.042)	
Not in labour force _mean							-0.555**	(-0.608, -0.503)		-0.442**	(-0.490, -0.394)	

Table 6 continued

Effect	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Unemployed_mean					-0.429**	(-0.570, -0.287)	-0.283**	(-0.415, -0.150)
Never married_mean					-0.039	(-0.084, 0.006)	-0.057**	(-0.098, -0.015)
Widowed_mean					-0.108**	(-0.153, -0.063)	-0.033	(-0.075, 0.008)
<12 years_mean					-0.217**	(-0.259, -0.176)	-0.124**	(-0.162, -0.085)
Exactly 12 years_mean					-0.059*	(-0.107, -0.010)	-0.019	(-0.064, 0.026)
Diploma_mean					-0.156**	(-0.196, -0.117)	-0.105**	(-0.142, -0.069)
<i>Equivalised income_md</i>					0.007**	(0.004, 0.010)	0.006**	(0.004, 0.009)
Not in labour force_md					-0.062**	(-0.082, -0.042)	-0.061**	(-0.081, -0.041)
Unemployed_md					-0.034*	(-0.068, -0.001)	-0.037*	(-0.071, -0.003)
Never married_md					-0.010	(-0.042, 0.022)	-0.018	(-0.049, 0.014)
Widowed_md					0.032*	(0.001, 0.064)	0.027	(-0.004, 0.058)
<12 years_md					0.009	(-0.060, 0.077)	0.008	(-0.059, 0.074)
Exactly 12 years_md					-0.106**	(-0.164, -0.048)	-0.098**	(-0.155, -0.041)
Diploma_md					-0.042	(-0.104, 0.020)	-0.041	(-0.102, 0.020)
Former smoker_md							-0.008	(-0.036, 0.020)
Current smoker_md							-0.046**	(-0.081, -0.012)
Former drinker_md							-0.008	(-0.044, 0.028)
Current drinker_md							0.058**	(0.026, 0.090)
Insufficient physical activity_md							0.124**	(0.105, 0.142)
Sufficient physical activity_md							0.260**	(0.239, 0.280)
Former smoker_mean							-0.111**	(-0.143, -0.078)
Current smoker_mean							-0.316**	(-0.351, -0.280)
Former drinker_mean							-0.287**	(-0.378, -0.196)
Current drinker_mean							0.042	(-0.014, 0.097)

Table 6 continued

Effect	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Insufficient physical activity _mean							0.573**	(0.504, 0.641)
Sufficient physical activity _mean							1.053**	(0.992, 1.114)

* $p < 0.05$; ** $p < 0.01$

Table 7 Multilevel linear mixed (model I) and hybrid (Models II, III and IV) regression model results showing estimates and their 95% confidence intervals (CI), with physical health as the outcome variable and duration of residence as the main exposure variable

Effect	Model I			Model II			Model III			Model IV		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Intercept	42.400**	(41.784, 43.015)		42.614**	(41.994, 43.233)		49.086**	(48.268, 49.903)		40.459**	(39.420, 41.498)	
ES; DOR < 10 years	2.030**	(1.041, 3.020)		2.074**	(1.088, 3.060)		1.412**	(0.462, 2.363)		0.972*	(0.075, 1.869)	
ES; DOR 11–20	0.710	(−0.163, 1.584)		0.738	(−0.133, 1.608)		0.261	(−0.549, 1.071)		0.227	(−0.560, 1.014)	
ES; DOR > 20	1.215**	(0.605, 1.825)		1.176**	(0.566, 1.786)		1.055**	(0.481, 1.629)		1.046**	(0.517, 1.575)	
NES; DOR < 10	−0.886*	(−1.599, −0.174)		0.905*	(0.034, 1.775)		1.391**	(0.528, 2.254)		1.382**	(0.522, 2.243)	
NES; DOR 11–20	−0.906*	(−1.620, −0.192)		0.517	(−0.345, 1.379)		0.520	(−0.310, 1.349)		0.364	(−0.440, 1.169)	
NES; DOR ≥ 20	−0.709*	(−1.370, −0.048)		0.350	(−0.352, 1.052)		0.201	(−0.457, 0.859)		0.281	(−0.352, 0.914)	
Australia (<i>R</i>)												
7*ES; DOR < 10 years	−0.095	(−0.248, 0.057)		−0.095	(−0.247, 0.058)		−0.100	(−0.249, 0.050)		−0.092	(−0.236, 0.052)	
7*ES; DOR 11–20	0.025	(−0.081, 0.130)		0.024	(−0.081, 0.130)		0.022	(−0.082, 0.127)		0.011	(−0.090, 0.112)	
7*ES; DOR > 20	−0.170**	(−0.240, −0.100)		−0.170**	(−0.240, −0.099)		−0.150**	(−0.220, −0.080)		−0.140**	(−0.207, −0.073)	
7*NES; DOR < 10	0.152**	(0.044, 0.259)		0.148**	(0.040, 0.256)		0.118*	(0.010, 0.226)		0.109*	(0.001, 0.216)	
7*NES; DOR 11–20	0.060	(−0.039, 0.158)		0.057	(−0.042, 0.155)		0.042	(−0.056, 0.139)		0.029	(−0.069, 0.126)	
7*NES; DOR ≥ 20	−0.076	(−0.154, 0.002)		−0.081*	(−0.159, −0.003)		−0.055	(−0.132, 0.022)		−0.054	(−0.131, 0.022)	
Age group												
15–29 years	9.665**	(9.234, 10.095)		9.544**	(9.113, 9.976)		3.530**	(2.938, 4.121)		3.370**	(2.824, 3.915)	
30–44 years	8.144**	(7.710, 8.577)		8.064**	(7.630, 8.498)		1.857**	(1.279, 2.435)		2.104**	(1.582, 2.626)	
45–59 years	5.083**	(4.595, 5.571)		5.021**	(4.534, 5.508)		0.110	(−0.464, 0.684)		0.086	(−0.419, 0.590)	
≥60 years (<i>R</i>)												
Gender												
Female	−0.787**	(−1.052, −0.523)		−0.754**	(−1.017, −0.490)		0.474**	(0.217, 0.731)		0.453**	(0.218, 0.688)	
Male (<i>R</i>)												
<i>T</i>	−0.182**	(−0.201, −0.164)		−0.182**	(−0.201, −0.164)		−0.200**	(−0.220, −0.180)		−0.185**	(−0.204, −0.165)	

Table 7 continued

Effect	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Number of times responded	0.267**	(0.213, 0.321)	0.252**	(0.198, 0.306)	0.174**	(0.122, 0.226)	0.097**	(0.050, 0.145)
English not good _Mean			-6.845**	(-8.364, -5.327)	-4.210**	(-5.674, -2.746)	-2.454**	(-3.937, -0.970)
English good _Mean			-1.096**	(-1.780, -0.412)	-0.928**	(-1.581, -0.274)	-0.251	(-0.878, 0.376)
English not good _md			-0.247	(-1.166, 0.672)	-0.224	(-1.139, 0.691)	-0.135	(-1.071, 0.801)
English good _md			-0.164	(-0.471, 0.143)	-0.121	(-0.428, 0.185)	-0.181	(-0.487, 0.124)
<i>Equivalised income _mean</i>					0.460**	(0.386, 0.534)	0.347**	(0.284, 0.411)
Not in labour force _mean					-6.953**	(-7.475, -6.432)	-5.617**	(-6.091, -5.144)
Unemployed _mean					-5.038**	(-6.399, -3.676)	-4.138**	(-5.414, -2.861)
Never married _mean					-0.286	(-0.672, 0.100)	-0.456*	(-0.817, -0.095)
Widowed _mean					-2.236**	(-2.705, -1.767)	-1.553**	(-1.980, -1.127)
<12 years _mean					-0.732**	(-1.105, -0.358)	0.106	(-0.240, 0.452)
Exactly 12 years _mean					0.170	(-0.238, 0.578)	0.478*	(0.093, 0.863)
Diploma _mean					-0.533**	(-0.872, -0.194)	-0.144	(-0.458, 0.170)
<i>Equivalised income _md</i>					0.067**	(0.043, 0.092)	0.056**	(0.031, 0.080)
Not in labour force _md					-1.203**	(-1.396, -1.010)	-1.177**	(-1.365, -0.989)
Unemployed _md					-0.845**	(-1.148, -0.543)	-0.878**	(-1.178, -0.577)
Never married _md					-0.269*	(-0.534, -0.005)	-0.355**	(-0.616, -0.093)
Widowed _md					-0.088	(-0.380, 0.203)	-0.157	(-0.443, 0.128)
<12 years _md					-0.187	(-0.686, 0.312)	-0.071	(-0.568, 0.426)
Exactly 12 years _md					-0.348	(-0.738, 0.041)	-0.267	(-0.654, 0.120)
Diploma _md					-0.034	(-0.482, 0.414)	0.039	(-0.404, 0.482)
Former smoker _md							-0.164	(-0.406, 0.079)
Current smoker _md							0.040	(-0.263, 0.343)
Former drinker _md							-0.406*	(-0.750, -0.061)

Table 7 continued

Effect	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Current drinker_md							0.857**	(0.554, 1.160)
Insufficient physical activity_md							1.850**	(1.656, 2.043)
Sufficient physical activity_md							2.959**	(2.746, 3.173)
Former smoker_mean							-0.743**	(-1.049, -0.437)
Current smoker_mean							-1.607**	(-1.937, -1.277)
Former drinker_mean							-3.563**	(-4.485, -2.640)
Current drinker_mean							0.255	(-0.289, 0.800)
Insufficient physical activity_mean							8.601**	(7.866, 9.335)
Sufficient physical activity_mean							11.844**	(11.175, 12.512)

* $p < 0.05$; ** $p < 0.01$

Table 8 Multilevel linear mixed (model I) and hybrid (Models II, III and IV) regression model results showing estimates and their 95% confidence intervals (CI), with mental health as the outcome variable and duration of residence as the main exposure variable

Effect	Model I			Model II			Model III			Model IV		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Intercept	47.568**	(46.960, 48.176)		47.805**	(47.193, 48.417)		52.514**	(51.668, 53.360)		45.477**	(44.397, 46.556)	
ES; DOR < 10 years	1.083	(-0.080, 2.245)		1.144	(-0.017, 2.305)		0.415	(-0.730, 1.561)		-0.053	(-1.096, 0.991)	
ES; DOR 11–20	0.260	(-0.681, 1.202)		0.297	(-0.643, 1.236)		-0.113	(-1.020, 0.793)		-0.167	(-1.052, 0.719)	
ES; DOR > 20	0.895**	(0.285, 1.505)		0.853**	(0.243, 1.463)		0.710*	(0.116, 1.304)		0.695*	(0.137, 1.253)	
NES; DOR < 10	-0.469	(-1.288, 0.350)		1.635**	(0.632, 2.638)		2.004**	(0.996, 3.012)		1.878**	(0.888, 2.868)	
NES; DOR 11–20	-1.307**	(-2.090, -0.524)		0.414	(-0.539, 1.367)		0.402	(-0.528, 1.331)		0.147	(-0.752, 1.045)	
NES; DOR ≥ 20	-1.569**	(-2.247, -0.890)		-0.309	(-1.059, 0.441)		-0.543	(-1.263, 0.178)		-0.468	(-1.151, 0.214)	
Australia (<i>R</i>)												
7*ES; DOR < 10 years	-0.118	(-0.292, 0.055)		-0.118	(-0.292, 0.056)		-0.114	(-0.285, 0.056)		-0.100	(-0.265, 0.065)	
7*ES; DOR 11–20	-0.004	(-0.120, 0.113)		-0.004	(-0.120, 0.113)		-0.004	(-0.118, 0.111)		-0.016	(-0.129, 0.096)	
7*ES; DOR > 20	-0.098**	(-0.167, -0.029)		-0.098**	(-0.167, -0.029)		-0.075*	(-0.144, -0.007)		-0.063	(-0.128, 0.003)	
7*NES; DOR < 10	0.063	(-0.066, 0.192)		0.059	(-0.070, 0.189)		0.038	(-0.091, 0.167)		0.030	(-0.099, 0.158)	
7*NES; DOR 11–20	0.017	(-0.084, 0.117)		0.015	(-0.086, 0.115)		-0.001	(-0.100, 0.098)		-0.013	(-0.111, 0.085)	
7*NES; DOR ≥ 20	-0.082*	(-0.159, -0.006)		-0.087*	(-0.164, -0.011)		-0.059	(-0.135, 0.016)		-0.058	(-0.134, 0.017)	
Age group												
15–29 years	1.873**	(1.444, 2.301)		1.764**	(1.335, 2.194)		-2.426**	(-3.042, -1.811)		-2.216**	(-2.796, -1.635)	
30–44 years	1.639**	(1.223, 2.055)		1.567**	(1.151, 1.983)		-3.164**	(-3.745, -2.583)		-2.631**	(-3.169, -2.093)	
45–59 years	1.315**	(0.861, 1.769)		1.254**	(0.802, 1.706)		-2.557**	(-3.118, -1.997)		-2.424**	(-2.931, -1.918)	
≥60 years (<i>R</i>)												
Gender												
Female	-1.240**	(-1.515, -0.964)		-1.207**	(-1.482, -0.932)		-0.276	(-0.553, 0.002)		-0.299*	(-0.558, -0.041)	
Male (<i>R</i>)												
<i>T</i>	-0.053**	(-0.073, -0.033)		-0.053**	(-0.072, -0.033)		-0.072**	(-0.093, -0.051)		-0.060**	(-0.080, -0.039)	

Table 8 continued

Effect	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Number of times responded	0.236**	(0.179, 0.293)	0.219**	(0.161, 0.276)	0.138**	(0.082, 0.194)	0.066*	(0.013, 0.119)
English not good _Mean			-6.968**	(-8.410, -5.526)	-4.889**	(-6.319, -3.459)	-3.378**	(-4.818, -1.939)
English good _Mean			-1.554**	(-2.309, -0.799)	-1.281**	(-2.016, -0.546)	-0.662	(-1.370, 0.046)
English not good _md			-0.036	(-0.940, 0.868)	-0.020	(-0.919, 0.880)	0.078	(-0.842, 0.998)
English good _md			-0.036	(-0.394, 0.322)	0.003	(-0.354, 0.361)	-0.048	(-0.405, 0.310)
<i>Equivalised income _mean</i>					0.458**	(0.382, 0.533)	0.342**	(0.275, 0.409)
Not in labour force _mean					-5.272**	(-5.813, -4.732)	-4.148**	(-4.645, -3.650)
Unemployed _mean					-6.670**	(-8.199, -5.141)	-5.488**	(-6.910, -4.065)
Never married _mean					-1.213**	(-1.653, -0.774)	-1.396**	(-1.811, -0.982)
Widowed _mean					-2.134**	(-2.608, -1.660)	-1.446**	(-1.887, -1.004)
<12 years _mean					-0.194	(-0.593, 0.206)	0.643**	(0.267, 1.020)
Exactly 12 years _mean					0.501*	(0.036, 0.966)	0.826**	(0.386, 1.265)
Diploma _mean					0.002	(-0.370, 0.375)	0.426*	(0.077, 0.775)
<i>Equivalised income _md</i>					0.090**	(0.063, 0.117)	0.079**	(0.052, 0.106)
Not in labour force _md					-0.830**	(-1.035, -0.626)	-0.835**	(-1.035, -0.635)
Unemployed _md					-1.061**	(-1.415, -0.708)	-1.112**	(-1.465, -0.758)
Never married _md					-0.591**	(-0.911, -0.271)	-0.681**	(-1.000, -0.363)
Widowed _md					-1.283**	(-1.627, -0.939)	-1.340**	(-1.680, -1.000)
<12 years _md					-0.258	(-0.923, 0.407)	-0.230	(-0.894, 0.433)
Exactly 12 years _md					-0.374	(-0.907, 0.158)	-0.277	(-0.811, 0.256)
Diploma _md					-0.273	(-0.886, 0.340)	-0.229	(-0.840, 0.382)
Former smoker _md							-0.160	(-0.435, 0.116)
Current smoker _md							-0.370*	(-0.713, -0.027)
Former drinker _md							-0.410*	(-0.786, -0.033)

Table 8 continued

Effect	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Current drinker_md							0.519**	(0.195, 0.843)
Insufficient physical activity_md							1.664**	(1.464, 1.864)
Sufficient physical activity_md							3.050**	(2.829, 3.270)
Former smoker_mean							-0.581**	(-0.906, -0.256)
Current smoker_mean							-2.301**	(-2.680, -1.923)
Former drinker_mean							-3.786**	(-4.742, -2.830)
Current drinker_mean							-0.197	(-0.754, 0.359)
Insufficient physical activity_mean							6.722**	(5.961, 7.482)
Sufficient physical activity_mean							10.765**	(10.083, 11.448)

* $p < 0.05$; ** $p < 0.01$

Table 9 Multilevel linear mixed (model I) and hybrid (Models II, III and IV) regression model results showing estimates and their 95% confidence intervals (CI), with self-assessed health as the outcome variable and duration of residence as the main exposure variable

Effect	Model I			Model II			Model III			Model IV		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Intercept	2.737**	(2.678, 2.796)		2.759**	(2.699, 2.818)		3.382**	(3.296, 3.468)		2.675**	(2.570, 2.780)	
ES; DOR < 10 years	0.230**	(0.113, 0.347)		0.234**	(0.117, 0.351)		0.154**	(0.045, 0.263)		0.106*	(0.000, 0.211)	
ES; DOR 11–20	0.101*	(0.002, 0.201)		0.103*	(0.004, 0.203)		0.054	(−0.042, 0.149)		0.049	(−0.040, 0.137)	
ES; DOR > 20	0.115**	(0.053, 0.177)		0.111**	(0.049, 0.173)		0.095**	(0.036, 0.153)		0.096**	(0.042, 0.150)	
NES; DOR < 10	0.063	(−0.022, 0.149)		0.230**	(0.128, 0.333)		0.239**	(0.135, 0.342)		0.235**	(0.132, 0.337)	
NES; DOR 11–20	−0.059	(−0.141, 0.024)		0.069	(−0.029, 0.166)		0.049	(−0.047, 0.144)		0.029	(−0.065, 0.124)	
NES; DOR ≥ 20	−0.144**	(−0.212, −0.077)		−0.050	(−0.124, 0.025)		−0.064	(−0.135, 0.008)		−0.055	(−0.123, 0.014)	
Australia (<i>R</i>)												
7*ES; DOR < 10 years	−0.002	(−0.022, 0.017)		−0.002	(−0.022, 0.017)		−0.003	(−0.023, 0.016)		−0.003	(−0.022, 0.016)	
7*ES; DOR 11–20	0.001	(−0.012, 0.013)		0.001	(−0.012, 0.013)		0.000	(−0.012, 0.013)		−0.001	(−0.013, 0.011)	
7*ES; DOR > 20	−0.009**	(−0.016, −0.002)		−0.009**	(−0.016, −0.002)		−0.008*	(−0.015, −0.001)		−0.008*	(−0.015, −0.001)	
7*NES; DOR < 10	−0.010	(−0.022, 0.003)		−0.011	(−0.023, 0.002)		−0.013	(−0.025, 0.000)		−0.013*	(−0.026, 0.000)	
7*NES; DOR 11–20	−0.001	(−0.011, 0.010)		−0.001	(−0.011, 0.009)		−0.002	(−0.012, 0.008)		−0.003	(−0.013, 0.007)	
7*NES; DOR ≥ 20	0.001	(−0.007, 0.008)		0.000	(−0.008, 0.008)		0.002	(−0.006, 0.009)		0.002	(−0.006, 0.009)	
Age group												
15–29 years	0.839**	(0.797, 0.881)		0.824**	(0.782, 0.867)		0.323**	(0.263, 0.383)		0.362**	(0.306, 0.418)	
30–44 years	0.629**	(0.589, 0.670)		0.620**	(0.579, 0.660)		0.096**	(0.041, 0.151)		0.170**	(0.119, 0.221)	
45–59 years	0.377**	(0.332, 0.421)		0.370**	(0.326, 0.414)		−0.045	(−0.098, 0.007)		−0.019	(−0.067, 0.028)	
≥60 years (<i>R</i>)												
Gender												
Female	0.001	(−0.027, 0.028)		0.004	(−0.023, 0.032)		0.102**	(0.074, 0.129)		0.099**	(0.073, 0.124)	
Male (<i>R</i>)												
<i>T</i>	−0.023**	(−0.025, −0.021)		−0.023**	(−0.025, −0.021)		−0.025**	(−0.027, −0.023)		−0.024**	(−0.026, −0.022)	
Number of times responded	0.021**	(0.016, 0.027)		0.020**	(0.014, 0.025)		0.010**	(0.005, 0.016)		0.003	(−0.002, 0.008)	

Table 9 continued

Effect	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
English not good _Mean			-0.740**	(-0.890, -0.590)	-0.481**	(-0.625, -0.336)	-0.341**	(-0.486, -0.195)
English good _Mean			-0.072	(-0.147, 0.004)	-0.064	(-0.138, 0.010)	0.002	(-0.070, 0.073)
English not good _md			-0.023	(-0.106, 0.061)	-0.019	(-0.103, 0.064)	-0.001	(-0.084, 0.083)
English good _md			0.020	(-0.018, 0.057)	0.023	(-0.014, 0.060)	0.016	(-0.022, 0.053)
<i>Equivalentised income _mean</i>					0.047**	(0.037, 0.057)	0.034**	(0.025, 0.042)
Not in labour force _mean					-0.559**	(-0.611, -0.506)	-0.444**	(-0.493, -0.396)
Unemployed _mean					-0.430**	(-0.571, -0.288)	-0.286**	(-0.419, -0.153)
Never married _mean					-0.038	(-0.083, 0.006)	-0.056**	(-0.098, -0.015)
Widowed _mean					-0.109**	(-0.154, -0.065)	-0.034	(-0.075, 0.007)
<12 years _mean					-0.208**	(-0.249, -0.166)	-0.115**	(-0.154, -0.077)
Exactly 12 years _mean					-0.053*	(-0.101, -0.004)	-0.014	(-0.059, 0.031)
Diploma _mean					-0.148**	(-0.188, -0.109)	-0.099**	(-0.136, -0.062)
<i>Equivalentised income _md</i>					0.007**	(0.004, 0.010)	0.006**	(0.004, 0.009)
Not in labour force _md					-0.062**	(-0.082, -0.042)	-0.062**	(-0.082, -0.042)
Unemployed _md					-0.035*	(-0.068, -0.001)	-0.037*	(-0.071, -0.004)
Never married _md					-0.011	(-0.043, 0.021)	-0.018	(-0.050, 0.013)
Widowed _md					0.032*	(0.001, 0.063)	0.027	(-0.004, 0.058)
<12 years _md					0.007	(-0.061, 0.075)	0.006	(-0.061, 0.073)
Exactly 12 years _md					-0.107**	(-0.165, -0.049)	-0.100**	(-0.156, -0.043)
Diploma _md					-0.044	(-0.106, 0.019)	-0.043	(-0.103, 0.018)
Former smoker _md							-0.008	(-0.036, 0.020)
Current smoker _md							-0.046**	(-0.080, -0.011)
Former drinker _md							-0.009	(-0.044, 0.027)
Current drinker _md							0.058**	(0.026, 0.090)

Table 9 continued

Effect	Model I		Model II		Model III		Model IV	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Insufficient physical activity_md							0.124**	(0.105, 0.142)
Sufficient physical activity_md							0.260**	(0.239, 0.280)
Former smoker_mean							-0.110**	(-0.142, -0.078)
Current smoker_mean							-0.312**	(-0.348, -0.277)
Former drinker_mean							-0.274**	(-0.365, -0.183)
Current drinker_mean							0.057*	(0.000, 0.113)
Insufficient physical activity_mean							0.570**	(0.502, 0.638)
Sufficient physical activity_mean							1.052**	(0.991, 1.113)

* $p < 0.05$; ** $p < 0.01$

References

- Abraido-Lanza, A., Armbrister, A., Florez, K., & Aguirre, A. (2006). Toward a theory-driven model of acculturation in public health research. *American Journal of Public Health*, 96(8), 1342–1346.
- Abraido-Lanza, A., Chao, M., & Florez, K. (2005). Do healthy behaviors decline with greater acculturation? Implications for the Latino mortality paradox. *Social Science and Medicine*, 61(6), 243–245.
- Akresh, I. R. (2007). Dietary Assimilation and Health among Hispanic Immigrants to the United States. *Journal of Health and Social Behavior*, 48(4), 404–417.
- Akresh, I. R., & Frank, R. (2008). Health selection among new immigrants. *American Journal of Public Health*, 98(11), 2058–2064.
- Allison, P. D. (2005). *Fixed effects regression methods for longitudinal data: Using SAS*. Cary: SAS Publishing.
- Anson, J. (2004). The migrant mortality advantage: A 70 month follow-up of the Brussels population. *Population Studies*, 20, 191–218.
- Antecol, H., & Bedard, K. (2006). Unhealthy assimilation: Why do immigrants converge to American health status levels? *Demography*, 43(2), 337–360.
- Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51(6), 1173–1182.
- Bauder, H. (2003). ‘Brain Abuse’ or the devaluation of immigrant labour in Canada. *Antipode*, 35(4), 700–717.
- Berry, J. W. (1990). Acculturation and adaptation: Health consequences of culture contact among circumpolar peoples. *Arctic Medical Research*, 49, 142–150.
- Biddle, N., Kennedy, S., & McDonald, J. T. (2007). *Health assimilation patterns amongst Australian immigrants*. *Economic Record*, 83(260), 16–30.
- Chiswick, B. R., Lee, Y. L., & Miller, P. W. (2004). Language skills and immigrant adjustments: What immigration policy can do!. IZA Discussion Paper 1419.
- Chiswick, B. R., Lee, Y. L., & Miller, P. W. (2008). Immigrant selection system and immigrant health. *Contemporary Economic Policy*, 26(4), 555–578.
- Cho, Y., Frisbie, W. P., Hummer, R. A., & Rogers, R. G. (2004). Nativity, duration of residence, and the health of Hispanic adults in the United States I. *International Migration Review*, 38(1), 184–211. doi:10.1111/j.1747-7379.2004.tb00193.x.
- Coons, S. J., Rao, S., Keininger, D. L., & Hays, R. D. (2000). A comparative review of generic quality-of-life instruments. *Pharmacoeconomics*, 17(1), 13–35.
- Deboosere, P., & Gadeyne, S. (2005). Adult migrant mortality advantage in Belgium: Evidence using census and register data. *Population*, 5, 655–698.
- Diggle, P. J., Heagerty, P. J., Liang, K. Y., & Zeger, S. L. (2002). *Analysis of longitudinal data*. Oxford: Oxford University Press.
- Domnich, A., Panatto, D., Gasparini, R., & Amicizia, D. (2012). The “healthy immigrant” effect: Does it exist in Europe today? *Italian Journal of Public Health*, 9(3), e7531–e7532.
- Dunn, J. R., & Dyck, I. (2000). Social determinants of health in Canada’s immigrant population: Results from the National Population Health Survey. *Social Science and Medicine*, 51, 1573–1593.
- Frisbie, W. P., Youngtae, C., & Hummer, R. A. (2001). Immigration and the health of Asian and Pacific Islander adults in the United States. *American Journal of Epidemiology*, 153(4), 372–380.
- Gerber, M., Barker, D., & Puhse, U. (2012). Acculturation and physical activity among immigrants: A systematic review. *Journal of Public Health*, 20(3), 313–341.
- Goel, M. S., McCarthy, E. P., Phillips, R. S., & Wee, C. C. (2004). Obesity among US immigrant subgroups by duration of residence. *The Journal of the American Medical Association*, 292(23), 2860–2867.
- Greenland, S., Pearl, J., & Robins, J. M. (1999). Causal diagrams for epidemiologic research. *Epidemiology*, 10(1), 37–48.
- Grondin, C. (2007). *Knowledge of official languages among new immigrants: How important is it in the labour market?*. Ottawa: Statistics Canada.
- Gunasekara, F. I., Carter, K., & Blakely, T. (2011). Change in income and change in self-rated health: Systematic review of studies using repeated measures to control for confounding bias. *Social Science and Medicine*, 72(2), 193–201. doi:10.1016/j.socscimed.2010.10.029.

- Gunasekara, F. I., Carter, K., & Blakely, T. (2012). Comparing self-rated health and self-assessed change in health in a longitudinal survey: Which is more valid? *Social Science and Medicine*, 74(7), 1117–1124.
- Gunasekara, F., Richardson, K., Carter, K., & Blakely, T. (2013). Fixed effects analysis of repeated measures data. *International Journal of Epidemiology*. doi:10.1093/ije/dyt221.
- Gushulak, B. (2007). Healthier on arrival? Further insight into the “healthy immigrant effect”. *Canadian Medical Association Journal*, 176(10), 1439–1440.
- Hemingway, H., Stafford, M., Stansfeld, S., Shipley, M., & Marmot, M. (1997). Is the SF-36 a valid measure of change in population health? Results from the Whitehall II Study. *British Medical Journal*, 315(7118), 1273–1279.
- Huber, P. J. (1967). The behavior of maximum likelihood estimates under nonstandard conditions. In *Proceedings of the fifth Berkeley symposium on mathematical statistics and probability*.
- Hull, D. (1979). Migration, adaptation, and illness: A review. *Social Science and Medicine*, 13A, 25–36.
- Hummer, R. A., Rogers, R. G., Nam, C. B., & LeClere, F. B. (1999). Race/ethnicity, nativity, and U.S. adult mortality. *Social Science Quarterly (University of Texas Press)*, 80(1), 136–153.
- Hyman, I. (2001). *Immigration and Health*. Ottawa: Health Canada.
- Hyman, I. (2007). Immigration and health: Reviewing evidence of the healthy immigration effect in Canada. Toronto: Joint Centre of Excellence for Research on Immigration and Settlement (CERIS) Working paper No. 55.
- Idler, E. L., & Benyamini, Y. (1997). Self-rated health and mortality: A review of twenty-seven community studies. *Journal of Health and Social Behavior*, 38, 21–37.
- Jasso, G., Massey, D. S., Rosenzweig, M. R., & Smith, J. P. (2004). Immigrant health: Selectivity and acculturation: IFS Working Papers, Institute of Fiscal Studies, W04/23.
- Jasso, G., Massey, D. S., Rosenzweig, M. R., & Smith, J. P. (2005). Immigration, health, and New York City: Early results based on the US New Immigrant Cohort of 2003. *FRBNY Economic Policy Review*, 11, 127–151.
- Jatrana, S., Pasupuleti, S. S., & Richardson, K. (2014). Nativity, duration of residence and chronic health conditions in Australia: Do trends converge towards the native-born population? *Social Science and Medicine*, 119, 53–63. doi:10.1016/j.socscimed.2014.08.008.
- Joshi, S. (2017). *Understanding health behaviour trajectories of immigrants in Australia: A longitudinal investigation*. (Ph.D. thesis), Deakin University. <http://hdl.handle.net/10536/DRO/DU:30088487>.
- Kandula, N., Kersey, M., & Lurie, N. (2004). Assuring the health of immigrants: What the leading health indicators tell us. *Annual Review of Public Health*, 25, 357–376.
- Kasl, S. V., & Berkman, L. F. (1983). Health consequences of the experience of migration. *Annual Review of Public Health*, 4, 69–90.
- Kinra, S. (2004). Commentary: Can conventional migration studies really identify critical age-period effects? *International Journal of Epidemiology*, 33(6), 1226–1227. doi:10.1093/ije/dyh340.
- Kobayashi, K. M., & Prus, S. G. (2012). Examining the gender, ethnicity, and age dimensions of the healthy immigrant effect: Factors in the development of equitable health policy. *International Journal for Equity in Health*, 11(1), 8.
- Kouris-Blazos, A. (2002). Morbidity mortality paradox of 1st generation Greek Australians. *Asia Pacific Journal of Clinical Nutrition*, 11(Suppl 3), S569–S575.
- Ladin, K., & Reinhold, S. (2013). Mental health of aging immigrants and native-born men across 11 European countries. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 68(2), 298–309. doi:10.1093/geronb/gbs163.
- Lara, M., Gamboa, C., Kahramanian, I., Morales, L., & Bautista, H. (2005). Acculturation and latino health in the United States: A review of the literature and its sociopolitical context. *Annual Review of Public Health*, 26, 367–397.
- Leão, T. S., Sundquist, J., Johansson, S.-E., & Sundquist, K. (2009). The influence of age at migration and length of residence on self-rated health among Swedish immigrants: A cross-sectional study. *Ethnicity & Health*, 14(1), 93–105. doi:10.1080/13557850802345973.
- Liang, K. Y., & Zeger, S. L. (1986). Longitudinal data analysis using generalized linear models. *Biometrika*, 73(1), 13–22.
- Markides, K. S., & Eschbach, K. (2005). Aging, migration, and mortality: Current status of research on the Hispanic paradox. *The Journals of Gerontology Series B, Psychological Sciences and Social Sciences*, 60(2), 68–75.
- McCallum, J. (1995). The SF-36 in an Australian sample: Validating a new, generic health status measure. *Australian Journal of Public Health*, 19(2), 160–166.

- McDonald, J. T., & Kennedy, S. (2004). Insight into the 'healthy immigrant effect': Health status and health service use of immigrants to Canada. *Social Science and Medicine*, 59, 1613–1627.
- McDonough, P., Worts, D., & Sacker, A. (2010). Socioeconomic inequalities in health dynamics: A comparison of Britain and the United States. *Social Science and Medicine*, 70(2), 251–260.
- McKay, S., Crac, M., & Chopra, D. (2006). *Migrant workers in England and Wales: An assessment of migrant worker health and safety risks*. London: Working Lives Research Institute.
- McKeever, M., & Klineberg, S. L. (1999). Generational differences in attitudes and socioeconomic status among Hispanics in Houston. *Sociological Inquiry*, 69(1), 33–50. doi:[10.1111/j.1475-682X.1999.tb00488.x](https://doi.org/10.1111/j.1475-682X.1999.tb00488.x).
- Morales, L. S., Lara, M., Kington, R. S., & Valdez, R. O. (2002). Socioeconomic, cultural, and behavioral factors affecting Hispanic health outcomes. *Journal of Health Care for the Poor and Underserved*, 13(4), 477–503.
- Newbold, K. B. (2005). Self-rated health within the Canadian immigrant population: Risk and the healthy immigrant effect. *Social Science and Medicine*, 60, 1359–1370.
- Newbold, K. B., & Danforth, J. (2003). Health status and Canada's immigrant population. *Social Science and Medicine*, 57, 1981–1995.
- Ng, E., Wilkins, R., Gendron, F., & Berthelot, J.-M. (2005). *Dynamics of immigrants' health in Canada: Evidence from the national population health survey*. Statistics Canada. <http://www.statcan.gc.ca/pub/82-618-m/82-618-m2005002-eng.htm>.
- Pearl, J. (2009). *Causality: Models, reasoning, and inference* (2nd ed.). New York: Cambridge University Press.
- Pottie, K., Ng, E., Spitzer, D., Mohammed, A., & Glazier, R. (2008). Language proficiency, gender and self-reported health. *Canadian Journal of Public Health*, 99(6), 505–510.
- Pudarcic, S., Sundquist, J., & Johansson, S. E. (2003). Country of birth, instrumental activities of daily living, self-rated health and mortality: A Swedish population-based survey of people aged 55–74. *Social Science and Medicine*, 56(12), 2493–2503.
- Reiss, K., Spallek, J., & Razum, O. (2010). 'Imported risk' or 'health transition'? Smoking prevalence among ethnic German immigrants from the former soviet union by duration of stay in Germany—Analysis of microcensus data. *Int J Equity Health*, 9, 15.
- Reynolds, M. M., Chernenko, A., & Read, J. G. (2016). Region of origin diversity in immigrant health: Moving beyond the Mexican case. *Social Science and Medicine*, 166, 102–109. doi:[10.1016/j.socscimed.2016.07.018](https://doi.org/10.1016/j.socscimed.2016.07.018).
- Richardson, K., Harte, D., & Carter, K. (2010). Understanding health and labour force transitions: Applying Markov models to SoFIE longitudinal data. Official Statistics Research Series, from <http://www.statisphere.govt.nz/further-resources-and-info/official-statistics-research/series/2011/page2.aspx>.
- Rivera, B., Casal, B., & Currais, L. (2015). Length of stay and mental health of the immigrant population in Spain: Evidence of the healthy immigrant effect. *Applied Economics*, 47(19), 1972–1982. doi:[10.1080/00036846.2014.1002895](https://doi.org/10.1080/00036846.2014.1002895).
- Rivera, B., Casal, B., & Currais, L. (2016). The healthy immigrant effect on mental health: Determinants and implications for mental health policy in Spain. *Administration and Policy in Mental Health and Mental Health Services Research*, 43(4), 616–627. doi:[10.1007/s10488-015-0668-3](https://doi.org/10.1007/s10488-015-0668-3).
- Robins, J. M., & Hernán, M. A. (2008). Estimation of the causal effects of time-varying exposures. In G. Fitzmaurice, M. Davidian, G. Verbeke & G. Molenberghs (Eds.), *Longitudinal data analysis* (pp. 553–599). CRC Press.
- Ryder, A. G., Alden, L. E., & Paulhus, D. L. (2000). Is acculturation unidimensional or bidimensional? A head-to-head comparison in the prediction of personality, self-identity, and adjustment. *Journal of Personality and Social Psychology*, 79(1), 49–65.
- Salant, T., & Lauderdale, D. (2003). Measuring culture: A critical review of acculturation and health in Asian immigrant populations. *Social Science and Medicine*, 57(1), 71–90.
- Setia, M., Quesnel-Vallee, A., Abrahamowicz, M., Tousignant, P., & Lynch, J. (2012). Different outcomes for different health measures in immigrants: Evidence from a longitudinal analysis of the National Population Health Survey (1994–2006). *Journal of Immigrant and Minority Health*, 14(1), 156–165. doi:[10.1007/s10903-010-9408-7](https://doi.org/10.1007/s10903-010-9408-7).
- Singh, G. P., & Siahpush, M. (2001). All-cause and cause-specific mortality of immigrants and native born in the United States. *American Journal of Public Health*, 91(3), 392–399.

- Singh, G., & Siahpush, M. (2002). Ethnic-immigrant differentials in health behaviors, morbidity, and cause-specific mortality in the United States: An analysis of two national data bases. *Human Biology*, 74(1), 83–109.
- Spinks, H. (2010). *Australia's Migration program social policy section*. Canberra: Parliament of Australia, Department of Parliamentary Services.
- Straiton, M., Grant, J. F., Winefield, H. R., & Taylor, A. (2014). Mental health in immigrant men and women in Australia: The North West Adelaide health study. *BMC Public Health*, 14(1), 1–15. doi:[10.1186/1471-2458-14-1111](https://doi.org/10.1186/1471-2458-14-1111).
- Strong, K., Trickett, P., & Bhatia, K. (1998). The health of overseas-born Australians, 1994–1996. *Australian Health Review: A Publication of the Australian Hospital Association*, 21(2), 124–133.
- Stronks, K., Ravelli, A. C., & Reijneveld, S. A. (2001). Immigrants in the Netherlands: Equal access for equal needs? *Journal of Epidemiology and Community Health*, 55(10), 701–707.
- Taylor, A. W., Wilson, D. H., & Wakefield, M. (1998). Differences in health estimates using telephone and door-to-door survey methods—a hypothetical exercise. *Australia and New Zealand Journal of Public Health*. doi:[10.1111/j.1467-842X.1998.tb01177.x](https://doi.org/10.1111/j.1467-842X.1998.tb01177.x).
- Thomas, T. N. (1995). Acculturative stress in the adjustment of immigrant families. *Journal of Social Distress and the Homeless*, 4(2), 131–142. doi:[10.1007/bf02094613](https://doi.org/10.1007/bf02094613).
- Valtonen, K. (2001). Social work with immigrants and refugees: Developing a participation-based framework for anti-oppressive practices. *British Journal of Social Work*, 31, 955–960.
- VanderWeele, T. J., & Robins, J. M. (2007). Directed acyclic graphs, sufficient causes, and the properties of conditioning on a common effect. *American Journal of Epidemiology*, 166(9), 1096.
- VanderWeele, T., & Vansteelandt, S. (2009). Conceptual issues concerning mediation, interventions and composition. *Statistics and its Interface*, 2, 457–468.
- Vega, W. A., Kolody, B., Aguilar-Gaxiola, S., & Catalano, R. F. (1999). Gaps in service utilization by Mexican Americans with mental health problems. *American Journal of Psychiatry*, 156(6), 928–934.
- Wallace, M., & Kulu, H. (2014a). Migration and Health in England and Scotland: A Study of Migrant Selectivity and Salmon Bias. *Population, Space and Place*, 20(8), 694–708. doi:[10.1002/psp.1804](https://doi.org/10.1002/psp.1804).
- Wallace, M., & Kulu, H. (2014b). Low immigrant mortality in England and Wales: A data artefact? *Social Science and Medicine*, 120, 100–109. doi:[10.1016/j.socscimed.2014.08.032](https://doi.org/10.1016/j.socscimed.2014.08.032).
- Watson, N., & Wooden, M. P. (2012). The HILDA Survey: A case study in the design and development of a successful Household Panel Survey. *Longitudinal and Life Course Studies*, 3(3), 13. doi:[10.14301/lcs.v3i3.208](https://doi.org/10.14301/lcs.v3i3.208).
- White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica: Journal of the Econometric Society*, 48(4), 817–831.
- Williams, R., Eley, S., Hunt, K., & Bhatt, S. (1997). Has psychological distress among UK South Asians been under-estimated? A comparison of three measures in the west of Scotland population. *Ethnicity & Health*, 2(1–2), 21–29.
- Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). Cambridge, MA: MIT Press.