Investigating the 'healthy immigrant effect' in Australia Using Fixed Effects Models: Findings from a Nationally-Representative Longitudinal Survey

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Abstract

We used a longitudinal analysis to assess the differences in health outcomes (physical, mental and self-rated health) (PH, MH, SAH), among Foreign-Born (FB) from English Speaking (ES) Countries and non-English Speaking (NES) Countries relative to Native-Born (NB) Australians over a 10 year period. We used hybrid regression models for evaluation of these health outcomes in 5,795 NB and 1,665 FB from the Household, Income and Labour Dynamics in Australia (HILDA) survey. After adjusting for all the time varying and time in-variant covariates, FB from NES countries who had been living in Australia for more than 20 years were found to have lower levels of physical health, mental health and self-rated health than the NB people. We did not find any significant differences in the PH, MH and SAH between FB from ES countries and the NB Australians.

Background

The motivation for this paper arises from observations by many observational studies of 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 & Eschbach 2005; McDonald & Kennedy 2004b; Morales et al. 2002; Newbold, K. B. 2005; Newbold, K.B. & Danforth 2003; Ng et al. 2005; Singh, GK & Siahpush 2002; Singh, GP & Siahpush 2001), Europe (Anson 2004; Deboosere & Gadeyne 2005; Williams et al. 1997), and Australia (Kouris-Blazos 2002; Strong, Trickett & Bhatia 1998; Taylor et al. 1999) has shown that immigrants to a new country have health advantage over the NB population on most indicators of health, including mortality, morbidity, disability and mental disorder, despite (often) lower socioeconomic status that might suggest poorer health profiles. This phenomenon is often referred to as the "immigrant health paradox" or "Hispanic paradox". Over time, however, immigrant health advantage dissipates and their health declines below that of new migrants or to the level of their native-born counterparts (Cho et al. 2004; Gushulak 2007; Hyman 2001; Markides & Eschbach 2005; Morales et al. 2002). The explanations offered for the initial advantaged health status of immigrants often focus on the "healthy immigrant effect", which assumes only those with good health are selected for migration, (Abraido-Lanza et al. 1999; Franzini, Ribble & Keddie 2001). Selection of healthy persons from the source country could be due to voluntary positive selection among immigrants (i.e., those migrating to Australia are a much healthier group than those who remain in their countries of origin), or the requirement that potential migrants undergo medical screening (direct selection), or from immigration policies favouring tertiary education, occupational skills and wealth (indirect selection) (Akresh & Frank 2008; Antecol & Bedard 2006; McDonald & Kennedy 2004b). Thus the link between migration and a range of health outcomes appears intuitively plausible and has been supported by earlier immigrant research it hardly merits another investigation. Or does it?

Much of the recent international literature on immigrant health has used single or repeated cross-sectional datasets which provide only snapshot(s) in time of differences in the outcome between migrants and non-migrants (Abraido-Lanza et al. 2006; Biddle, Kennedy & McDonald 2003; McDonald & Kennedy 2004a; McKay, Craw & Chopra 2006). However, processes such as migration are dynamic and require several years to have their full impact on health. The effect of migration on health will therefore not be evident in purely cross-sectional analysis of the data which implicitly assume that migration has an immediate impact on health Moreover, estimating migration effects presents additional challenges because exposure to migration is not a random event. Migrants (FB) and non-migrants (NB) may differ in important ways due to self-selection and other processes: for example, migration into a new country sparks a process of labour market adjustment that NB workers do not undergo, and that may bias estimation of the exposure-outcome relationship by introducing confounding (Rothman, Greenland & Lash 2008).

The present study advances the migrant health literature by providing the first estimates of the nativity health gap (i.e. changes in migrant health vis-à-vis the Australian-born) for Australia, based on an analysis of a nationally representative longitudinal dataset. Specifically, using a multi-level group-mean-centred mixed model (discussed in the methodology section) that separates between- and within-person variation over time, we examine how migrant health changes relative to the Australian born.

The key question addressed is whether differences in the various health outcomes (as measured by SF-36 with subscales mental health, physical functioning; and self-assessed health (SAH)) exist between the NB and FB, and among the different migrant groups (English-speaking (ES) and non-English speaking (NES) countries of origin) in Australia and if there is a difference, whether it persists over time after adjusting for various covariates.

We address the following specific questions:
(1) Do immigrants to Australia have a health advantage relative to the NB?
(2) If existent, is this relative health advantage (between the FB and NB) different for different migrant subgroups (specifically, ES and NES countries of origin)?
(3) If the FB have a health advantage, does it decline as duration of residence increases and for all FB groups?

Methodology

Data

This paper utilises data from the Household, Income and Labour Dynamics in Australia (HILDA) survey. HILDA is a nationally representative panel survey of Australian people occupying private dwellings. The survey was commenced in 2001 with a large and nationally representative sample of 7,682 households, with at least one eligible person aged 15 years and above. All the members of these households aged 15 years and over form the basis of the panel to be interviewed in all the subsequent waves. Although 13,969 respondents have responded in the first wave of HILDA only 7,460 responds have responded (balanced panel) in all of the subsequent nine waves. Attrition of balanced panel in HILDA survey, by country of birth of respondents, was shown in the form of Figure A1. Attrition (per cent not responding in at least one wave between waves 2 and 10) is more among immigrants from NES countries (58%) than among immigrants from ES countries (47%) and among NB people (44%). In this study, we have used responses from those 7,460 individuals who have responded in all of the first ten waves (i.e. a balanced panel) of HILDA, conducted during 2001-2010. Of these total 7,460 study respondents, 5,795 are NB and the remaining 1,665 are

FB. Among all FB respondents 819 were born in ES countries, and the remaining 846 were born in NES countries.

Variables and measures

Main Exposure

The main exposure/explanatory variable is nativity status, i.e., FB or NB. The FB level is further divided into born in an ES or NES country. Duration of residence is used as a proxy measure to investigate how exposure to the social, cultural and physical environment of the host population might be associated with the health of migrant population. For the DoR analysis, this is categorised into less than 10 years, 10-19 years and equal or more than 20 years in Australia (in wave 1), and combined with the nativity status variable described above.

Health

The three health outcome measures used in this study are: self-assessed health (SAH), physical component summary score (PCS) and mental component summary score (MCS). All these health measures were obtained using the SF-36 questionnaire, part of the HILDA self-completion questionnaire. SAH varies between 1 (poor health) and 5 (excellent health) and was considered as a continuous variable for regression analysis, and as a binary variable for the descriptive analysis with the categories being poor or fair health and others (good or very good or excellent). Eight health domains, namely general health (GH), physical functioning (PF), role limitations due to physical functioning (RP), bodily pain (BP), general mental health (MH), role limitations due to emotional problems (RE), vitality (VT), and social functioning (SF) were derived using 35 questions collected as a part of SF-36 questionnaire. Each of these domain ranges from a score of 0 (worst health) to 100 (best health). Finally, PCS and MCS were derived by from these eight domains of health by using correlated principal component factor analysis technique: see Appendix A for further details on the construction of PCS and MCS. Both PCS and MCS vary between 0 and 100 with a mean score of 50 and were modelled as continuous outcomes in regression analyses. A score of 100 in physical 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.

Observed (time varying) control variables

Age, sex, marital status (single, married, cohabiting), highest education level (university, diploma/certificate, year 12, less than year 12), employment status (full-time employed, part-time employed, unemployed, not in the labour force), household income and time are used as controls in all multivariate analyses as they are associated with both migration and health. The effect of time-varying variables is typically best understood by focussing on the within-person variation as explained below.

Methods

We used multilevel group-mean-centred mixed models to test whether the FB have a health advantage relative to the NB, and if so whether the health advantage declines as duration of residence increases for both ES and NES FB subgroups. This approach models both within-person (group mean-centered) and between-person (group means) variability for time-varying variables, and time-invariant variables for estimation of effects. They were popularized as “hybrid” models by Allison (Allison, Paul David 2005), and for brevity we follow that nomenclature here. Parameter estimates for group mean centred variables have the strengths of econometric fixed effect models (FE) models under conditions required by such models. In particular they control all unmeasured time invariant confounding, provided that “strict exogeneity” conditions are met (in particular, reverse causation or state dependence are not important). Estimates for groups means and time-invariant covariates have the strengths of conventional mixed models (commonly referred to as random effects (RE) models in statistical terminology), but assume unmeasured confounding is uncorrelated with groups means and time-invariant covariates (Wooldridge, 2010). Note the FE and RE terminology used here derives from the econometric literature, and is based solely on whether unobserved confounding is the focus of analysis.

Like FE methods, hybrid models control for all stable (time invariant) characteristics of individuals while estimating the effects of time-varying exposure variables. In addition, this method provides coefficient estimates for time-invariant predictor variables such as nativity status and duration of residence, which conventional fixed effects methods cannot give. However, such estimates may be biased if there is time-invariant confounding i.e., if (unmeasured) between individual differences are correlated with both the exposure of interest (say nativity status and duration of residence) and the outcome (say health). But, the extent of bias is relative smaller when compared with the estimates obtained through conventional RE models.

Our research questions are concerned primarily about the effect of nativity and DoR on health. Since these exposures are time invariant an important question to consider when using hybrid models is whether the assumption of no unmeasured confounding of the exposure-outcome relation is valid. There is no time-invariant confounding between nativity and health (question) since nativity is exogenous to the model. For DoR, we argue that all the FB require a high level of vitality to re-establish oneself in a new environment and are a relatively homogenous group in that respect. While unmeasured confounding of the DoR-health relationship is possible, the fact that the FB are a relativity homogenous group in terms of selectivity of migration suggests unmeasured confounding may be a less significant source of bias.

Because hybrid models use within and between-person variations estimation may be more efficient than those obtained through conventional fixed effects models i.e., it may produce smaller standard errors for model parameters. Additionally, hybrid models control for cluster (individual) mean effects of all measured time-varying exposure variables resulting in less biased estimates for the coefficients of time-invariant variables (like nativity) than those obtained from conventional mixed models (Allison 2005, page 37).

The following hybrid (multilevel group-mean-centred mixed) models have been used in this study to investigate the association between immigrant status and duration of residence with physical health, mental health and self-rated health:

$$Y_{it} = \alpha_i + \beta_1(X_{it} - \overline{X}_{i.}) + \beta_2 \overline{X}_{i.} + \gamma Z_i + \varepsilon_{it}$$

where Y_{it} denotes PCS_{it}, MCS_{it}, or SRH_{it}. The outcomes PCS_{it} and MCS_{it} are respectively the physical and mental component summary scores for i^{th} respondent (i=1….n where is n is sample size) in the t^{th} wave (t=1 to 10), and SRH_{it} is self-rated health of i^{th} respondent in t^{th} wave. In each of the above regression models α_i represents individual-level time-invariant confounding, $X_{it} - \overline{X}_{i.}$ is a vector of within-person exposure, $\overline{X}_{i.}$ is a vector of person-level means of time-varying exposure variables X_{it}, Z_i is a vector of time-invariant exposure variables, and β_1, β_2 and γ are respectively their coefficient vectors. Wave (time) effects are included in X_{it}.The terms $\overline{X}_{i.}$ and Z_i are referred in this study as between-person exposure variables as they only change between people i.e. are constant within people. Since clustering is within individuals in longitudinal data, between-person exposure effects are often referred to as between-cluster or cross-sectional effects, and within-person exposure effects are often referred to as within-cluster or longitudinal effects in the statistical literature. The same terminology has been used in this study as well.

Contrasts were used in testing whether FB people (combining all FB subgroups) have any health advantage over the NB people. They were also used in testing whether FB from ES countries and the FB from NES countries differ in their health or not. For each FB subgroup, contrasts were separately used in even testing whether DOR has any effect in their health. Before regression analysis, basic characteristics of all the FB and the NB respondents and trends in mean levels of PH and MH have been provided to give some feeling for data empirical characteristics. We also showed trends in proportion of people reporting poor/fair SAH, across the waves of HILDA. All the statistical analyses for this study were carried out by using Statistical Analysis System (SAS) version 9.3.

Results

Characteristics of the study respondents

The baseline (wave 1) characteristics of the balanced panel by immigrant status are in Table 1. Out of 7460 respondents, 5795 (78%) were NB, 819 (11%) were born in ES countries and 846 (11%) were born in Non-ES countries. On the whole, there were more women (4066 or 55%) than the men (3394 or 46%) in the sample. The per cent of female respondents among NB, among immigrants from ES countries and NES countries was 55%, 51% and 55% respectively. NB respondents were relatively younger than the FB respondents. For example, about 22% of NB were in the 15-29 year age group as compared to only 9% of FB from ES countries and 15% of FB from NES countries in that age group. The majority of the respondents, both from NB and FB categories, were from New South

Wales, Victoria and Queensland, consistent with the population sizes of these states. About 7% of NB, 11% of FB from ES countries, and 10% of FB from NES countries reported graduate level education. About 56% of NB were living in major urban areas at the baseline versus 70% and 82% for the FB from ES and NES countries respectively. A greater proportion of FB were either married or in de-facto relation (75% overall; 76% from ES and 74% from NES countries), compared with NB respondents (66%). A higher proportion of NB (44%) and FB from ES (46%) countries reported being in full time employed, compared with the FB from NES countries (37%). As expected, FB people from NES countries were less proficient in English with only 39% of them reporting to be proficient in English. This is in contrast to 98% among NB and FB from ES countries who reported being proficient in English. Majority of the FB from ES countries (more than 60%) arrived in Australia before 1980 compared with 47% of FB from NES countries. The equivalised income levels of FB people were on par with those of the NB people. The mean level of mental health (MH) and the proportion reporting fair/poor health are consistent among NB and FB people, though NB had slightly better mean level of PH (52%) as compared to FB people (50%). The FB from NES countries had lower mean levels of both PH and MH (48% and 47% respectively) and a higher proportion of reporting fair/poor health (17%) as compared to FB from ES (mean level of PH and MH was 52%) countries and NB people (52% and 51%).

(Table 1 about here)

Observed trends in Physical health, mental health and self-rated health

Trends PH, MH and SRH, observed across the ten waves of HILDA, by immigrant status and the duration of residence in Australia are shown in Figure 1. In particular, figures 1(A), 1(B) and 1(C) show trends in PH, MH and SRH by immigrant status. Figures 1(D), 1(E) and 1(F), on the other hand, show trends in the above mentioned health aspects by duration of residence among FB people, in comparison to the NB people.

(Figure 1 about here)

It is apparently clear from figures 1(A) through 1(C) that irrespective of immigrant status, there is a clear decline in the levels of PH, MH and SRH among all the respondents during the study period. While the observed decline in health status can be partially attributed to increasing age, there are noticeable differentials in PH, MH and SRH by immigrant status. At the baseline, the mean PH score was highest in FB from ES countries (53.8), followed by NB (52.4), while the FB from NES countries had the lowest mean PH score (48.1) .Over time, the mean PH score decreased in all the groups, however, the mean PH score for FB from NES countries remained systematically below those for other groups . The mean PH score for FB from NES countries was about 3-6 unit lower for each year of data collection as compared to the other two groups. Echoing the PH pattern, declining mean MH score and an increasing proportion reporting fair/poor health was observed, though the gap between FB from NES countries and the other two groups (FB from ESC and NB) was highest in case of mean MH score at the end of 2010- last wave of data collection (a difference of 6 units).

Figures 1(D) through 1 (F) show changes in health according to immigration status and DoR over the 10 year period. There was an evidence of better PH, MH and SRH for the FB living in Australia for less than 10 years than the longer standing FB and the NB. For example, the mean physical health score for FB people living in Australia for less than 10 years was (54.9) at baseline. The corresponding estimate for FB residents in Australia for more than 20 years was 43.8, compared with

52.3 for the NB. Although the mean physical health and mental health declined over time in each group, the curve for FB residents in Australia for less than 10 years remained systematically above those FB living in Australia for more than or equal to 20 years and the NB. This trend was maintained for all other health measures during all the 9 wave of follow up data collection, though the difference between mean MH score for FB residents in Australia for less than 10 years and NB was generally small.

However, it is acknowledged that the differentials seen in levels and trends of various health outcomes (seen through Figures 1(A) and 1(F)) may be because of the influence of other variables associated with immigrant status, length of stay in Australia and various health outcomes. Hence, to control for the influence of all such confounders, the present study proceeds with the hybrid regression models, in the following section.

Results of regression analysis

Tables 2 show the results of regression analysis for PH, MH and SRH, with immigrant status as the main exposure variable. Table 3, on the other hand, shows results of regression analysis for these three health outcomes with duration of residence in Australia, segregated by country of birth, as the main exposure variable. Results from Table 2 suggests that after adjusting for other covariates there were no significant differences in the average PH scores between various FB subgroups and the NB people. Also when overall FB and the NB differences were tested using contrasts no significant differences were found in their PH. However, significant differences were found in the PH between FB people from ES countries and the NES countries. FB people from ES countries also do not have any MH advantage over the NB people. But, FB people from NES countries were disadvantaged by about 3.3 points in MH to those of the NB people. As a result of the disadvantage faced by immigrants from NES countries, there was a significant disadvantage for FB people overall in comparison to the NB in MH. Results of SAH showed a health advantage for the FB from ES countries (relative to the NB), and a health disadvantage for the FB from NES countries. The magnitudes of these advantage and disadvantage are such that there was no overall difference in SAH by nativity status. Contrast results showed that MH and SAH levels of FB people from ES countries are significantly better than those of the FB people from NES countries.

Results from Table 3 shows that irrespective of their length of stay in Australia FB from ES countries do not differ from the NB people in terms of their PH. FB from NES countries, on the other hand, were also found not differing from the NB people when their length of stay is less than 20 years. However, after 20 years of stay in Australia they were found to have disadvantage over the NB people by 2.8 points in PH. Contrast results showed DOR does not matter in the PH of FB from ES countries but it matters in case of FB from NES countries.

(Tables 2 and 3 about here)

Regression results for MH showed that FB people from ES countries, irrespective of their duration of residence, did not differ in their MH from those of the NB people. Similarly, the FB from NES countries living in Australia for less than 10 years were also found not differing from the NB people, in terms of their MH. But, the FB from NES countries staying in Australia for 10 to 19 years had a MH disadvantage of about 4.0 points. This disadvantage increased to 5.3 points for the FB from NES countries living in Australia for more than 20 years in Australia. Hypotheses tested using contrasts showed that there was no significant difference in MH for FB from ES countries with DOR, however, we found a significant difference in MH for FB from NES countries with DOR.

Regression results for SAH were mostly similar to those of the PH and MH results. When their length of stay is either less than 10 years or above 20 years, FB from ES countries were found not differing in their SAH levels from those of the NB people. However, between 10 to 19 years of stay in Australia, they were found to have an advantage of 1.3 points in SAH than the NB people. Similarly, the FB from NES countries living in Australia for less than 10 years were not found differing in their SAH level from those of the NB people. However, with 10 to 19 of stay and with more than 20 years of stay in Australia they became disadvantaged in comparison to NB people by about 0.1 points in SAH.

In summary, no HIE with respect to PH, MH and SAH were found for FB people living in Australia. Increase in the length of stay leads to decline in health for immigrants from NES and eventually they become disadvantaged to the NB people and the immigrants from ES countries. But, irrespective of their length of stay immigrants from ES countries were on par with the NB people in terms of their health.

Discussion & conclusion

We have examined whether the FB in Australia have a health advantage relative to the NB and if existent, is this relative health advantage different for different FB subgroups. We also examined whether any health advantage of the FB declines as duration of residence increases and for all FB groups?

Unlike many analyses that examined these research questions using cross-sectional data, we have used 10 waves of longitudinal data to investigate the nature of the association between migration and health in the Australian setting. Also unlike previous longitudinal work (e.g., {Setia, 2011 #1544; Setia, 2009 #1546; Setia, 2012 #1545}), we took advantage of hybrid model to improve estimates of the time invariant exposures. With respect to our three research questions, we found that:

1. There was no overall difference by nativity status in PH and SRH, however, substantial differences in MH between the FB and NB were observed.

2. Significant differences among FB subgroups exist in all health measures. FB people from NES countries have health disadvantage relative to NB people, with respect to all health outcomes and the disadvantage was huge with respect to MH. By contrast, the FB from ES countries reported similar levels of PH, MH and SRH as those of the NB people.

3. The FB from both ES and NES countries living in Australia for less than 10 years, do not have any health advantage relative to their NB counterparts. However, FB from NES

countries living in Australia for more than 10 years are significantly disadvantaged in terms of MH and SAH relative to NB people. After 20 years of their stay they even became disadvantaged with respect to PH compared to those of the NB people. Irrespective of their duration of residence, FB from ES countries did not differ from the NB with respect to their PH and MH.

Many earlier studies conducted around the world showed that immigrants upon their arrival to the host country are better in their health than the NB people due to voluntary positive selection among immigrants, cultural buffering by their native culture, and legal barriers against entry by those in poor health (Akresh & Frank 2008; Antecol & Bedard 2006; McDonald & Kennedy 2004b). Many studies even showed health advantage among new immigrants winds down as the length of residence in their adopted country increases. But, contrary to many studies (Denton, Prus & Walters 2004; Lahelma et al. 2001; Lahelma et al. 1999; Macintyre, Hunt & Sweeting 1996)(Denton, Prus, & Walters, 2004; Lahelma, Arber, Martikainen, Rahkonen, & Silventoinen, 2001; Lahelma, Martikainen, Rahkonen, & Silventoinen, 1999; Macintyre, Hunt, & Sweeting, 1996)(Denton, Prus & Walters 2004; Lahelma et al. 2001; Lahelma et al. 1999; Macintyre, Hunt & Sweeting 1996) which found that FB have better health than NB, we found absolutely no evidence for better health of FB people over the NB people, even when their length of stay is less than 10 years in Australia. Instead, on the whole, we found some of the FB subgroups (FB from NES countries) are significantly disadvantaged to the NB people with respect to all the health outcomes considered in this study.

We found a compelling evidence of DoR effects for FB living in Australia, particularly for FB people from NES countries. FB from NES countries although have similar levels of PH, MH and SAH levels as those of the NB people when their length of stay is less than 10 years, they become disadvantaged with respect to MH and SAH after they stay longer than 10 years.period. After 20 years of stay they also become disadvantaged to the NB people in terms of their PH. No effect of DOR is found for FB from ES countries.

These results are contrary to 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, 2012 #1545}. In our study, FB people from NES countries were more likely to have lower levels of PH, MH, and SAH than the NB people. Possible explanations for the apparent health disadvantage of FB people from NES countries (relative to comparable NB Australians) include barriers to care, acculturation to the host country, and discrimination. It may also be due to increasing experience of the Australian health system, those living longer in Australia increasingly likely to use the health system, and thus become more likely to be diagnosed with physical and mental health issues. It remains possible that FB from NES countries are underserved proportionate to their need for care, given the dramatic declines in health status of those FB from NES countries who had been living in Australia for more than 10 years.

This research has produced several important findings related to nativity gap in health in Australia using nationally representative longitudinal survey data, but the present set of analyses was not without limitations.

First, results and conclusions of the present study for DoR assume that there is no unmeasured confounding of the DoR-health relation. However, the extent of bias is expected to be smaller than that obtained through the application of conventional random effects model.

Second, our analyses may have been affected by selection bias as a higher proportion of FB dropped from the study. If those who dropped out of the study were more likely to have reported poorer health than those that remained, then the true population relationship between nativity and health would be stronger than found in this study. However, the nativity-health gap relationship in the “drop-outs” would need to be very different to the “stay-ins” to change our conclusions. Third, although we have adjusted for several time-varying confounding variables in the DoR analysis, it is possible that the differences we found in DoR-health gap could be the result of other time-varying factors associated with both DoR and health status that we did not measure.

Fourth, sources of measurement error also need consideration. For example, SRH might also be affected by FB-NB differential reporting behaviour and one could therefore question the reliability and validity of SRH. If the reporting of health outcome among FB differed in some systematic way from NB, this may bias the results, though the magnitude and direction of such bias is unknown.
However, self-rated health is widely used in the social sciences and population longitudinal surveys; it is well-established as a valid predictor of mortality {Idler, 1997 #119} and considered an excellent instrument for large-scale nationally-representative population surveys.

Fifth, grouping all the classes of FB and were treated as one category (economic, family and refugees) and FB from NES countries in one category underestimates the heterogeneity of this group. However, small numbers prevented us from using smaller sub-groups for the FB. Despite these limitations, the results presented here are important in several ways. This study uses a large, original, national survey with the longest duration of follow- up- and a variety of health measures in examining the nativity-health gap. By analysing 10 years of longitudinal data, we can account for changes in health status over a period of time. This study shows that in the context of Australia immigrants from NES countries have poorer levels of health than the NB people and the immigrants from ES countries. Immigrants from ES countries have similar levels of health as those of the NB people.

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Table 1: Unweighted wave 1 characteristics (per cent with a particular characteristic) of the study respondents

	Country of birth				All
	NB	FB			
Characteristics		ES	NES	*All FB*	
Sex					
Male	45.1	49.3	44.7	*47.0*	**45.5**
Female	54.9	50.7	55.3	*53.0*	**54.5**
Age group					
15-29	22.2	9.2	15.0	*12.1*	**19.9**
30-44	34.9	31.5	33.0	*32.3*	**34.3**
45-59	25.8	35.3	29.2	*32.2*	**27.2**
60+ years	17.0	24.1	22.8	*23.4*	**18.4**
State					
New South Wales	29.7	28.6	31.7	*30.2*	**29.8**
Victoria	24.5	18.3	32.2	*25.3*	**24.7**
Queensland	21.8	20.6	10.3	*15.4*	**20.4**
South Australia	9.8	10.5	9.3	*9.9*	**9.8**
Western Australia	8.7	16.2	11.8	*14.0*	**9.9**
Tasmania	3.4	2.6	1.0	*1.7*	**3.0**
Northern Territory	0.6	0.9	1.1	*1.0*	**0.7**
Australian Capital Territory	1.5	2.3	2.7	*2.5*	**1.7**
Level of education					
<=12 years of schooling	52.3	43.5	49.3	*46.4*	**51.0**
Bachelors or diploma	40.4	45.3	40.3	*42.8*	**40.9**
Graduation and above	7.3	11.2	10.4	*10.8*	**8.1**
Type of place of residence					
Major Urban	56.4	69.5	82.3	*76.0*	**60.8**
Other Urban	25.6	15.9	10.5	*13.2*	**22.8**
Rural Balance	18.0	14.7	7.2	*10.9*	**16.4**
Marital status					
Married/in de facto	65.7	75.7	74.3	*75.0*	**67.8**
Separated/Widowed	13.3	14.0	13.6	*13.8*	**13.4**
Never married/in de facto	21.0	10.3	12.1	*11.2*	**18.8**
Type of employment					
Full time employ	44.4	45.8	37.0	*41.3*	**43.7**
Part time employ	21.1	17.3	17.0	*17.2*	**20.2**
Un employed	3.2	2.4	4.0	*3.2*	**3.2**
Not in labour force	31.4	34.4	41.9	*38.3*	**32.9**
English language proficiency					
Proficient	98.1	98.2	38.9	*68.0*	**91.4**
Good	1.9	1.8	53.0	*27.8*	**7.7**
Not good	0.0	0.0	8.2	*4.1*	**0.9**
Period of arrival					
Not known	.	5.3	6.9	*6.1*	
<1960	.	16.6	22.0	*19.3*	
1961-1980	.	46.5	24.7	*35.4*	
1981-1990	.	20.8	21.5	*21.1*	
>= 1991	.	10.9	24.9	*18.0*	
Level of income					
<=20,000	14.7	13.8	19.9	*16.9*	**15.2**
(20,000-40,000]	20.2	21.4	22.0	*21.7*	**20.5**
(40,000-60,000]	19.5	18.3	19.7	*19.0*	**19.4**
>60,000	45.6	46.5	38.5	*42.4*	**44.9**
Mean level of PH	52.4	52.4	48.0	*50.0*	**51.9**
Mean level of MH	50.8	52.4	47.3	*49.6*	**50.5**
% reported poor/fair SRH	14.8	13.0	16.8	*15.1*	**14.9**
Total sample size (un weighted)	**5795**	**819**	**846**	**1665**	**7460**
Total sample size (weighted)	**5553**	**782**	**1145**	**1907**	**7460**

Figure 1: Observed trends in health by country of birth and duration of residence

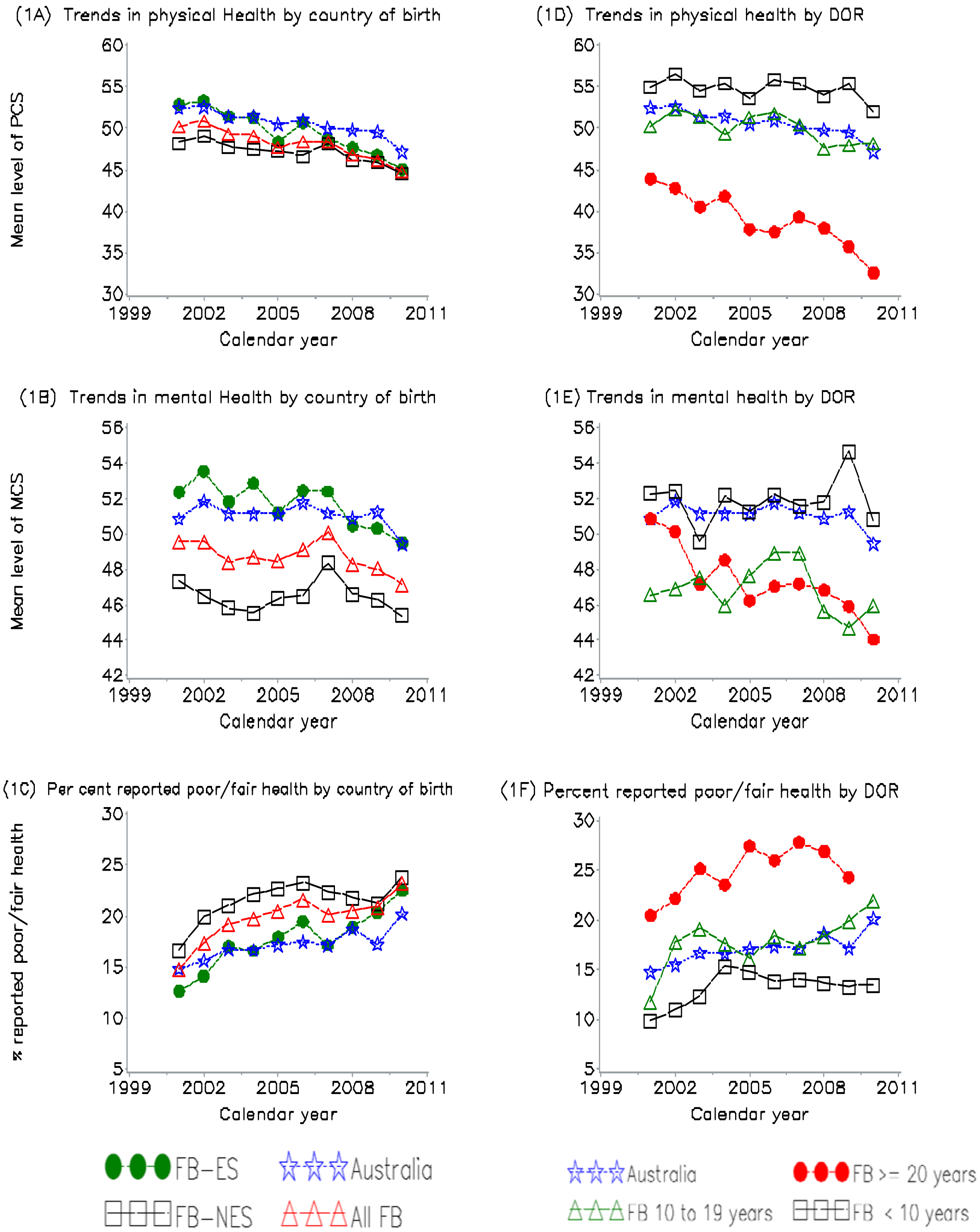

Table 2: Hybrid model results - country of birth

Factor and categories if any	*PH*		*MH*		*SRH*	
	Estimate	95% Confidence interval	Estimate	95% Confidence interval	Estimate	95% Confidence interval
Between-person exposure effect of time-invariant factors (cross-sectional effects)						
Country of birth						
ES	1.310	(-0.293,2.913)	0.519	(-1.179,2.216)	0.056*	(0.003,0.109)
NES	-1.301	(-2.896,0.294)	-3.325**	(-5.014,-1.636)	-0.093**	(-0.145,-0.040)
Australia (R)						
Age group						
15-29 years	6.294**	(4.110,8.478)	-11.133**	(-13.446,-8.821)	0.136**	(0.064,0.209)
30-44 years	1.179	(-0.758,3.117)	-12.747**	(-14.799,-10.695)	-0.067*	(-0.131,-0.003)
45-59 years	-4.142**	(-5.915,-2.370)	-10.809**	(-12.685,-8.932)	-0.182**	(-0.241,-0.124)
>=60 years (R)						
Sex						
Female	1.061*	(0.014,2.109)	-0.426	(-1.535,0.683)	0.105**	(0.070,0.139)
Male (R)						
Between-person exposure effects of time-varying factors (cross-sectional effects)						
Equalised income		(1.195,1.771)	1.470**	(1.164,1.775)	0.047**	(0.037,0.056)
Employment status						
Not in labour force	-21.870**	(-23.679,-20.060)	-17.317**	(-19.233,-15.401)	-0.538**	(-0.598,-0.478)
Un employed	-23.173**	(-29.662,-16.683)	-31.757**	(-38.630,-24.885)	-0.624**	(-0.839,-0.410)
Employed ®						
Marital Status						
Never married/never in de facto relation	-2.672**	(-4.422,-0.922)	-5.444**	(-7.297,-3.591)	-0.076**	(-0.134,-0.018)
Separated/Widowed	-7.335**	(-8.915,-5.754)	-7.145**	(-8.818,-5.471)	-0.115**	(-0.167,-0.062)
Married/in de facto relation ®						
Level of education						
Less than 12 years	-2.675**	(-4.186,-1.163)	-0.971	(-2.571,0.630)	-0.238**	(-0.288,-0.188)
Exactly 12 years	1.060	(-0.794,2.913)	2.292*	(0.329,4.254)	-0.037	(-0.099,0.024)
Diploma	-1.373	(-2.815,0.070)	0.178	(-1.349,1.705)	-0.155**	(-0.203,-0.107)
University education ®						
Within-person exposure effects of time-varying factors (cross-sectional effects)						
Equalised income		(0.086,0.250)	0.235**	(0.143,0.327)	0.007**	(0.004,0.010)
Employment status						
Not in labour force	-3.641**	(-4.117,-3.165)	-2.601**	(-3.135,-2.067)	-0.059**	(-0.077,-0.042)
Un employed	-2.785**	(-3.697,-1.873)	-3.461**	(-4.483,-2.438)	-0.054**	(-0.088,-0.021)
Employed ®						
Marital Status						
Never married/never in de facto relation	-1.203**	(-2.036,-0.370)	-2.430**	(-3.365,-1.496)	-0.028	(-0.059,0.003)
Separated/Widowed	-0.014	(-0.784,0.757)	-4.127**	(-4.990,-3.263)	0.048**	(0.020,0.076)
Married/in de facto relation ®						
Level of education						
Less than 12 years	-1.559	(-3.231,0.112)	-1.747	(-3.623,0.129)	-0.010	(-0.072,0.051)
Exactly 12 years	-2.169**	(-3.573,-0.765)	-1.878*	(-3.454,-0.301)	-0.141**	(-0.193,-0.090)
Diploma	-0.448	(-1.970,1.073)	-1.023	(-2.731,0.686)	-0.041	(-0.097,0.015)
University education ®						
Year	-0.656**	(-0.701,-0.611)	-0.239**	(-0.289,-0.188)	-0.025**	(-0.026,-0.023)

Hypotheses tested using contrasts

Hypothesis	**F-Statistic**	**P(F>Fcal)**	Conclusion
There is no difference in PH between FB and the NB people	0.000	0.994	Accepted
There is no difference in PH between ES and NES immigrants	5.923	0.015	Rejected
There is no difference in MH between FB and the NB people	4.649	0.031	Rejected
There is no difference in MH between ES and NES immigrants	11.447	0.001	Rejected
There is no difference in SAH between FB and the NB people	0.809	0.368	Accepted
There is no difference in SAH between ES and NES immigrants	17.691	0.000	Rejected

Table 3 - Hybrid model results - country of birth and duration of residence in Australia

Factor and categories if any	PH		MH		SRH	
	Estimate	95% Confidence interval	Estimate	95% Confidence interval	Estimate	95% Confidence interval
	Between-person exposure effect of time-invariant factors (cross-sectional effects)					
DOR at wave 1 by country of birth						
ES/DOR < 10 years	1.939	(-2.689,6.568)	-0.406	(-5.304,4.493)	0.113	(-0.040,0.266)
ES/DOR 11 to 20	2.259	(-1.107,5.625)	0.937	(-2.625,4.500)	0.130*	(0.018,0.241)
ES/DOR > 20	0.969	(-0.928,2.867)	0.573	(-1.435,2.582)	0.026	(-0.037,0.089)
NES/DOR < 10	2.930	(-0.364,6.223)	2.461	(-1.024,5.946)	0.042	(-0.067,0.151)
NES/DOR 11to20	-1.756	(-4.611,1.100)	-4.048**	(-7.071,-1.024)	-0.107*	(-0.201,-0.012)
NES/DOR >=20	-2.804**	(-4.978,-0.631)	-5.313**	(-7.614,-3.012)	-0.141**	(-0.213,-0.070)
Australia (R)						
Age at wave 1						
15-29 years	5.916**	(3.710,8.122)	-11.549**	(-13.884,-9.214)	0.121**	(0.048,0.194)
30-44 years	0.896	(-1.058,2.850)	-13.057**	(-15.125,-10.990)	-0.079*	(-0.143,-0.014)
45-59 years	-4.252**	(-6.028,-2.476)	-10.930**	(-12.809,-9.050)	-0.187**	(-0.245,-0.128)
>=60 years						
Sex						
Female	1.037	(-0.010,2.084)	-0.457	(-1.565,0.651)	0.104**	(0.069,0.139)
Male						
	Between-person exposure effects of time-varying factors (cross-sectional effects)					
Equalised income	1.488**	(1.199,1.776)	1.483**	(1.178,1.789)	0.047**	(0.037,0.056)
Employment status						
Not in labour force	-21.938**	(-23.748,-20.128)	-17.403**	(-19.319,-15.487)	-0.540**	(-0.600,-0.480)
Un employed	-23.252**	(-29.741,-16.764)	-31.877**	(-38.745,-25.009)	-0.624**	(-0.839,-0.410)
Employed ®						
Marital Status						
Never married/never in de facto relation	-2.646**	(-4.395,-0.897)	-5.413**	(-7.265,-3.562)	-0.075**	(-0.133,-0.017)
Separated/Widowed	-7.330**	(-8.910,-5.750)	-7.137**	(-8.809,-5.465)	-0.115**	(-0.167,-0.062)
Married/in de facto relation ®						
Level of education						
Less than 12 years	-2.488**	(-4.005,-0.972)	-0.730	(-2.335,0.875)	-0.232**	(-0.282,-0.182)
Exactly 12 years	1.228	(-0.627,3.084)	2.509**	(0.545,4.473)	-0.031	(-0.093,0.030)
Diploma	-1.202	(-2.649,0.245)	0.411	(-1.120,1.942)	-0.150**	(-0.198,-0.102)
University education ®						
	Within-person exposure effects of time-varying factors (cross-sectional effects)					
Equalised income	0.169**	(0.087,0.251)	0.236**	(0.144,0.328)	0.007**	(0.004,0.010)
Employment status						
Not in labour force	-3.640**	(-4.116,-3.164)	-2.601**	(-3.135,-2.068)	-0.059**	(-0.077,-0.042)
Un employed	-2.785**	(-3.697,-1.872)	-3.459**	(-4.482,-2.437)	-0.054**	(-0.088,-0.021)
Employed ®						
Marital Status						
Never married/never in de facto relation	-1.201**	(-2.035,-0.368)	-2.426**	(-3.361,-1.492)	-0.028	(-0.059,0.003)
Separated/Widowed	-0.014	(-0.785,0.756)	-4.129**	(-4.993,-3.266)	0.048**	(0.020,0.076)
Married/in de facto relation ®						
Level of education						
Less than 12 years	-1.554	(-3.226,0.117)	-1.736	(-3.612,0.140)	-0.010	(-0.072,0.051)
Exactly 12 years	-2.167**	(-3.571,-0.763)	-1.871*	(-3.448,-0.295)	-0.141**	(-0.193,-0.090)
Diploma	-0.447	(-1.968,1.075)	-1.019	(-2.728,0.689)	-0.041	(-0.097,0.015)
University education ®						
Year	-0.655**	(-0.700,-0.611)	-0.238**	(-0.288,-0.187)	-0.025**	(-0.026,-0.023)

Hypotheses tested using contrasts

Hypothesis	F-Statistic	P(F>Fcal)	Conclusion
There is no change in PH with DOR, among immigrants from ES countries	0.259	0.772	Accepted
There is no change in PH with DOR, among immigrants from NES countries	4.284	0.014	Rejected
There is no change in MH with DOR, among immigrants from ES countries	0.098	0.907	Accepted
There is no change in MH with DOR, among immigrants from NES countries	7.083	0.001	Rejected
There is no change in SAH with DOR, among immigrants from ES countries	1.608	0.200	Accepted
There is no change in SAH with DOR, among immigrants from NES countries	3.987	0.019	Rejected

Appendix

Figure A1: HILDA balanced panel attrition by various waves and by country of birth

	N	% RI	NB	FB-ES	FB-NES
Wave 1	13,969	85.9	10,413	1,556	2,030
Wave 2	11,993	89.9	9,095	1,305	1,593
Wave 3	10,777	91.4	8,250	1,159	1,368
Wave 4	9,855	94.5	7,611	1,066	1,178
Wave 5	9,311	95.2	7,204	1,005	1,102
Wave 6	8,864	94.9	6,872	956	1,036
Wave 7	8,409	95.5	6,536	911	962
Wave 8	8,034	96.1	6,245	875	914
Wave 9	7,721	96.6	6,001	843	877
Wave 10	7,460		5,795	819	846
Overall attrition (%)	***46.6%***		***44.3%***	***47%***	***58%***

Note: '% RI' indicate 'per cent of people in previous wave that were re-interviewed again in the next wave'.

'NB' indicate native born; FB-ES indicate foreign-born people from English speaking countries; FB-NES indicate foreign-born people from non-English speaking countries.

Computation of physical and mental health component summary scores

Based on principle component factor analysis earlier studies have consistently shown mainly two factors are driving correlations among various subscales of health (Mishra & Schofield 1998; Sanson-Fisher & Perkins 1998; Ware, Kosinski & Keller 1994). Studies even showed that one of these two factors have more loadings for physical health related components (PF, RP and BP), and hence was named as Physical Component Summary (PCS). The other factor was found to have more loadings for mental health related components (SF, VT, RE and MH), and hence was named as Mental Component Summary (MCS).

The basic assumption used while deriving these two factors is that the underlying factors which are driving correlations among various subscales of health are "uncorrelated". Because of this assumption, PCS has negative loadings for mental health related components and MCS has negative loadings for physical health related components. As a result, the usage of PCS and MCS have some undesired properties, particularly while using them to measure changes in physical and mental health at person level. For example, consider a person whose mental health (one or more components related to mental health) has declined over subsequent waves of HILDA, without any changes in physical health related components. In this case, PCS values for that person over subsequent waves gives an impression that physical health of that person is increasing, which is actually not true. The increase in PCS is just because of decline in mental health, instead of increase in physical health.

Although the very purpose of using summary scores is to minimize problems associated with multiple comparisons, but forcefully deriving summary scores under the assumption of "uncorrelated factors" may yield inconsistent results compared to using subscales of health (Hann & Reeves 2008; Taft, Karlsson & Sullivan 2001). Removing the constraint of "uncorrelated factors" will reduce discrepancies between various subscales of health and summary scores (Farivar, Cunningham & Hays 2007).

In this study, using pooled data from waves 1 to 10 of HILDA and using principle component factor analysis with oblique rotation technique (i.e. allowing for correlation among factors) we have obtained factor loadings for the two factors PCS and MCS. The following Table A1 shows factor loadings for PCS and MCS, obtained in this study, along with those obtained by Australian Bureau of statistics (ABS 1997) with the assumption of "uncorrelated factors". Couple of interesting observations can be made from this table. Factor loadings obtained by assuming "uncorrelated factors" are totally different from those of the factor loading obtained by assuming "correlated factors". But, more loading to mental health subscales for a factor related to mental health and more loading to physical health subscales for factor related to physical health is common in both the "correlated" and the "uncorrelated" factor analyses.

It is also clear from table A1 that there is only one negative term in the factor loadings of PCS and MCS. Any negative loading(s) in PCS and MCS will result in undesired properties to PCS and MCS, just like in the case of "uncorrelated factors". Adopting the procedure of earlier studies (Dockery 2006), to avoid complications due to negative loadings, we have replaced negative loadings with zero value while computing PCS and MCS scores for this study.

Table A1: Factor loadings

	ABS 1995 loadings		Loadings obtained in this study	
Variable	Mental component	Physical component	Mental component	Physical component
Physical function	-0.244	0.473	-0.127	0.913
Role limits - physical	-0.134	0.382	0.065	0.821
Bodily pain	-0.124	0.368	0.082	0.791
General health	0.053	0.190	0.389	0.514
Vitality	0.271	-0.019	0.632	0.331
Social function	0.265	-0.013	0.755	0.151
Role limits – emotional	0.359	-0.150	0.713	0.082
Mental health	0.488	-0.271	1.003	-0.202