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SSM - Population Health

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Article

Immigration factors and potentially avoidable hospitalizations in Canada

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ARTICLE INFO

Keywords:

ambulatory care sensitive conditions
preventable hospitalizations
immigration

ABSTRACT

Objective: Estimate the effect of immigration characteristics on the risk of a hospitalization for an ambulatory care sensitive condition (ACSC).

Research design: We analyzed data on the Canadian resident adult population aged 18 to 74 years who responded to the 2006 long form Census. The Census data were linked to the Canadian Institute for Health Information (CIHI)'s Discharge Abstract Database (DAD) for fiscal years 2006–2007, 2007–2008, and 2008–2009. We conducted a logistic regression on the binary variable we created for an ACSC admission.

Measures: The CIHI definition of ACSC hospitalizations was used to identify potentially avoidable hospitalizations in the DAD. Immigration factors analyzed included years in Canada, ethnic origin, and ability to speak one of the official languages.

Results: There were 3,342,450 respondents aged between 18 and 74. Using the Canadian at birth as our reference population, recent immigrants (up to five years in Canada) had lower odds of an ACSC hospitalization, regardless of their ethnic origins, with the exception of immigrants from Oceania and from other North American countries for whom the effect was not significant. The protective effect was still present in children of immigrants (AOR = 0.89). Immigrants from the Caribbean, from Southern, Eastern, and Western Europe, as well as those from East Asia had lower odds across categories of time spent in Canada. The protective effect was stronger in immigrants from East Asia and lower in those of Oceanic and other North American countries.

Conclusions: Our results suggest that the healthy immigrant effect dissipates with time in Canada but remains even in children of immigrants. The protective effect differs depending on the ethnic origin of the immigrant.

1. Introduction

A number of studies have found that immigrants arrive in a country in better health than the population of the host country and labelled the idea the “healthy immigrant effect”, hereafter HIE (Bruce Newbold, 2005; Gushulak, Pottie, Roberts, Torres, & Desmeules, 2011; Kennedy, Kidd, McDonald, & Biddle, 2015; McDonald & Kennedy, 2004). Evidence supports the theory of a self-selection in that immigrants are also healthier than the population of the country they left (Kennedy et al., 2015; Riosmena, Kuhn, & Jochem, 2017). With time spent in the host country, immigrants' health deteriorates to become similar to that of the local population (Gushulak et al., 2011). Researchers have hypothesized that the deterioration reflects an acculturation process whereby immigrants take cultural characteristics and behavioral habits of the non-immigrant host population (Gotay, Reid, Dawson, & Wang, 2015). The relationship between the acculturation and health is not clear either. The lifestyle changes within the acculturation process can differ between men and women (Gotay et al., 2015). Immigrants may

take lifestyle habits that either hinder their health, such as being more sedentary, or eating more processed food, or lifestyle habits that benefit their health, such as reducing their tobacco consumption (Gotay et al., 2015). There is stronger evidence supporting the former than the latter.

Immigrants also face numerous barriers in accessing health care services and in obtaining quality care, which could contribute to the decline of their health (Guruge, Birpreet, & Samuels-Dennis, 2015; Scheppers, van Dongen, Dekker, Geertzen, & Dekker, 2006). Even in countries, such as Canada, where immigrants theoretically have the same access as the non-immigrant population through universal health insurance they tend to show lower health literacy, inability to navigate the system, difficulty understanding how and where to obtain services or the inability to adequately communicate in the local language. This could hinder immigrants' capacity to benefit from health care services received (Guruge et al., 2015; Ahmed et al., 2016; Geltman et al., 2014; Kalich, Heinemann, & Ghahari, 2016; Ng & Omariba, 2014; Tsai & Lee, 2016). There is also evidence that immigrants receive lower quality care, an example of which are lower rates of retinopathy screening after

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a type 2 diabetes diagnosis (Lovshin & Shah, 2017). Immigrant women in Canada and in the U.S. were less likely to receive preventive cancer screening than non-immigrants of their host countries (Echeverria & Carrasquillo, 2006; Lofters, Moineddin, Hwang, & Glazier, 2010).

The duration of the HIE is up for debate from studies showing a rapid decline even within two years (Newbold, 2009), to others suggesting that there is transmission to the next generation (Kwak, 2016). For instance, immigrants with diabetes in Canada were found to be at a lower risk for cardiovascular events compared with long-term residents, and the effect persisted for at least 10 years after their arrival (Okraïnec, Bell, Hollands, & Booth, 2015). The evidence does suggest that the protective effect diminishes over time (Gimeno-Feliu et al., 2015; Ng, Sanmartin, & Manuel, 2016; Sohail et al., 2015).

Part of the decline in immigrants' health is attributed to a lower utilization of health care services. In the US, immigrants had lower medical expenditures and utilization of the emergency department than US-born citizens (Tarraf, Miranda, & González, 2012; Tarraf, Vega, & González, 2014). Another study found that cancer patients who were immigrants had significantly fewer physician visits than US-born patients (Wang, Wilson, & Chen, 2017). Asian immigrants had a lower utilization of health care services compared to US born Asian Americans (Ye, Mack, Fry-Johnson, & Parker, 2012). In Canada, immigrants were found to have a lower hospital utilization than Canadian at birth residents, with variations depending on the country of origin (Ng et al., 2016; Ng, Sanmartin, Tu, & Manuel, 2014). In Spain, in comparing with the local population, one study reported hospital utilization to be lower for immigrant males but higher for immigrant females. Rué et al., (2008). In other studies, utilization of prescription drugs, primary and specialized hospital and emergency care were all lower in immigrants than in the non-immigrant Spanish population (Buron, Cots, Garcia, Vall, & Castells, 2008; Cots et al., 2007; Gimeno-Feliu et al., 2013; Gimeno-Feliu et al., 2016). Others, after adjusting for case-mix, found higher utilization of diagnostic tests and emergency services among immigrants, suggesting that lower utilisation found elsewhere could be driven by lower health care needs – or the HIE (Calderón-Larrañaga et al., 2011). In Australia, immigrants were more likely to use the hospital emergency room because they did not have a regular general practitioner (GP) or access to a family doctor (Mahmoud, Eley, & Hou, 2015).

The HIE is not equal for all immigrants upon arrival and varies across countries of origin and host countries and so does their utilization of health care services (Gimeno-Feliu et al., 2015; Diaz, Mbanya, Gele, & Kumar, 2017; Marie Norredam et al., 2004). For instance, immigrants to Western European countries were at similar risk of ischemic heart disease as the local population (Sohail et al., 2015). Immigrants to Denmark had a higher emergency room (ER) utilization if they were from Somalia, Turkey and ex-Yugoslavia, but a lower ER utilization if they were from another European country (Marie Norredam et al., 2004). In a Swedish study, higher health services utilization was specifically associated with organised violence in the country of origin (Hjern, Haglund, Persson, & Rosn, 2001).

Some studies also examined the effect of speaking the language of the host country. One study of immigrants in Canada and the US found that not being able to speak English was associated with lower access to care (Lebrun, 2012). In Australia, speaking another language than English was associated with a lower utilization of services (Mahmoud, Hou, Chu, & Clark, 2013).

Most studies examining hospital utilization use data from all admissions. Yet many of these admissions are for acute care and may not reflect the general health of an individual (for instance trauma from an accident), their habits or a degradation of their health for lack of access to quality ambulatory services. No study has investigated the relationship between immigration characteristics and hospitalizations that are considered preventable, i.e. hospitalization for ambulatory care

sensitive conditions (ACSC) (Billings et al., 1993; Roos, Walld, Uhanova, & Bond, 2005). The ACSC hospitalization rate for people between 18 to 75 of age is used as an indicator of access and efficacy of primary care services (Ansari, Laditka, & Laditka, 2006; Laditka, Laditka, & Probst, 2005; Rosano et al., 2012). Adequate primary care physician supply and long-term relationship between primary care physicians and patients were associated with lower rates of hospitalizations for ACSCs in high-income countries (van Loenen, van den Berg, Westert, & Faber, 2014). In Canada, the indicator is used as a measure of the performance of the health care system and the list of ACSCs includes only chronic conditions. The list of conditions included in the ACSC indicator varies from country to country, in part reflecting characteristics of the local health care system. In Canada, the hospital remains the usual place of care for a number of acute conditions that may be treated in specialized facilities elsewhere. Yet, the definition of the indicator has been validated through expert groups and used in other studies to measure health system performance in Canada (Roos et al., 2005; Laberge, Wodchis, Barnsley, & Laporte, 2017).

The objective of this study is to estimate the effect of immigration on having an ACSC hospitalization in Canada. More specifically, we aim to identify and test how different immigration factors, acculturation (which we measure with the time spent in Canada), ethnicity, and languages could affect ACSC hospitalizations among immigrants, compared to the Canadian at birth population. Given evidence of the healthy immigrant effect, we hypothesize that immigrants will be at lower risk of an ACSC hospitalization, particularly when they are newly arrived. We hypothesize that immigrants' health status will decline with time spent in Canada, which will translate in reducing the gap with the Canadian population on the risk of an ACSC hospitalization. We also hypothesize that immigrants from countries that are culturally more similar and where the population may have a lifestyle and daily habits that are most like those of Canadians at birth will have a similar risk of an ACSC hospitalization. In contrast, immigrants from countries where eating and other habits are healthier than those of Canadians at birth will be at a lower risk of an ACSC hospitalization. The effect of not speaking an official language is expected to be associated with lower risk of hospitalization. For principal applicants in the economic category, Canada uses a points-based system that credits proficiency in an official language. Even though spouses and other family members may not have a very good level in an official language, nor might immigrants from other categories such as family and refugee entrants, the majority of immigrants do speak English or French, which could differ from countries that do not have such a criterion in the selection of immigrants. Canada also offers free language classes for immigrants to support their integration, including their integration to the labour market. Lack of proficiency in a host country's language is a barrier to economic and social integration. Not speaking an official language could also be a sign of limited acculturation. Overall, despite potential barriers for immigrants to accessing quality primary care, we suggest that the risk of an ACSC will be lower in immigrants, reflective of a better health status.

2. Methods

2.1. Data sources

Data from the Statistics Canada 2006 long form census were linked to the Canadian Institute for Health Information (CIHI) Discharge Abstract Database (DAD), which contains hospitalizations data. The DAD contains comprehensive hospitalization information such as the reason for admission, the admission date, the hospitalisation duration, and the hospital location. The census form is distributed to all dwellings, with one respondent expected to answer for him/herself as well as for all other occupants of the dwelling. It is available in English and

French, the two official languages of Canada. It collects date of birth, sex, marital status, relationship to respondent and mother tongue data. The census covers the entire Canadian population, including Canadian citizens (by birth and by naturalization), landed immigrants, and non-permanent residents. The long form was distributed systematically to every fifth dwelling to cover 20% of dwellings. The long form of Statistics Canada's 2006 census contains additional individual characteristics including the highest level of education attained, immigration status, before and after tax income, languages spoken, and current residency (the long form was eliminated in the following Census and hence could not be used here). Data from the census goes through a thorough process of error detection, editing and imputation to ensure completeness and validity. When an answer is missing, the imputation process includes inferences from responses to other questions. Statistics Canada reports an under-coverage rate of 2.8% and an overall response rate of 96.5%.

2.2. Study population

The study population consisted of all Canadian citizen and landed immigrant respondents of the 2006 census long form, aged 18 to 75 inclusively, with the exclusion of respondents from the province of Quebec for whom the data linkage to the DAD was not possible. We excluded non-permanent immigrants, i.e. people claiming refugee status and holders of a student or work permit. Applicants to permanent residency must go through a medical exam. Canada's criteria in the selection of immigrants includes health status whereby a candidate must not only be free of a disease that could represent a public health risk, but also, free of a disease that could represent an overwhelming burden. This criterion does not apply to those claiming refugee status.

2.3. Measures

2.3.1. Outcome

The outcome was a binary variable of whether the respondent had an ACSC over the three-year period starting April 1st 2006 and ending March 31st, 2009. We used the definition of an ACSC hospitalizations from CIHI, which limits ACSC to seven chronic conditions: angina, asthma, congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), diabetes mellitus (DM), grand mal status and other epileptic conditions (hereafter referred to as epilepsy), and hypertension (Sanmartin, Khan, & LHAD Research Team, 2011). This definition has also been used in other Canadian studies on ACSC hospitalizations (Laberge et al., 2017). ACSC hospitalizations were identified in the DAD using the diagnosis codes of the International Classification of Diseases version 10 (ICD-10).

2.3.2. Immigration

We identified three characteristics of immigration: acculturation, ethnicity, and capacity to speak an official language. Immigrants were defined as residents born in another country without having Canadian citizenship at birth, excluding foreign workers and people with working/student visas.

We measured acculturation with the time - in years - that an immigrant had been living in Canada, as well as the first generation born in Canada of immigrant parents. We defined four mutually exclusive groups: recent immigrants having lived in Canada for up to 5 years, immigrants with 6 to 10 years in Canada, immigrants having lived in Canada for at least 11 years, and Canadian-born children of immigrants.

We measured ethnicity based on the respondent's place of birth (POB). We used the classification made by Statistics Canada which defines 12 ethnic origins groups: Other North American; Caribbean; Latin, Central and South American; European; Western European; Northern European; Eastern European; Southern European; Other

European; African; Arab; West Asian; South Asian; East and Southeast Asian; Oceania.

We used questions on languages spoken to identify whether immigrants were able to communicate in at least one of the official languages of Canada, i.e. English and French. Although there are no details as to the level, the question asks specifically about the "ability to carry a conversation".

2.3.3. Other explanatory

We controlled for the individual's sex (binary), age (continuous and squared), highest education level attained, income, marital status (binary), and rurality (binary). We grouped levels of education into four categories: 1- no degree, 2- high school diploma or equivalent, 3- non-university post-secondary degree or some university; 4- university degree. We used self-reported after-tax income to create quintiles from all the respondents' income data, and we used income quintile 1 as the lowest.

2.4. Statistical analyses

We produced descriptive statistics for each population group and conducted t-test to determine whether observed differences were significant. We conducted logistic regressions with clustering based on the province to determine the effect of immigration factors on the risk of an ACSC hospitalization. Our generic model was defined as:

$$\begin{aligned} \log(ACSCH)_i = & \beta_0 + \beta_1 immigration_i + \beta_2 age_i + \beta_3 male_i \\ & + \beta_4 education_i + \beta_5 incomequintile_i + \beta_6 rurality_i \\ & + \beta_7 marr_i + \epsilon \end{aligned}$$

We had four categories to measure acculturation: three of the time the respondent lived in Canada (up to 5 years, 6 to 10 years, and over 11 years), and the fourth was being a child of immigrants. We created immigration categories for each combination of acculturation and ethnic origin (except for children of immigrant), and a binary variable for whether the immigrant could communicate in an official language.

The variable "Canadian at birth" excluded children of immigrants.

We also conducted separate regressions on each of the health conditions and present the results in [Appendix A](#).

The analyses were conducted using Stata, version 14 at the Quebec inter-University Centre for Social Statistics (QICSS) at Université Laval. Results on number of observations are rounded to the closest 50th as per guidelines from Statistics Canada on this linked dataset.

3. Results

The study population contained 3,342,450 individuals, which corresponds to the number of people who had filled the long-form version of the 2006 Census and who were aged 18 to 75. Respondent characteristics differed across groups depending on variables. Mean age was similar between Canadian born citizens and children of immigrants (43 years old). Immigrants had a higher mean age with the time spent in Canada.

Immigrants from European countries were on average older, particularly those from Western Europe (56 years old), while immigrants from West Asia were the youngest (38 years old). The proportion of males were just under 50% except in the group of immigrants who did not speak English or French where it was much lower at 36%. There were significant differences in groups on distributions of education levels and income quintiles. There are higher proportions of recent immigrants in the lower income quintiles but the situation reverses with time spent in Canada and children of immigrants are more likely to be wealthier. Education and income levels vary depending on the origin of

Table 1
Descriptive statistics of population groups by immigration characteristics.

| Variable | All | Canadian at birth (≠imm child) | Imm under 5 years | Imm 6to10 years | Imm 11+ years | Imm child | Imm speaks En/Fr | Imm does not speak En/Fr |
|--------------------|--------------|--------------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| N | 3,342,450 | 1,913,850 | 126,400 | 109,300 | 594,250 | 563,900 | 781,750 | 47,850 |
| Average age (s.d.) | 43.78 (15.1) | 42.6 (14.7) | 37.32 [*] (12.2) | 39.41 [*] (12.8) | 50.61 [*] (14.0) | 43.47 [*] (16.3) | 46.58 [*] (14.6) | 55.74 [*] (13.9) |
| %Male | 48.97 | 49.31 | 46.11 [*] | 47.53 [*] | 48.32 [*] | 49.30 [*] | 48.58 [*] | 36.39 [*] |
| % Education 1 | 19.46 | 22.27 | 12.01 [*] | 12.46 [*] | 18.56 [*] | 14.11 [*] | 14.14 [*] | 59.34 [*] |
| % Education 2 | 33.14 | 34.98 | 23.18 [*] | 27.88 [*] | 29.90 [*] | 33.84 [*] | 28.91 [*] | 23.79 [*] |
| % Education 3 | 23.06 | 23.98 | 11.91 [*] | 14.66 [*] | 22.96 [*] | 24.74 [*] | 21.05 [*] | 6.17 [*] |
| % Education 4 | 24.34 | 18.77 | 52.90 [*] | 45.00 [*] | 28.58 [*] | 27.31 [*] | 35.90 [*] | 10.70 [*] |
| % rural | 23.06 | 32.10 | 3.25 | 3.30 | 8.45 | 16.74 [*] | 7.32 [*] | 1.52 [*] |
| % married | 55.08 | 50.77 | 71.15 | 67.22 | 67.41 | 51.43 [*] | 67.50 [*] | 75.26 [*] |
| % IQ 1 | 20.00 | 19.71 | 40.76 [*] | 28.03 [*] | 16.28 [*] | 17.09 [*] | 20.64 [*] | 36.49 [*] |
| % IQ 2 | 20.00 | 20.09 | 22.58 [*] | 21.50 [*] | 20.23 [*] | 18.42 [*] | 19.70 | 37.99 [*] |
| % IQ 3 | 20.00 | 19.92 | 18.20 [*] | 20.94 [*] | 21.28 [*] | 19.44 [*] | 21.00 [*] | 16.90 [*] |
| % IQ 4 | 20.00 | 20.17 | 11.13 [*] | 16.31 [*] | 21.32 [*] | 21.49 [*] | 19.90 [*] | 6.27 [*] |
| % IQ 5 | 20.00 | 20.11 | 7.32 [*] | 13.21 [*] | 20.89 [*] | 23.55 [*] | 18.76 [*] | 2.34 [*] |
| % ACSCH | 3.24 | 3.40 | 0.92 [*] | 1.59 [*] | 3.59 [*] | 3.24 [*] | 2.81 [*] | 4.02 [*] |

Education levels: 1- no degree, 2- high school diploma or equivalent, 3- non-university post-secondary degree or some university; 4- university degree; IQ= Income Quintile; s.d.: standard deviation.

* Significantly different from the reference group.

immigrants. However, immigrants are generally more educated compared to the Canadian at birth population, except for those who do not speak one of the official languages, and those from Southern Europe. Immigrants who do not speak an official language and immigrants of Latin America and of Asia (West, South, and East) also have a lower income profile. Immigrants are less likely to live in rural areas [Tables 1 and 2](#).

[Table 3](#) shows the results from the logistic regression. Recent immigrants (up to 5 years in Canada) have significantly and consistently across all ethnic origins (except Oceanic and other countries), lower odds of an ACSC hospitalization, varying from 0.31 in immigrants from Western Europe, to 0.69 in immigrants from Arabic countries. Immigrants who have been in Canada for 6 to 10 years appear have odds significantly lower than Canadians at birth if they are from Caribbean, Southern, Western, and Eastern Europe, as well as from East Asia. Theirs odds are not significantly different if they are from Latin America, Northern Europe, Sub-Saharan Africa, Arabic countries, Western and Southern Asia, Oceanic and other countries. For immigrants who have been in Canada for 11 years or more, odds of an

ACSC hospitalization are significantly lower except if they are from South Asia. Children of immigrants and immigrants who did not speak an official language had significantly lower odds of an ACSC hospitalization (AOR = 0.89 and AOR = 0.77, respectively). Higher education, higher income, and being married are associated with lower odds of an ACSC hospitalization. Being male, living in a rural area, and older age are associated with higher odds. The effect of these variables were consistent in regressions for each condition presented in [Appendix A](#). However, there are differences in the effect of ethnic origin and acculturation for the different conditions.

We report results with robust standard errors. We tested with clustering at the provincial levels and the results did not change.

4. Discussion

The results show that there are significant differences between the groups of immigrants and that immigration characteristics affect the odds of an ACSC hospitalization, controlling for social, economic and demographic factors. The descriptive statistics and the results from the

Table 2
Descriptive statistics of population groups by origin.

| | All | Canada | Other NA | Latin | Caribbean | Eur-S | Eur- W | Eur- E | Eur-N | African | Arabic | Asia- W | Asia-E | Asia- S | Oceania |
|------------------------|---------------|---------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| N | 3,342,450 | 2,477,700 | 37,100 | 53,450 | 41,800 | 93,100 | 51,650 | 62,800 | 97,300 | 26,050 | 51,050 | 9,200 | 222,350 | 108,800 | 9,300 |
| Average age (age s.d.) | 43.78 (15.14) | 42.81 (15.12) | 47.18 [*] (14.14) | 42.17 [*] (13.42) | 46.12 [*] (14.08) | 53.86 [*] (13.75) | 56.08 [*] (13.34) | 46.20 [*] (15.27) | 53.81 [*] (13.24) | 41.63 [*] (13.44) | 41.30 [*] (14.25) | 38.49 [*] (13.50) | 43.44 [*] (14.03) | 42.48 [*] (14.02) | 44.45 [*] (14.02) |
| % Male | 48.97 | 49.31 | 43.27 [*] | 48.64 [*] | 44.86 [*] | 50.97 [*] | 50.31 [*] | 47.45 [*] | 49.08 | 49.29 | 52.79 | 50.41 [*] | 44.89 [*] | 50.28 [*] | 47.79 [*] |
| % Education 1 | 19.46 | 20.41 | 8.06 [*] | 22.70 [*] | 14.28 [*] | 40.75 [*] | 14.92 [*] | 8.50 [*] | 8.28 [*] | 11.49 [*] | 11.57 [*] | 21.08 | 14.73 [*] | 17.39 [*] | 13.11 [*] |
| % Education 2 | 33.14 | 34.72 | 29.80 [*] | 31.85 [*] | 33.75 [*] | 28.66 [*] | 27.47 [*] | 25.61 [*] | 32.15 [*] | 30.66 [*] | 27.05 [*] | 21.08 [*] | 26.58 [*] | 27.78 [*] | 32.94 [*] |
| % Education 3 | 23.06 | 24.15 | 17.37 [*] | 21.09 [*] | 30.30 [*] | 17.18 [*] | 34.87 [*] | 25.29 [*] | 31.79 [*] | 22.40 [*] | 15.72 [*] | 13.38 [*] | 14.27 [*] | 10.89 [*] | 25.10 [*] |
| % Education 4 | 24.34 | 20.71 | 44.76 [*] | 24.36 [*] | 21.67 [*] | 13.42 [*] | 22.74 [*] | 40.60 [*] | 27.78 [*] | 35.45 [*] | 45.66 [*] | 35.24 [*] | 44.43 [*] | 43.94 [*] | 28.84 [*] |
| % rural | 23.06 | 28.60 | 25.91 [*] | 9.32 [*] | 4.04 [*] | 4.99 [*] | 26.80 [*] | 5.91 [*] | 16.14 [*] | 1.98 [*] | 2.56 [*] | 1.36 [*] | 1.46 [*] | 1.53 [*] | 9.10 [*] |
| % married | 55.08 | 50.92 | 63.96 [*] | 61.15 [*] | 48.61 [*] | 75.00 [*] | 68.51 [*] | 64.87 [*] | 67.31 [*] | 55.22 [*] | 62.92 [*] | 64.32 [*] | 65.78 [*] | 79.47 [*] | 66.35 [*] |
| % IQ 1 | 20.00 | 19.12 | 22.22 [*] | 22.23 [*] | 17.63 [*] | 15.67 [*] | 14.92 [*] | 20.20 [*] | 13.00 [*] | 23.22 [*] | 30.45 [*] | 34.40 [*] | 28.77 [*] | 26.95 [*] | 18.01 [*] |
| % IQ 2 | 20.00 | 19.71 | 17.25 [*] | 21.94 [*] | 18.50 [*] | 22.44 [*] | 20.10 [*] | 20.59 [*] | 16.82 [*] | 20.66 [*] | 21.65 [*] | 27.54 [*] | 21.37 [*] | 23.42 [*] | 17.66 [*] |
| % IQ 3 | 20.00 | 19.81 | 17.45 [*] | 22.61 [*] | 21.65 [*] | 23.34 [*] | 22.49 [*] | 21.34 [*] | 19.85 | 19.58 | 17.11 [*] | 18.77 [*] | 19.65 | 20.81 [*] | 21.13 [*] |
| % IQ 4 | 20.00 | 20.47 | 17.77 [*] | 19.92 [*] | 24.74 [*] | 20.74 [*] | 20.71 | 19.31 [*] | 22.22 [*] | 18.68 [*] | 13.73 [*] | 11.20 [*] | 16.72 [*] | 16.24 [*] | 22.21 [*] |
| % IQ 5 | 20.00 | 20.90 | 25.31 [*] | 13.30 [*] | 17.49 [*] | 17.82 [*] | 22.04 [*] | 18.56 [*] | 28.11 [*] | 17.86 [*] | 17.06 [*] | 8.09 [*] | 13.50 [*] | 12.57 [*] | 20.99 [*] |
| % ACSCH | 3.24 | 3.36 | 3.02 [*] | 1.99 [*] | 2.88 [*] | 4.68 [*] | 5.02 [*] | 2.79 [*] | 4.52 [*] | 2.16 [*] | 1.98 [*] | 1.48 [*] | 1.30 [*] | 2.49 [*] | 2.69 [*] |

Education levels: 1- no degree, 2- high school diploma or equivalent, 3- non-university post-secondary degree or some university; 4- university degree.

IQ= Income Quintile; s.d.: standard deviation; *significantly different from the Canadian at birth population.

* Significantly different from the reference group.

Table 3
Results of Adjusted Odds Ratios (and 95% Confidence Intervals) from the regression on having an ACSC hospitalization.

| ACSC hospitalization | Odds ratio [95% C.I.] |
|--|-------------------------|
| Canadian at birth | Reference |
| Child of immigrant | 0.89*** [0.878-0.910] |
| Latin America | |
| Latin America immigrant < 5 years | 0.50*** [0.395-0.640] |
| Latin America immigrant 6 to 10 years | 0.86 [0.692-1.072] |
| Latin America immigrant > 10 years | 0.72*** [0.675-0.772] |
| Caribbean | |
| Caribbean immigrant < 5 years | 0.41*** [0.276-0.595] |
| Caribbean immigrant 6 to 10 years | 0.76* [0.581-0.998] |
| Caribbean immigrant > 10 years | 0.81*** [0.758-0.858] |
| Europe – South | |
| Europe – South < 5 years | 0.61** [0.462-0.816] |
| Europe – South immigrant 6 to 10 years | 0.75** [0.617-0.923] |
| Europe – South immigrant > 10 years | 0.72*** [0.698-0.746] |
| Europe – West | |
| Europe – West immigrant < 5 years | 0.31*** [0.168-0.555] |
| Europe – West immigrant 6 to 10 years | 0.58** [0.396-0.841] |
| Europe – West immigrant > 10 years | 0.76*** [0.725-0.788] |
| Europe – East | |
| Europe – East immigrant < 5 years | 0.46*** [0.368-0.579] |
| Europe – East immigrant 6 to 10 years | 0.82* [0.695-0.971] |
| Europe – East immigrant > 10 years | 0.76*** [0.722-0.802] |
| Europe – North | |
| Europe – North immigrant < 5 years | 0.45*** [0.318-0.626] |
| Europe – North immigrant 6 to 10 years | 0.81 [0.604-1.096] |
| Europe – North immigrant > 10 years | 0.84*** [0.816-0.871] |
| Africa (sub-Saharan) | |
| Africa (sub-Saharan) immigrant < 5 years | 0.65** [0.492-0.852] |
| Africa (sub-Saharan) immigrant 6 to 10 years | 1.05 [0.816-1.358] |
| Africa (sub-Saharan) immigrant > 10 years | 0.85** [0.774-0.938] |
| Arabic | |
| Arabic immigrant < 5 years | 0.69*** [0.579-0.817] |
| Arabic immigrant 6 to 10 years | 0.97 [0.836-1.132] |
| Arabic immigrant > 10 years | 0.74*** [0.689-0.802] |
| Asia – West | |
| Asia – West immigrant < 5 years | 0.51*** [0.360-0.732] |
| Asia – West immigrant 6 to 10 years | 1.03 [0.761-1.398] |
| Asia – West immigrant > 10 years | 0.69** [0.537-0.876] |
| Asia- East | |
| Asia – East immigrant < 5 years | 0.30*** [0.266-0.345] |
| Asia – East immigrant 6 to 10 years | 0.43*** [0.384-0.473] |
| Asia – East immigrant > 10 years | 0.46*** [0.427-0.478] |
| Asia – South | |
| Asia – South immigrant < 5 years | 0.58*** [0.523-0.650] |
| Asia – South immigrant 6 to 10 years | 0.98 [0.891-1.066] |
| Asia – South immigrant > 10 years | 0.97 [0.926-1.021] |
| Oceanic | |
| Oceanic immigrant < 5 years | 0.76 [0.433-1.325] |
| Oceanic immigrant 6 to 10 years | 1.27 [0.796-2.021] |
| Oceanic immigrant > 10 years | 0.82** [0.714-0.940] |
| Other origin | |
| Other origin immigrant < 5 years | 0.83 [0.642-1.07] |
| Other origin immigrant 6 to 10 years | 0.90 [0.657-1.232] |
| Other origin immigrant > 10 years | 0.85*** [0.795-0.906] |
| Imm does not speak En/Fr | 0.77*** [0.733-0.814] |
| Age | 1.15*** [1.148-1.157] |
| Age squared | 1.00*** [0.9993-0.9994] |
| Male | 1.37*** [1.352-1.387] |
| Education: no degree | Reference |
| High school | 0.77*** [0.756-0.781] |
| Some college/university | 0.75*** [0.735-0.762] |
| University degree | 0.59*** [0.574-0.599] |
| Income quintile 1 | Reference |
| Income quintile 2 | 0.96*** [0.939-0.976] |
| Income quintile 3 | 0.76*** [0.747-0.778] |
| Income quintile 4 | 0.66*** [0.644-0.672] |
| Income quintile 5 | 0.56*** [0.550-0.576] |

Table 3 (continued)

| ACSC hospitalization | Odds ratio [95% C.I.] |
|-----------------------|-----------------------|
| rurality | 1.17*** [1.158-1.192] |
| Married | 0.82*** [0.810-0.832] |
| C-statistic | 0.80 |
| Pseudo R ² | 0.13 |

Significant at *** p < 0.001. ** p < 0.01. * p < 0.05.

logistic regression are consistent with the concept of HIE and reflective of Canada’s immigration selection policies which favor healthy and educated immigration candidates. In fact, it has been stated that most migrants (> 90%) arriving in Canada report very good to excellent health and possess health characteristics that are equal or superior to those of Canadians at birth (Gushulak et al., 2011).

Results from other studies suggest that the HIE dissipates over time. Gushulak et al., (2011; Newbold, 2009; Kwak, 2016; Okrainec et al., 2015; Gimeno-Feliu et al., 2015; Ng et al., 2016; Sohail et al., 2015) Our results raise new questions about the potential narrowing of the health gap. Indeed, for immigrants from various origins, there is no significant difference when they have been living in Canada for 6 to 10 years. However, the gap widens again in some ethnic groups after the immigrants have lived in Canada for over 10 years. Even children of immigrants are less likely to have an ACSC hospitalization, compared to other Canadians at birth.

Although time spent in Canada may appear as a simplistic measure of acculturation, our descriptive statistics on socio-economic variables suggest that the process is happening through time in Canada. The acculturation process appears to be reflected in the distribution of immigrants across income quintiles. Recent immigrants may have difficulty finding employment relative to their level of education and having their diploma recognized (Frank, 2013; Fuller, 2015; Phythian, Walters, & Anisef, 2011), which could explain the higher concentration of them in lower income quintiles. Yet such challenges may disappear overtime, and be reflected in the shift whereby immigrants who have lived in Canada for at least 11 years are less likely to be in low IQs compared to the Canadians at birth.

Immigrants are a very heterogeneous population. The descriptive statistics on immigrants by ethnic origin and the regression show that odds of an ACSC also depend on the ethnic origin of immigrants. A study found lower morbidity among Asian immigrants (Gimeno-Feliu et al., 2015). Most of ACSC are chronic conditions for which incidence may be affected by combination of lifestyle habits as well as genetic and environmental factors. Immigrants from East Asia are the least likely to have an ACSC hospitalization (AOR=0.30 to AOR=0.46 for recent immigrants and immigrants over 10 years respectively) whereas odds for those from Oceanic and Other North American countries are only significantly different from those of Canadians at birth when they have been in Canada for at least 10 years (AOR=0.82 and AOR=0.85, respectively). The environment from which they come from is also similar to that of Canada and their lower odds after they have been in Canada for over 10 years is puzzling and could reflect different waves of immigration with distinct characteristics. The results showing lower odds for recent immigrants suggest that immigrants are in better health when they arrive in Canada. The additional results in Appendix A suggest that the prevalence of diseases may vary across ethnic origins. Only a few immigrant groups have significantly lower odds of a hospitalization for epilepsy, angina, or heart failure, where as the majority of immigrant groups have significantly lower odds of a hospitalization for COPD. For all diseases, most groups of immigrants who have been in Canada for 6 to 10 years do not have statistically different odds of a hospitalization. These could reflect a combination of genetic baggage and lifestyle habits that contribute to the developing such chronic conditions. A recent study in Australia on the prevalence of risk factors for cardiovascular diseases (CVD) such as smoking and overweight/obesity found that

immigrants from Asia had fewer of the CVD risk factors, but they also noted a narrowing of the gap with acculturation (Guo, Lucas, Joshy, Banks, & Targher, 2015). Another study in Ontario found that immigrants from South Asia were more likely than immigrants from Western Europe and North America to have diabetes (Creatore et al., 2010).

We note that immigrants who do not speak an official language have lower odds of an ACSC (AOR=0.77). These results could appear surprising given that not speaking a local language could be a barrier to accessing quality services (Ahmed et al., 2016), to health literacy and to managing one's health. Wang et al. studied health services utilization among diabetes in British Columbia and Quebec and found that the ability to speak an official language among immigrants did not affect their utilization. Wang et al. (2012) Upon further analysis, we found that the group of immigrants who do not speak an official language is composed of immigrants whose ethnic origin is associated with the lowest odds of an ACSC hospitalization (and likely to be healthier) and of more recent immigrants.

Consistent with results from other studies, we found that the odds of an ACSC hospitalization decrease with higher income (Roos et al., 2005; Laberge et al., 2017), and higher education level (Billings et al., 1993). These odds are higher for men (Roos et al., 2005) and for people living in rural areas (Laberge et al., 2017).

There are some limitations to our study. First, we did not have data on ACSC diagnoses or on prevalence of the conditions in the different population groups, nor do we have data on health status, which limits the interpretation regarding access to primary care services. We also do not know if there were differences between populations groups about having a primary care provider. Yet it is unlikely that immigrants would have better access (given the empirical evidence of the contrary). We cannot identify from our results the reasons behind the lower odds of ACSC hospitalizations nor can we infer causality between an acculturation process, presence of the diseases, and hospitalizations. However, the results do align with our expectations and support our hypothesis that immigrants to Canada are in better health than the Canadian at birth population.

Claimants of the refugee status were excluded from the study. This choice was made on the consideration that their refugee status suggests that they would be likely to be in poorer health. It would be interesting for future research to examine this specific population and changes in their health status with acculturation.

Finally, we identified ACSC hospitalizations through diagnoses listed in the discharge files, where there can be more than one ICD code, and the admission could be related to a combination of factors and of conditions. In a study conducted in Ontario, over 10% of the population with an ACSC diagnosis had at least 2 ACSCs (Laberge et al., 2017). In a sense, combining the ACSCs together rather than examining them separately can better reflect potential multimorbidity.

Our results are aligned with the idea that immigrants to Canada are in better health than the population of Canadians at birth. Despite potential difficulties accessing care, which were not within the scope of

our study, the healthy immigrant effect remains even into the next generation, although it does diminish over time, and in various ways depending on the ethnic origin. This effect appears to be in large part related to their country of origin and the lifestyle that have kept them healthy in their own country and that they maintain to a certain extent after immigrating to Canada.

Our results have important implications in the current context where immigration is in many countries a dividing issue, with arguments about the burden that immigrants could represent for health care systems. The findings suggest that immigrants have a lower utilization, at least in terms of ACSC hospitalizations. Rather than representing a burden, immigrants could be higher contributors to the health care system. Although they may also in the first years also have lower revenues and other morbidities not examined here. More research is needed to better understand how immigrants adapt and contribute to their host country, and the impact that such adaptation may have on their health services utilization.

Acknowledgement

The analysis presented in this paper was conducted at the Quebec Interuniversity Centre for Social Statistics which is part of the Canadian Research Data Centre Network (CRDCN). The services and activities provided by the QICSS are made possible by the financial or in-kind support of the Social Sciences and Humanities Research Council (SSHRC), the Canadian Institutes of Health Research (CIHR), the Canada Foundation for Innovation (CFI), Statistics Canada, the Fonds de recherche du Québec - Société et culture (FRQSC), the Fonds de recherche du Québec - Santé (FRQS) and the Quebec universities. The views expressed in this paper are those of the authors, and not necessarily those of the CRDCN or its partners.

Ethics approval

The study uses data from the Canadian census linked to administrative data from the hospital discharge administrative database.

The analysis presented in this paper was conducted at the Quebec Interuniversity Centre for Social Statistics which is part of the Canadian Research Data Centre Network (CRDCN). The data were analyzed in the secure environment of the QICSS, under high standards of data protection. Reporting of data is consistent with the regulations of the QICSS.

The project did not require approval from the research ethics board.

Conflict of interest statement

None to declare.

Financial disclosure statement

None to declare.

Appendix A

see: [Table A1](#).

Table A1
Results of Adjusted Odds Ratios (and 95% Confidence Intervals) from regressions on each condition.

| | Epilepsy | COPD | Asthma | Diabetes | Heart Failure | Hypertension | Angina |
|----------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Canadian at birth | – | – | – | – | – | – | – |
| Child of immigrant | <u>0.91*</u> [0.828–0.998] | <u>0.90***</u> [0.862–0.933] | <u>0.92*</u> [0.855–0.981] | <u>0.77***</u> [0.746–0.795] | <u>0.86***</u> [0.824–0.901] | <u>1.01</u> [0.987–1.033] | <u>0.82***</u> [0.779–0.858] |
| Latin America | | | | | | | |
| < 5 years | <u>0.47</u> [0.177–1.243] | <u>0.17**</u> [0.542–0.527] | <u>0.44*</u> [0.210–0.929] | <u>0.44***</u> [0.285–0.671] | <u>0.54</u> [0.268–1.079] | <u>0.60**</u> [0.429–0.844] | <u>0.46</u> [0.207–1.030] |
| 6 to 10 years | <u>0.75</u> [0.282–2.012] | <u>0.19**</u> [0.062–0.605] | <u>0.61</u> [0.274–1.364] | <u>1.04</u> [0.745–1.440] | <u>0.84</u> [0.447–1.567] | <u>0.93</u> [0.685–1.272] | <u>0.75</u> [0.372–1.500] |
| > 10 years | <u>0.44***</u> [0.284–0.688] | <u>0.27***</u> [0.209–0.345] | <u>0.52***</u> [0.380–0.700] | <u>0.78***</u> [0.701–0.875] | <u>0.53***</u> [0.430–0.647] | <u>0.91*</u> [0.834–0.987] | <u>0.59***</u> [0.481–0.722] |
| Caribbean | | | | | | | |
| < 5 years | – | <u>0.09*</u> [0.013–0.661] | <u>0.62</u> [0.231–1.647] | <u>0.48</u> [0.266–0.868] | <u>0.49</u> [0.182–1.293] | <u>0.52*</u> [0.315–0.869] | <u>0.15</u> [0.022–1.080] |
| 6 to 10 years | <u>0.95</u> [0.356–2.542] | <u>0.08*</u> [0.012–0.598] | <u>0.41</u> [0.131–2.261] | <u>0.91</u> [0.602–1.375] | <u>0.90</u> [0.450–1.814] | <u>1.05</u> [0.746–1.488] | <u>0.65</u> [0.271–1.570] |
| > 10 years | <u>0.78</u> [0.547–1.102] | <u>0.15***</u> [0.114–0.209] | <u>0.77*</u> [0.599–0.999] | <u>1.01</u> [0.916–1.113] | <u>0.74***</u> [0.624–0.866] | <u>0.96*</u> [0.889–1.038] | <u>0.61***</u> [0.502–0.734] |
| Europe – South | | | | | | | |
| < 5 years | <u>1.25</u> [0.521–3.020] | <u>0.48</u> [0.213–1.089] | <u>0.39</u> [0.125–1.207] | <u>0.47**</u> [0.271–0.807] | <u>0.55</u> [0.248–1.229] | <u>0.71</u> [0.479–1.040] | <u>0.61</u> [0.251–1.460] |
| 6 to 10 years | <u>0.32</u> [0.080–1.292] | <u>0.43*</u> [0.213–0.865] | <u>0.42</u> [0.176–1.019] | <u>0.55**</u> [0.368–0.822] | <u>1.29</u> [0.0.627–0.738] | <u>0.99</u> [0.762–1.278] | <u>0.89</u> [0.514–1.528] |
| > 10 years | <u>0.57***</u> [0.444–0.723] | <u>0.38***</u> [0.345–0.414] | <u>0.63***</u> [0.528–0.741] | <u>0.76***</u> [0.718–0.805] | <u>0.68***</u> [0.627–0.738] | <u>0.86***</u> [0.824–0.895] | <u>0.61***</u> [0.555–0.669] |
| Europe – West | | | | | | | |
| < 5 years | <u>0.53</u> [0.075–3.773] | <u>0.26</u> [0.357–1.843] | – | <u>0.32*</u> [0.119–0.852] | – | <u>0.38*</u> [0.171–0.852] | <u>0.50</u> [0.125–2.017] |
| 6 to 10 years | <u>0.47</u> [0.067– 3.371] | <u>0.51</u> [0.164–1.614] | – | <u>0.18**</u> [0.057–0.547] | <u>0.38</u> [0.095–1.527] | <u>0.84</u> [0.533–1.325] | <u>1.35</u> [0.670–2.713] |
| > 10 years | <u>0.83</u> [0.629–1.103] | <u>0.50***</u> [0.450–0.560] | <u>0.76*</u> [0.617–0.938] | <u>0.66***</u> [0.608–0.711] | <u>0.72***</u> [0.649–0.796] | <u>0.84***</u> [0.799–0.888] | <u>0.70***</u> [0.626–0.780] |
| Europe – East | | | | | | | |
| < 5 years | <u>0.23*</u> [0.057–0.901] | <u>0.15**</u> [0.049–0.474] | <u>0.11**</u> [0.027–0.427] | <u>0.39***</u> [0.257–0.595] | <u>0.31**</u> [0.140–0.698] | <u>0.68**</u> [0.514–0.900] | <u>0.57</u> [0.294–1.092] |
| 6 to 10 years | <u>1.23</u> [0.658–2.292] | <u>0.28**</u> [0.126–0.630] | – | <u>0.51***</u> [0.352–0.731] | <u>0.81</u> [0.492–1.322] | <u>1.08</u> [0.875–1.339] | <u>1.07</u> [0.689–1.666] |
| > 10 years | <u>0.49**</u> [0.327–0.732] | <u>0.46***</u> [0.400–0.535] | <u>0.42***</u> [0.312–0.577] | <u>0.65***</u> [0.704–0.795] | <u>0.78***</u> [0.691–0.891] | <u>0.95</u> [0.891–1.012] | <u>0.81**</u> [0.710–0.929] |
| Europe – North | | | | | | | |
| < 5 years | <u>0.56</u> [0.140– 2.250] | <u>0.10*</u> [0.015–0.732] | <u>0.49</u> [0.159–1.530] | <u>0.28**</u> [0.131–0.579] | <u>0.23*</u> [0.058–0.931] | <u>0.61*</u> [0.394–0.933] | <u>0.56</u> [0.231–1.338] |
| 6 to 10 years | <u>0.86</u> [0.214–3.438] | <u>0.69</u> [0.283–1.677] | <u>1.08</u> [0.448–2.600] | <u>0.54</u> [0.289–1.007] | <u>0.79</u> [0.327–1.893] | <u>0.85</u> [0.562–1.291] | <u>0.44</u> [0.140–1.356] |
| > 10 years | <u>0.85</u> [0.688–1.058] | <u>0.75***</u> [0.693–0.809] | <u>0.86*</u> [0.738–0.998] | <u>0.75***</u> [0.704–0.795] | <u>0.77***</u> [0.709–0.839] | <u>0.88***</u> [0.842–0.916] | <u>0.78***</u> [0.716–0.852] |
| Africa (sub-Sahara) | | | | | | | |
| < 5 years | <u>0.66</u> [0.246–1.754] | <u>0.09*</u> [0.013–0.639] | <u>0.29*</u> [0.093–0.901] | <u>0.67</u> [0.433–1.049] | <u>0.44</u> [0.163–1.179] | <u>0.81</u> [0.554–1.196] | <u>0.40</u> [0.129–1.241] |
| 6 to 10 years | <u>0.55</u> [0.137–2.193] | <u>0.35</u> [0.113–1.114] | <u>0.61</u> [0.229–1.633] | <u>1.40</u> [0.969–2.031] | <u>1.01</u> [0.478–2.146] | <u>1.04</u> [0.705–1.524] | <u>0.65</u> [0.243–1.718] |
| > 10 years | <u>1.12</u> [0.722–1.746] | <u>0.28***</u> [0.189–0.414] | <u>0.85</u> [0.588–1.240] | <u>0.96</u> [0.822–1.131] | <u>0.80</u> [0.613–1.033] | <u>0.94</u> [0.832–1.069] | <u>1.01</u> [0.794–1.275] |
| Arabic | | | | | | | |
| < 5 years | <u>0.50</u> [0.226–1.127] | <u>0.24***</u> [0.105–0.530] | <u>0.28**</u> [0.127–0.635] | <u>0.66**</u> [0.492–0.888] | <u>0.68</u> [0.414–1.118] | <u>0.74*</u> [0.581–0.954] | <u>1.41</u> [0.973–2.034] |
| 6 to 10 years | <u>0.61</u> [0.274–1.370] | <u>0.42**</u> [0.225–0.790] | <u>0.46*</u> [0.228–0.916] | <u>1.07</u> [0.838–1.368] | <u>0.92</u> [0.587–1.428] | <u>1.08</u> [0.875–1.331] | <u>1.52*</u> [1.071–2.154] |

(continued on next page)

Table A1 (continued)

| | Epilepsy | COPD | Asthma | Diabetes | Heart Failure | Hypertension | Angina |
|-----------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| > 10 years | <u>0.75</u> [0.500-1.121] | <u>0.36***</u> [0.280-0.467] | <u>0.58**</u> [0.412-0.819] | <u>0.74***</u> [0.647-0.846] | <u>0.74**</u> [0.606-0.899] | <u>0.83***</u> [0.754-0.919] | <u>0.93</u> [0.774-1.113] |
| Asia – West | | | | | | | |
| < 5 years | <u>0.25</u> [0.036-1.752] | <u>0.12*</u> [0.017-0.0865] | <u>0.27</u> [0.067-1.067] | <u>0.45*</u> [0.239-0.833] | <u>0.41</u> [0.130-1.274] | <u>0.80</u> [0.515-1.232] | <u>1.52</u> [0.784-2.952] |
| 6 to 10 years | <u>0.81</u> [0.202-3.224] | <u>0.63</u> [0.236-1.681] | <u>0.67</u> [0.215-2.093] | <u>0.98</u> [0.589-1.647] | <u>0.93</u> [0.385-2.252] | <u>1.54*</u> [1.064-2.231] | <u>1.45</u> [0.687-3.041] |
| > 10 years | <u>0.27</u> [0.038-1.921] | <u>0.23**</u> [0.087-0.622] | <u>0.63</u> [0.235-1.677] | <u>0.70</u> [0.458-1.066] | <u>0.49</u> [0.233-1.034] | <u>0.86</u> [0.629-1.163] | <u>0.47</u> [0.213-1.058] |
| Asia- East | | | | | | | |
| < 5 years | <u>0.05***</u> [0.012-0.197] | <u>0.20***</u> [0.126-0.307] | <u>0.15***</u> [0.087-0.265] | <u>0.29***</u> [0.227-0.359] | <u>0.28***</u> [0.191-0.414] | <u>0.38***</u> [0.315-0.448] | <u>0.30***</u> [0.195-0.450] |
| 6 to 10 years | <u>0.13***</u> [0.053-0.311] | <u>0.15***</u> [0.093-0.230] | <u>0.25***</u> [0.158-0.391] | <u>0.47***</u> [0.400-0.562] | <u>0.38***</u> [0.277-0.511] | <u>0.52***</u> [0.457-0.601] | <u>0.36***</u> [0.261-0.508] |
| > 10 years | <u>0.25***</u> [0.180-0.348] | <u>0.15***</u> [0.121-0.175] | <u>0.27***</u> [0.215-0.338] | <u>0.52***</u> [0.480-0.556] | <u>0.33***</u> [0.292-0.383] | <u>0.57***</u> [0.540-0.604] | <u>0.32***</u> [0.273-0.365] |
| Asia – South | | | | | | | |
| < 5 years | <u>0.43**</u> [0.247-0.760] | <u>0.12***</u> [0.065-0.215] | <u>0.35***</u> [0.226-0.542] | <u>0.60**</u> [0.496-0.714] | <u>0.59***</u> [0.440-0.793] | <u>0.66***</u> [0.568-0.766] | <u>1.02</u> [0.795-1.308] |
| 6 to 10 years | <u>0.55*</u> [0.314-0.958] | <u>0.22***</u> [0.138-0.339] | <u>0.63*</u> [0.434-0.904] | <u>1.08</u> [0.939-1.251] | <u>0.97</u> [0.767-1.226] | <u>1.09</u> [0.69-1.233] | <u>1.24</u> [0.992-1.555] |
| > 10 years | <u>0.64**</u> [0.459-0.894] | <u>0.26***</u> [0.214-0.326] | <u>0.72**</u> [0.576-0.899] | <u>1.14**</u> [1.050-1.231] | <u>0.93</u> [0.820-1.055] | <u>1.05</u> [0.988-1.123] | <u>1.31***</u> [1.168-1.463] |
| Oceanic | | | | | | | |
| < 5 years | – | – | <u>0.53</u> [0.075-3.794] | <u>0.83</u> [0.340-2.002] | <u>0.50</u> [0.071-3.575] | <u>0.96</u> [0.451-2.049] | <u>0.56</u> [0.792-3.995] |
| 6 to 10 years | – | <u>0.82</u> [0.202-3.309] | <u>1.40</u> [0.349-5.655] | <u>1.14</u> [0.509-2.539] | <u>2.13</u> [0.784-5.764] | <u>1.29</u> [0.658-2.531] | <u>1.14</u> [0.279-4.627] |
| > 10 years | <u>0.66</u> [0.273-1.580] | <u>0.49**</u> [0.326-0.746] | <u>0.68</u> [0.364-1.260] | <u>0.99</u> [0.797-1.237] | <u>1.07</u> [0.784-1.471] | <u>0.75**</u> [0.617-0.909] | <u>1.08</u> [0.790-1.487] |
| Other origin | | | | | | | |
| < 5 years | <u>0.83</u> [0.930-2.648] | <u>1.57</u> [0.930-2.648] | <u>1.35</u> [0.700-2.590] | <u>0.71</u> [0.444-1.126] | <u>0.82</u> [0.391-1.714] | <u>0.87</u> [0.613-1.249] | <u>0.55</u> [0.231-1.330] |
| 6 to 10 years | – | <u>1.42</u> [0.675-2.965] | <u>1.16</u> [0.484-2.792] | <u>0.73</u> [0.401-1.310] | <u>1.50</u> [0.716-3.144] | <u>1.10</u> [0.729-1.659] | <u>0.77</u> [0.291-2.047] |
| > 10 years | <u>0.76</u> [0.511-1.145] | <u>0.85*</u> [0.722-0.995] | <u>1.01</u> [0.789-1.293] | <u>0.81***</u> [0.719-0.907] | <u>0.86</u> [0.727-1.022] | <u>0.86**</u> [0.793-0.943] | <u>0.69***</u> [0.571-0.836] |
| Imm does not speak En/Fr | <u>0.68</u> [0.447-1.037] | <u>0.73***</u> [0.609-0.867] | <u>1.33*</u> [1.050-1.693] | <u>0.87**</u> [0.802-0.950] | <u>0.82**</u> [0.724-0.934] | <u>0.80***</u> [0.751-0.859] | <u>0.70***</u> [0.598-0.815] |
| Age | <u>1.11***</u> [1.092-1.122] | <u>1.39***</u> [1.366-1.422] | <u>1.05***</u> [1.037-1.058] | <u>1.16***</u> [1.152-1.166] | <u>1.24***</u> [1.219-1.260] | <u>1.32***</u> [1.309-1.330] | <u>1.43***</u> [1.403-1.451] |
| Age squared | <u>1.00***</u> [0.999-0.999] | <u>1.00***</u> [0.998-0.998] | <u>1.00***</u> [0.999-0.999] | <u>1.00***</u> [0.999-0.999] | <u>1.00***</u> [0.999-0.999] | <u>1.00***</u> [0.998-0.998] | <u>1.00***</u> [0.997-0.998] |
| Male | <u>1.36***</u> [1.271-1.458] | <u>1.47***</u> [1.429-1.522] | <u>0.47***</u> [0.441-0.493] | <u>1.20***</u> [1.175-1.228] | <u>1.78***</u> [1.719-1.838] | <u>1.38***</u> [1.357-1.405] | <u>2.24***</u> [2.163-2.326] |
| Education: no degree | Reference | Reference | Reference | Reference | Reference | Reference | Reference |
| High school | <u>0.65***</u> [0.599-0.708] | <u>0.69***</u> [0.668-0.720] | <u>0.73***</u> [0.682-0.782] | <u>0.70***</u> [0.685-0.723] | <u>0.74***</u> [0.710-0.770] | <u>0.80***</u> [0.785-0.820] | <u>0.80***</u> [0.770-0.841] |
| Some college/ university | <u>0.65***</u> [0.588-0.713] | <u>0.62***</u> [0.590-0.646] | <u>0.82***</u> [0.758-0.881] | <u>0.69***</u> [0.668-0.711] | <u>0.69***</u> [0.654-0.720] | <u>0.79***</u> [0.771-0.890] | <u>0.78***</u> [0.747-0.824] |
| University degree | <u>0.48***</u> [0.425-0.537] | <u>0.33***</u> [0.309-0.352] | <u>0.68***</u> [0.628-0.741] | <u>0.52***</u> [0.498-0.537] | <u>0.52***</u> [0.491-0.553] | <u>0.64***</u> [0.622-0.658] | <u>0.61***</u> [0.574-0.645] |
| Income quintile 1 | Reference | Reference | Reference | Reference | Reference | Reference | Reference |
| Income quintile 2 | <u>0.89*</u> [0.817-0.972] | <u>1.06*</u> [1.012-1.110] | <u>0.98</u> [0.910-1.052] | <u>0.91***</u> [0.884-0.942] | <u>1.00</u> [0.950-1.052] | <u>0.96*</u> [0.941-0.994] | <u>1.10**</u> [1.038-1.162] |
| Income quintile 3 | <u>0.52***</u> [0.474-0.579] | <u>0.71***</u> [0.679-0.750] | <u>0.81***</u> [0.749-0.875] | <u>0.70***</u> [0.679-0.726] | <u>0.69***</u> [0.653-0.728] | <u>0.82***</u> [0.800-0.846] | <u>0.92**</u> [0.872-0.980] |
| Income quintile 4 | <u>0.37***</u> [0.327-0.411] | <u>0.50***</u> [0.471-0.527] | <u>0.66***</u> [0.604-0.717] | <u>0.59***</u> [0.574-0.617] | <u>0.56***</u> [0.524-0.590] | <u>0.74***</u> [0.723-0.767] | <u>0.87***</u> [0.815-0.918] |

(continued on next page)

Table A1 (continued)

| | Epilepsy | COPD | Asthma | Diabetes | Heart Failure | Hypertension | Angina |
|-----------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Income quintile 5 | 0.27*** [0.240-0.313] | 0.34*** [0.315-0.362] | 0.67*** [0.611-0.737] | 0.47*** [0.447-0.485] | 0.39*** [0.361-0.414] | 0.67*** [0.651-0.693] | 0.74*** [0.690-0.784] |
| rurality | 1.02 [0.944-1.098] | 1.00 [0.964-1.032] | 1.01 [0.954-1.073] | 1.35*** [1.316-1.381] | 1.08*** [1.039-1.119] | 1.17*** [1.145-1.190] | 1.25*** [1.204-1.299] |
| Married | 0.60*** [0.558-0.645] | 0.58*** [0.567-0.603] | 0.80*** [0.753-0.841] | 0.78 [0.766-0.801] | 0.73*** [0.704-0.752] | 0.88*** [0.867-0.989] | 1.01 [0.977-1.052] |
| C-statistic | 0.7041 | 0.8894 | 0.6732 | 0.7843 | 0.8680 | 0.8249 | 0.8369 |
| Pseudo R ² | 0.0367 | 0.1927 | 0.0265 | 0.0971 | 0.1608 | 0.1443 | 0.1255 |

Significant at ***p < 0.001. **p < 0.01. *p < 0.05.

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