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Immigration and Depression in Canada: Is there really a Healthy Immigrant Effect? What is the Pattern of Depression by Time since Immigration?

Diaz, Ruth

UNIVERSITY OF CALGARY

Immigration and Depression in Canada: Is there really a Healthy Immigrant Effect? What is the

Pattern of Depression by Time since Immigration?

by

Ruth Leonora Diaz

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Abstract

Objective: This study aimed to contribute to the understanding on inequalities in mental health in Canada by exploring whether or not immigrants have lower prevalence of past-year major depressive episode (MDE) than non-immigrants (i.e., the healthy immigrant effect HIE).

Methods: Data were from ten cross-sectional Canadian population health surveys. Survey-specific log odd ratios were calculated, and then pooled using random effects meta-analytic techniques.

Results: Evidence of the HIE on MDE was found; however, the HIE disappears with age. The pattern of the HIE by age was observed overall, and when the analysis was conducted by sex, country of birth, and time since immigration. Elder immigrants seem to be at similar or higher risk of MDE than elder Canadian-born.

Conclusion: More research is needed to replicate this findings, and to understand why elder immigrants may be at higher risk of MDE than elder non-immigrants.

Preface

Chapter three of this thesis includes the following manuscript which will be submitted to the Social Psychiatry and Psychiatric Epidemiology Journal. The first author was responsible for the development of the research idea, research questions, data analysis, interpretation of the results, and preparation of the manuscript. The supervisor (Dr. Scott Patten), and the committee members (Dr. Andrew Bulloch, Dr. Bejoy Thomas, and Dr. Tolulope Sajobi) provided support and guidance in the process. Jeanne Williams and Dina Lavorato provided guidance on data management and data analysis. All authors critically revised the manuscript prior to submission.

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To Merardo, Andrés, Kevin, and Denver with all my love

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List of Symbols, Abbreviations and Nomenclature

Symbol	Definition
CCHS	Canadian Community Health Survey
CES-D	Center for Epidemiological Studies Scale-Depression
CIDI	Composite Diagnostic Interview
CIDI-SFMD	Composite Diagnostic Interview Short Form Major Depression
DALY	Disability adjusted life years
DSM	Diagnostic and Statistical Manual of Mental Disorders
EMM	Effect measurement modification
GBD	Global Burden of Disease
GDS	Geriatric Depression Scale
HDI	Human Development Index
HIE	Healthy immigrant effect
ICD-10	10th revision of the International Classification of Diseases and Related Health Problems
LFS	Labour Force Survey
MDE	Major depressive episode
NPHS	National Population Health Survey
WHO	World Health Organization
WMH-CIDI	World Mental Health Composite Diagnostic interview
YLD	Years lived with disabilities

Chapter One: Introduction

1.1 Overview of Research Problem

Canada ranks second in the world, after Australia, as having the largest percentage of its total population consisting of immigrants (Statistics Canada, 2013b). In 2011, 20.6% of the Canadian population were foreign-born (Statistics Canada, 2013b). Immigration plays an important role in Canada's socio-economic wellbeing. Net migration accounted for two third of the actual population growth between 2011 and 2016 (Statistics Canada, 2017). New immigrants are projected to account for over 80% of Canadian population growth by 2031 (Statistics Canada, 2011b). Immigration also contributes to Canadian labour growth, and helps to cover specific labour needs (Statistics Canada, 2011a). In 2006, immigrants represented 21.6% of the Canadian labour force. This percentage is expected to increase to 33% in 2031 (Statistics Canada, 2011a).

Given the number of immigrants, and the importance of immigration to Canada's growth and economic prosperity, it is crucial to understand factors related to immigrants' mental health (Canadian Task Force on Mental Health Issues Affecting & Refugees, 1998; Mental Health Commission of Canada, 2009). Of particular interest is major depression, since there is evidence that the stressors associated with immigration increase the risk of developing depression (Beiser, 1999; Bhugra, 2004; Hansson et al., 2012). In 2015, depressive disorders, including major depression, were considered the third leading cause of years lived with disabilities (YLDs) worldwide, after lower back and neck pain; and sense organ diseases (Global Burden of Diease Disease Injury Incidence Prevalence Collaborators, 2016); and the 15th cause of disability-adjusted life years (DALYs) worldwide (Global Burden of Disease DALYs HALE Collaborators, 2016). The YLDs and the DALYs are measurements of disease burden in the

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population (World Health Organization, 2017). The YLDs are calculated as the product of the number of incidence cases, the disability weight, and the average duration of the case in years (World Health Organization, 2017). The DALYs are calculated as the YLDs plus the years of life lost due to premature death (YLL) (World Health Organization, 2017). In addition to being a social burden, depression also constitute an economic burden. It is estimated that in 2006 mental illness, including depression, cost the Canadian economy $51.6 billion dollars in disability claims, loss of productivity, and health care costs (Lim et al., 2008).

One of the main mandates of the Mental Health Strategy for Canada is to reduce inequalities in health service provided; and to provide adequate mental health services and support to immigrants and ethno-cultural groups (Mental Health Commission of Canada, 2012). There is evidence in Canada that immigrants have lower prevalence of depression than Canadian-born (i.e., healthy immigrant effect; see literature review section). However, the results are inconsistent, and based on outdated data. The international literature is equally inconclusive. To fulfill the goals of reducing inequalities in mental health, more research is needed to better understand the epidemiology of mental health among immigrants and native-born.

1.2 Literature Review

1.2.1 Overview of Immigration in Canada

Canada is a multicultural country and home to approximately 6.8 million immigrants from around the world (Statistics Canada, 2013b). Prior to the 1970s, approximately 80% of immigrants came from Europe (Statistics Canada, 2013b). However, changes in the immigration

policies which allow for more inclusive, multicultural practices produced a shift in the countries of origin of Canadian immigrants (Boyd & Vickers, 2000). Between 2006 and 2011, only 13.7% of immigrants came from Europe, while 56.9% came from Asia. An increased on immigration from Caribbean, Central and South America (from 5.4% to 12.3%); and Africa (from 1.9% to 12.5%) was also observed (Statistics Canada, 2013b).

Besides the ethno-cultural diversity, Canadian immigrants also differ in their motives for immigration (Boyd & Vickers, 2000). Immigrants come to Canada under three categories of immigration a) economic immigrants, b) family class, and c) refugees (Government of Canada, 2002). Economic immigrants are allowed to immigrate based on their potential to contribute to the Canadian economy. They are granted immigration status based on a points system that was introduced in 1967 (Boyd & Vickers, 2000), formalized in the Immigration Act of 1976 (Boyd & Vickers, 2000), and further revised in 2012 with an amendment to the Immigration and Refugee Protection Act of 2002 (Citizenship and Immigration Canada, 2012). The amended points system gives priority to younger age, language proficiency, and eased Canadian recognition of education credentials and work experience. Family class includes spouses, dependent children, parents and grandparents sponsored by permanent residents or by Canadian citizens (Government of Canada, 2002). Refugees are granted immigration status for humanitarian reasons, or based on the definition of refugees provided by the 1951 United Nations (UN) convention (Boyd & Vickers, 2000). Between 1990 and 2014, on average, 55.3% of new immigrants were economic immigrants, 29.8% were family class, and 12.4 % were refugees (Citizenship and Immigration Canada, 2015).

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Compared to Canadian-born, immigrants have higher levels of education (Xu & Xu, 2010). Even though immigrants are highly qualified, they have lower levels of income, and higher levels of unemployment than Canadian-born (Desjardins & Cornelson, 2011). Poor language skills, discrimination, and the lack recognition of their foreign credentials are possible explanations for these gaps (Desjardins & Cornelson, 2011).

Regulations related to physical and mental health pre-immigration screening processes were created in 1869 (Chadha, 2008; Gushulak, 2010). Specific policy changes have been incorporated over the years, primarily in the Immigration Act of 1976 and further in the Immigration and Refugee Protection Act of 2002, to guarantee that those with physical and mental illness are not granted immigration status (Gushulak, 2010). Grounds for inadmissibility include threat to public health or public safety, or possibility of excessive burden to the health care or social system (Government of Canada, 2015). The excessive burden policy only applies to the economic immigrant category.

In conclusion, Canadian immigrants are very diverse in socio-demographic factors that are important determinants of mental health. Also, they seem to be exposed to environmental factors post-immigration that could jeopardize their mental health.

1.2.2 Immigration and Depression in Canada

1.2.2.1 Definition of major depressive episode

According to the Diagnostic and Statistical Manual, 5th edition (DSM-5; American Psychiatric Association, 2013), a Major Depressive Episode (MDE) is characterized by at least five of nine depressive symptoms present most of the time, nearly every day, lasting at least two weeks and having an effect on functioning. At least one of the symptoms must be either a depressed mood state, or a loss of interest or pleasure in almost all activities. Other symptoms include fatigue, changes in sleep patterns, feelings of worthlessness or guilt, psychomotor agitation or retardation, changes in appetite or in weight (significant weight loss or gain without dieting), reduced ability to think, concentrate or make decisions, recurrent thoughts of death or suicidal ideation. The symptoms must persist for at least two weeks and cause clinical significant impairment in social, occupational, educational or other functioning. The symptoms must not be due to direct effects of another medical condition or a substance (American Psychiatric Association, 2013). The description of MDE provided by the DSM-5 is similar to the description provided in previous Diagnostic and Statistical Manuals (i.e., DSM-III-R; and DSM-IV); however, the DSM-5 does not include a requirement (included in prior editions of DSM) that the symptoms cannot be better accounted for by bereavement (American Psychiatric Association, 2013).

1.2.2.2 Conceptual framework

Several conceptual frameworks have been used to study immigrants' physical and mental health. This study will use as conceptual frameworks the Healthy Immigrant Effect paradigm (Beiser,

2005; Hyman, 2007; Islam, 2013), and the theoretical model adapted by Beiser (1999) from the stress process model.

The Healthy Immigrant Effect is one of the most widely used paradigms to study immigrants' health. The paradigm postulates that immigrants have better health than non-immigrants. The host country's immigration process (i.e., immigration rules and pre-immigration medical examination), and immigrants' self-selection (Beiser, 2005; Hyman, 2007; Jasso et al., 2004; Kennedy et al., 2015; Ng et al., 2005) explain this paradigm. However, some immigrants do not retain their health advantage over time, but converge to, or get worse than, the levels of non-immigrant's physical or mental illness over time (Beiser, 2005; Hyman, 2007; Islam, 2013). Factors related to pre- and post-immigration can put immigrants at risk of developing physical and mental illness (Beiser, 1999, 2005; Bhugra, 2004; Canadian Task Force on Mental Health Issues Affecting & Refugees, 1998). This paradigm however, does not help to explain other aspects that could influence immigrants' mental health (Beiser, 2005).

Beiser (1999)'s theoretical model explains how the immigration process affects immigrants' mental health. The model proposes that pre-immigration stressors like trauma exposure at a refugee camp, experience of war or political instability, and post-migration stressors such as lack of employment, lack of recognition of credentials, and discrimination could lead to the development of mental illnesses (Beiser, 1999). Socio-demographic factors such as age, gender, education, and work experience can influence post-migration outcomes, and the availability social and personal factors (Beiser, 1999). Social factors such as family, and support from people

from the same ethnicity; and personal factors such as language proficiency may be protective

factors against the effect of stress on mental health (Beiser, 1999).

1.2.2.3 The healthy immigrant effect on depression in Canada

There is evidence in the literature that the healthy immigrant effect found (HIE) in physical

health (Hyman, 2004; Ng et al., 2005; Vang et al., 2015) is also found in mental health (Aglipay

et al., 2013; Islam, 2013; Lou & Beaujot, 2005; Vang et al., 2015), including depression. Ali

(2002) found support for the HIE on depression using the Canadian Community Health Survey

(CCHS) 2000-2001. Immigrants (i.e. born outside of Canada and not Canadian by birth) have

lower prevalence of past-year major depressive episode (MDE) than Canadian-born (6.2% vs.

8.3%). This effect was independent of age, marital status, education, and income. Wu and

Schimmele (2005) used data from the National Population Health Survey (NPHS) 1996-1997.

The results indicated that immigrants (i.e. born outside of Canada and not Canadian by birth)

have a lower prevalence of past year MDE (crude annual prevalence ratio (PR) 0.75), and

presented fewer symptoms of depression than Canadian-born. Akhtar-Danesh and Landeen

(2007) used the CCHS-Mental Health 2002 (cycle 1.2) and found that among residents in

Ontario, immigrants (i.e., born outside of Canada and not Canadian by birth) have lower

prevalence of past year MDE than Canadian-born (4.0% vs. 5.4%). Similarly, Patten et al. (2015)

using the CCHS-Mental Health 2012 found that immigrants have a lower past year prevalence of

MDE than Canadian-born (PR 0.7).

There is evidence that the HIE on depression is not universal, but may depend on country of origin and class of immigrant. Ali (2002) study found that immigrants from Asia; Africa; South and Central America and the Caribbean have lower prevalence of past year MDE than Canadian-born. Immigrants from Europe and North America have similar past year prevalence of MDE than Canadian-born. The author suggested that time since immigration might play a role in the discrepancy in the HIE found. Since immigrants from Europe and North America have higher length of residence in Canada, and their prevalence of MDE might have converged to levels similar to those of Canadian-born (Ali, 2002).

Beiser (1999) used data from the Refugee Resettlement Project, a ten-year longitudinal study of the resettlement process of Southeast Asian refugees (i.e., from Vietnam, and Laos) in Vancouver. The study was based on a random sample of 1,348 adult refugees. Depression was measured as the presence of depressive symptoms in the past week using a symptoms-based instrument designed by the authors. The instrument included culturally specific idioms of distress, and was derived from a factor analysis of items taken from other well-known instruments used to measure depression. At the time of the first interview, in 1981, the study found that, compared to an age- and gender-matched sample of Vancouver residents, refugees had a higher prevalence of depression (5.2% vs. 6.4 %, respectively). It is not clear whether or not the sample of Vancouver residents contained Canadian-born only, or a mix of Canadian-born and immigrants. However, these results could be a reflection of the effects of pre-migration stressors that put refugees at higher risk of mental illness (Canadian Task Force on Mental Health Issues Affecting & Refugees, 1998). This study was conducted over three decades ago

using data from a specific group of refugees, and on a specific Canadian city. Generalizing the results from this study to other immigrants or refugees is not possible.

Fenta et al. (2004) used a sample of 342 Ethiopian immigrants and refugees in Toronto 1999-2000. MDE was assessed using the World Health Organization Composite Diagnostic Interview (WHO-CIDI). The study indicated that compared to estimates reported in the Ontario population, Ethiopian immigrants and refugees have higher lifetime prevalence of depression (7.3% vs. 9.8% respectively). This study did not include a Canadian-born comparison group, which makes it impossible to make judgement of the HIE on depression.

In conclusion, the evidence of the existence of the HIE on depression in Canada is both scarce and inconclusive. Only two studies (Ali, 2002; Wu & Schimmele, 2005) have been conducted at the population level with the objective of confirming that the HIE applies to MDE. Moreover, with the exception of Patten et al. (2015), the evidence is based on data from over a decade ago, and approximately 226,000 immigrants a year have come to Canada in the past 18 years (Citizenship and Immigration Canada, 2015). More research is needed to confirm the existence of the HIE on depression in Canada.

The HIE paradigm postulates that immigrants do not retain their health advantage but rather converge with native-born with increasing time since immigration (Beiser, 2005; Hyman, 2007; Islam, 2013). The next section summarizes the literature of the effect of time since immigration on depression among immigrants in Canada.

1.2.2.4 Effect of time since immigration on depression: Is there an effect? What is the pattern of depression by time since immigration?

Some studies have explored the effect of time of immigration on depression in Canada. Also, there have been attempts to determine the pattern of MDE by time since immigration. Ali (2002) found that compared to Canadian-born, immigrants who have been in Canada 0-4 years, 5-9 years, and 15-19 years since immigration are less likely to have MDE (OR: 0.33, 0.45, and 0.55 respectively). The levels of MDE for immigrants who have been in Canada for 10-14 years, 20-29 years, and over 30 years since immigration are similar to those of Canadian-born (OR: 0.90, 0.90, and 1.15 respectively). These results were adjusted by demographic variables, and the effect of language barriers, employment status, and sense of belonging. Wu and Schimmele (2005) also found an effect of time since immigration. The pattern found was similar to that of Ali (2002) in the sense that immigrants in Canada less than ten years since immigration, and those 15-19 years since immigration were less likely to have MDE. However, in distinction to Ali (2002), the authors found that those who have been in Canada for 30-34 years were also less likely to have MDE. Immigrants in the other categories of time since immigration have similar levels of MDE as Canadian-born. The results presented were adjusted by demographic variables, chronic conditions, self-rated health, race/ethnicity, the presence of children under six years of age, and rural residence. The results from these two studies suggest that immigrants' prevalence of MDE converge to Canadian-born levels of MDE with time since immigration after 35 years in the country. However, the pattern of the HIE by time since immigration is not consistent over time.

Wu and Schimmele (2005) conducted the analysis restricting the sample to immigrants only, and including a quadratic term for time since immigration in their modelling. The unadjusted model indicated that the expected probability of MDE by years since immigration followed an inverted U shape. Recent immigrants (i.e., less than ten years in Canada) and very long-term immigrants (over 43 years in Canada) were less likely to have MDE. The probability of MDE increased sharply after immigration. However, the adjusted results showed a different pattern. The probability of MDE by time since immigration increased sharply until around 35 years since immigration and then plateaus. Since this analysis did not include a non-immigrant comparison group, the inverted U shape found only quantifies the frequency of depression in relation to time since immigration, and it cannot explain anything about the pattern of the HIE on depression with time since immigration.

Fenta et al. (2004) determined the incidence of depression post-migration in 325 immigrants having no history of depression before immigrating to Canada, according to the WHO-CIDI. The results suggested that the risk of developing depression was low in the first years of immigration (up to five years), and gradually increased reaching the maximum at 15 years since immigration, then decreased and remained low. The pattern found here sounds similar to the one reported by Wu and Schimmele (2005). However, in the absence of a Canadian-born referent group, it is impossible to determine the pattern of the HIE on MDE with time since immigration. Beiser (1999) reported that the level of depression for most of the Southeast Asian refugees decreased with increasing time since immigration. This study was longitudinal, and almost half of the sample was lost due to attrition, potentially introducing bias. It could be that those who

were depressed more often moved and were therefore lost to attrition. The resulting bias could produce a false impression of declining prevalence of depression over time. In addition, the study only followed the refugees over time. The lack of comparison to a non-immigrant group makes it difficult to determine any variation of the HIE with time since immigration.

A lack of association between time since immigration and depression has been reported in Iranian immigrants and refugees (Sedighdeilami, 2002), in Korean Immigrants in Toronto (Kim & Chen, 2011; Noh et al., 1992) and in South Asian immigrants in Calgary (Lai & Surood, 2008). These studies however probably lack power to find an association since their sample size was relatively small.

In conclusion, the literature on the effect of time since immigration on depression in Canada is not consistent across studies. Most of the existing literature is based on outdated data; or on data collected form specific immigrant populations without a non-immigrant comparison group. Also, whether or not the pattern of the HIE on depression by time since immigration follows a linear or a non-linear trend cannot be established from the existing evidence. More research is needed to clarify this.

1.2.3 Immigration and Depression in Other Countries
This section presents an overview of the evidence on immigration and depression outside of Canada. The intention is to illustrate how the Canadian evidence on the HIE on depression

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compares to the international literature, and not to provide a detailed literature review on the topic outside Canada.

1.2.3.1 Evidence from Europe and Australia

Contrary to what has been reported in Canada, studies in Europe (Beutel et al., 2016; Levecque et al., 2007; Missinne & Bracke, 2012; Sieberer et al., 2012; Tinghög et al., 2007; Wittig et al., 2008) and in Australia (Straiton et al., 2014) found no support for the healthy immigrant effect. Overall, the evidence indicates that immigrants have higher levels of depressive symptomatology than non-immigrants (Beutel et al., 2016; Levecque et al., 2007; Missinne & Bracke, 2012; Sieberer et al., 2012; Straiton et al., 2014; Tinghög et al., 2007; Wittig et al., 2008). However, some studies also reported similar levels of depressive symptomatology in some subgroups of immigrants compared to non-immigrants (Beutel et al., 2016; Levecque et al., 2007; Missinne & Bracke, 2012; Straiton et al., 2014). Methodological differences between these studies and the ones in Canada that found evidence for the HIE may explain the discrepancy in the results. Specifically, design factors associated with: 1) the type of instrument used to measure depression; 2) the definition of immigrants; and 3) the inclusion criteria applied to immigrants.

First, different instruments were used to measure depression. In Europe and in Australia, most of the studies used symptom-based scales. For example, Missinne and Bracke (2012), Sieberer et al. (2012) and Straiton et al. (2014) used the Center for Epidemiological Studies Scale- Depression (CES-D; Radloff, 1977). This scale measures depressive symptoms in the past week. Levecque et al. (2007) used the Symptom Checklists 90-subscale (Derogatis, 1997). This scale also

measures severity of symptoms in the week prior to the interview. Beutel et al. (2016) used the Health Patient Questionnaire (HPQ)-8 items (Kroenke et al., 2009). This questionnaire measures how often an individual has been bothered by eight diagnostic criteria of major depression in the past two weeks. The HPQ-8 does not include questions about suicide (Kroenke et al., 2009). Tinghög et al. (2007) used the Major Depression Inventory Scale (MDI; Bech, 1997; Bech et al., 2015). This scale was created to provide either scores for depressive severity symptoms or diagnoses of depressive disorders based on the 10th revision of the International Classification of Diseases and Related Health Problems (ICD-10) or the DSM-IV (American Psychiatric Association, 2013). The authors in this study measured depression as the severity of depressive symptoms in the past two weeks. Wittig et al. (2008) used the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983). The scale measures non-physical symptoms of depression in the past week. In Canada, the studies used diagnostic instruments. Ali (2002), and Wu and Schimmele (2005) used the World Health Organization (WHO) Composite Diagnostic Interview Short Form Major Depression (CIDI-SFMD; Kessler et al., 1998), and Patten et al. (2015) and Akhtar-Danesh and Landeen (2007) used the Canadian adaptation of the World Mental Health Composite Diagnostic Interview (WMH-CIDI; Kessler & Ustun, 2004). In the Canadian studies, depression was measured as past-year major depressive episode. The variety of scales used by these studies limit the comparability of their findings.

Second, the definition of immigration varies in some studies. In the Canadian studies (Akhtar-Danesh & Landeen, 2007; Ali, 2002; Patten et al., 2015; Wu & Schimmele, 2005), immigrants are considered foreign-born who are not Canadian citizen are by birth (see chapter two for a

detail explanation on this). This definition corresponds to first-generation immigrants. The study

conducted in Australia (Straiton et al., 2014), and two European studies (Levecque et al., 2007;

Tinghög et al., 2007) defined immigrants as foreign-born which is similar to the definition in

Canadian studies. However, it is not clear if these studies also have the restriction of not being

citizens by birth. Wittig et al. (2008) used a slightly different definition. In this study, immigrants

were considered as foreign-born if they did not hold a German citizenship. This definition of

immigrants misclassifies foreign-born with a German citizenship as native-born. If these

immigrants were less likely to be depressed, this could contribute to a lower prevalence of

depression in non-immigrants compared to immigrants. Missinne and Bracke (2012); and Beutel

et al. (2016) classified immigrants as first-generation (i.e., foreign-born); and second-generation

(i.e., born in the host country but with at least one foreign-born parent). These studies present

results by first-, second-generation immigrants, and by native-born. The definition used by these

two studies differs significantly from the one used in the Canadian studies (Akhtar-Danesh &

Landeen, 2007; Ali, 2002; Patten et al., 2015; Wu & Schimmele, 2005). Based on the results

reported by Missinne and Bracke (2012), and Beutel et al. (2016), second generation immigrants

have similar or higher depressive symptomatology than non-immigrants. Since the category of

native-born in their studies did not include second-generation immigrants, the prevalence of

depression in native-born might be an underestimation of the real prevalence. In summary,

differences in the classification of exposure across studies makes it impossible to draw

conclusions on the association between immigration status and depression.

Third, the inclusion criteria applied to immigrants might be contributing to the higher prevalence of depression found in the Australian, and some European studies. For example, Straiton et al. (2014); Missinne and Bracke (2012); and Beutel et al. (2016) studies included only immigrants who were able to respond the questionnaire in the host's countries language. Tinghög et al. (2007) included only immigrants with Swedish citizenship. If the immigrants not included were those less likely to be depressed, this could lead to an overestimation of the prevalence of depression symptoms reported for immigrants in those studies.

In summary, the above mentioned factors do not allow comparability of the prevalence estimates between the studies in Canada, Europe and Australia, and make it impossible to draw a conclusion on the existence or not of the HIE on depression. In addition, factors associated to differences in immigration policies and health care services across countries may also help explain the discrepancy in findings across studies.

1.2.3.2 Evidence from the US

Similar to what have been suggested in Canada, studies in the US found support for the HIE on depression. Overall, immigrants have lower prevalence of depression than US-born (Alegria et al., 2008; Budhwani et al., 2015; Gonzalez et al., 2010; Grant et al., 2004; Lau et al., 2013; Szaflarski et al., 2016; Vega et al., 2004). The evidence also indicates a variation of the HIE with country of birth. Studies have found that the HIE is more pronounced in some immigrants than in others (Alegria et al., 2008; Budhwani et al., 2015; Gonzalez et al., 2010; Szaflarski et al., 2016). However, immigrants from Puerto Rico (Alegria et al., 2008; Gonzalez et al., 2010; Szaflarski et

al., 2016) and from Cuba (Alegria et al., 2008; Gonzalez et al., 2010) seem to be at higher risk of depression than US-born. In addition, some studies indicate that the HIE depends on time since immigration (Cook et al., 2009; Szaflarski et al., 2016; Vega et al., 2004). Immigrants' levels of depression converge to those of US-born with increased time since immigration (Cook et al., 2009; Szaflarski et al., 2016; Vega et al., 2004).

In the US, and additional effect, that merits special attention, has been reported. Gonzalez et al. (2010) indicated that the association between immigration status and major depression is age dependent. Next section provides a more detailed explanation of the findings and the implications for research and policy.

1.2.4 Variation of the HIE on Depression with Age

Gonzalez et al. (2010) used data from the US National Institute of Mental Health's Collaborative Psychiatric Epidemiology Survey (CPES) collected between February 2001 and November 2003. The CPES is a combination of three different surveys. 1) The National Survey of American Life (NSAL); 2) the National Comorbidity Survey Replication (NCS-R); and 3) the National Latino and Asian American Study (NLAAS) (Pennell et al., 2004). A total of 14,710 US residents 18 years of age and older participated in the CPES. Depression was measured using the World Mental Health Composite International Diagnostic Interview (WMH-CIDI; Kessler & Ustun, 2004). The study presented the prevalence of past-year and of lifetime major depression stratified by ethnicity, immigration status (i.e. foreign-born; US-born), and by age (18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75+). The results indicated that overall, immigrants have lower

prevalence of past-year major depression than US-born (6.3 vs. 10.2 respectively; i.e., The HIE).

However, immigrant's mental health advantage was evident only among those between 18 and

64 years of age. At a more advanced age, immigrants had higher prevalence of past-year major

depression than non-immigrants (5.1 vs. 4.3 for 65-74 years of age; and 3.7 vs. 2.8 for 75+

respectively). A similar pattern was reported for lifetime prevalence.

1.2.4.1 No support for the HIE on depression at older age.

Similar to what it is suggested by Gonzalez et al. (2010), studies on immigration and depression

indicate that older immigrants are at higher risk of depression than non-immigrants of similar

age. For example, in Australia, (Stanaway et al., 2010), using data from the Concord Health and

Ageing in Men Project (CHAMP) collected between 2005 and 2007 (Cumming et al., 2009),

found that the prevalence of depressive symptoms of Italian-born men 70+ years old was almost

twice the one of Australian-born of the same age (18% vs. 10%). Depression was measured

using the 15-item Geriatric Depression Scale (GDS; Sheikh & Yesavage, 1986).

In Europe, Aichberger et al. (2010) used data from the first wave (2004) of the Survey of Health,

Aging and Retirement in Europe (SHARE; Börsch-Supan & Jürges, 2005). The survey is a cross-

national survey of men and women 50 years of age and over. It was conducted in 11 European

countries (Austria, Belgium, Denmark, France, Germany, Greece, Italy, The Netherlands, Spain,

and Switzerland) and Israel (Börsch-Supan & Jürges, 2005). Aichberger et al. (2010) limited

their analysis to the 11 European countries. Depression was measured using the EURO-D scale

(Prince et al., 1999). Higher prevalence of depression symptoms was found for immigrants

(30.6%) than non-immigrants (24.2%) (Crude OR: 1.38). The effect of immigration status was evident for countries in Western and Northern Europe, but not in Southern Europe. Overall, no effect of time since immigration was found. Ladin and Reinhold (2013), also used data from SHARE but restricted the sample to men in the 11 European countries who arrived in the host-country post-1949. The restriction to the sample was included to control for possible effects of World War II displacement on mental health. The study indicated higher risk of depression in immigrants than non-immigrants (OR: 1.71). This was found independent of time since immigration. Lanari and Bussini (2012) also used data from the SHARE survey, but restricted the sample to immigrants from Northern and Western European countries. Therefore, data from Spain, Greece, and Italy were not included in the study. The results indicated higher prevalence of depression symptoms for immigrants (44.57%) than for non-immigrants (34.96 %). A variation of the relative risk of depression symptoms was reported by country of birth. Contrary to what was found by Aichberger et al. (2010) and by Ladin and Reinhold (2013); this study found an effect of time since immigration. Older immigrants who were in the country less than ten years had similar depressive symptomatology than non-immigrants. However, older immigrants who have been in the country for ten years or more were more likely to report depression symptoms than their non-immigrants counterparts.

In the US, Lum and Vanderaa (2010) used data from the first wave (1993) of the Asset and Health Dynamic of the Oldest Old Study (AHEAD; Spoldo et al., 1997) survey. The survey is longitudinal and included a national sample of non-institutionalized seniors who in 1992 were 70+ years (Spoldo et al., 1997). Depression was measured using the (CES-D 10; Andersen et al.,

1994). The results indicated that older immigrants were almost twice as likely to have

depressive symptomatology as older US-born (Crude OR: 1.92). González et al. (2001) used

baseline data (1998/1999) from the longitudinal survey The Sacramento Area Latino Study of

Aging (SALSA; described in Haan et al., 2003). SALSA is a population-based study of Latinos

60 years of age and older (Haan et al., 2003). Depression was measured used the CES-D 20

(Radloff, 1977). Older Mexican immigrants have higher prevalence of depression (30.4%) than

US-born Mexicans (20.5%). Gerst et al. (2010) used data from the 2004/2005 (fifth wave) of the

Hispanic Established Population for Epidemiologic Studies of the Elderly (Hispanic EPESE;

Markides et al., 1999). The Hispanic EPESE is a longitudinal study of health of older Mexican

Americans 65+ years old, living in the Southwestern United States. Baseline data was collected

in 1993/1994 (Markides et al., 1999). The fifth wave included an additional sample of Mexican

Americans aged 75+. Depression was measured using the CES-D 20 (Radloff, 1977).

Immigrants have higher odds of depressive symptoms than US-born (OR: 1.73). Black et al.

(1998) used baseline data from the Hispanic EPESE (Markides et al., 1999). The results

indicated that recent immigrants (i.e., 5 or less years in the US) have higher prevalence of

depression (57.2%) compared to non-recent immigrants (26.3%) and to US-born (23.6%).

US community-sample studies conducted on specific immigrant groups also provide evidence

for higher risk of depression among elder immigrants. For example, Stokes et al. (2002) used a

convenience sample of 102 elderly Chinese immigrants 60+ years of age living in Santa Clara

County, California. Depression was measured with the 30-item GDS scale (Yesavage et al.,

1982). Immigrants' prevalence of depressive symptomatology (29.4%) was higher than the one

found in the older US population (13%-20%). Recent immigrants were at higher risk of depression; and the prevalence of depression decreased with increased time since immigration. Oh et al. (2002) used a sample of 157 Korean immigrants in Pittsburgh, Pennsylvania. Depression was measured using the CES-D 20 (Radloff, 1977). Approximately 40% of immigrants have high prevalence of depressive symptomatology. Mui and Kang (2006) used data from the Asian American Elders in New York City survey (2000). The survey includes Asian American Elders 65+ years of age from the following ethnic groups: Chinese, Filipino, Indian, Japanese, Korean, and Vietnamese. Depression was measured using the 30-item GDS (Yesavage et al., 1982). The results indicated that overall, approximately 40% of immigrants reported at least mild depressive symptomatology. The risk of depression symptoms increased with increased time since immigration. The studies mentioned here did not include a US-born referent group. This makes it difficult to quantify the HIE on depression in older immigrants.

In Canada, there is also evidence indicating that older immigrants may be at higher risk of depression than non-immigrants. For example, Lai and Surood (2008) used data from a random sample of 220 South Asians immigrants 55 years of age and older residing in Calgary, Alberta. The data were collected between 2004 and 2005. Depression was measured using the 15-item GDS (Yesavage & Sheikh, 1986). The results indicated that 21.4% of the participants have at least mild depression symptoms. No effect of time since immigration was found. Lai (2004) used data from the cross-sectional multisite Study of Health and Well-being of Elderly Chinese in Canada aged 55 and over. The study restricted the sample to elderly Chinese from Mainland China aged 65 and over (n = 444). Depression was measured with a Chinese version of the 15-

item GDS (Mui, 1996). Twenty three percent of immigrants reported having depressive symptoms. Higher symptoms of depression were found in recent immigrants. Lai (2005) used data from the same survey as Lai (2004); but restricted the sample to 98 immigrants from Taiwan aged 55 and older. The results indicated that 21.5% of immigrants reported at least mild depressive symptomatology. The study found no significant association between time since immigration and depressive symptoms. Kim and Chen (2011) used a probability sample of 148 Korean immigrants aged 60+ years, living in Toronto, Ontario. Depression was measured with the Korean version of the CES-D 20 (Cho & Kim, 1998). The results indicated that the prevalence of depression symptoms was 32.2%. The study found no effect of time since immigration. The lack of a Canadian-born comparison group in these studies does not allow determining the relative risk of depression in immigrants. However, the studies on Chinese and Korean elder immigrants in Canada replicated the findings in the US, which provide evidence of an elevated risk of depression in elder immigrants.

In summary, there is consistent evidence in the literature that elder immigrants are at higher risk of depression than elder non-immigrants. It could be argued that the evidence in Australia and Europe are just the reflection of the evidence that overall immigrants are at similar of higher risk of depression than non-immigrants. Nonetheless, the fact that studies in the US and in Canada also report higher risk of depressive symptomatology in elder immigrants provide evidence of the possible vulnerability of this population. The symptoms-based scales used to measure depression in the studies are considered appropriate screening tools for depression symptoms in older adults. Specially, the GDS and the CES-D have been widely used for this purpose (Roman

& Callen, 2008). The EURO-D scale, was designed based on the CES-D scale, and shows good

validity and reliability in screening for depression symptoms in the elder population (Prince et

al., 1999).

Overall, the results from Gonzalez et al. (2010), and the studies conducted in elderly population

suggest a variation of the HIE on depression with age. This indicates a possible effect

measurement modification by age in the association between immigration status and depression.

The existing literature either might have lack the power to detect this effect, or might have failed

to assess for one in the analyses. The next section provides a definition of the effect

measurement modification and its implications.

1.2.4.2 Definition of effect measurement modification and importance of assessing for it

In epidemiological studies, effect measurement modification is present when the association

between an exposure and a disease variable differs across levels of an extraneous variable

(Patten, 2015). The term measurement is included in the definition to indicate that this effect

depends on the type of measurement of association used (i.e., risk difference, or risk ratio;

Patten, 2015). When an effect measurement modification is found, separate measures of effect

should be presented for each level of the extraneous variable (Patten, 2015).

Failing to assess for effect measurement modification could lead to erroneous interpretation of

the exposure-disease relationship (Patten, 2015). First, it could obscure the fact that a subset of

the population might be at higher risk of the disease than others (Patten, 2015). In the case of the

effect suggested in Gonzalez et al. (2010), assuming an overall HIE could have masked that older immigrants are at higher risk of major depression than elder US-born. This could be detrimental since depression has been associated with increased disability, mortality, and high levels of health care utilization in the elderly (Blazer, 2003; Fiske et al., 2009). Second, it could lead to erroneous formulation of policies, programs and the allocation of resources. Going back to what it has been suggested by Gonzalez et al. (2010). Assuming an overall HIE, might lead to decreased awareness of the need for screening for depression in elder immigrants because they are assumed to be at lower risk of MDE than elder non-immigrants. It could also lead to a lack of information on the importance of policies and programs to reduce inequalities in depression in the elder immigrant population.

1.2.5 Gaps in the Literature

The reduction of inequalities in health relies in population-based evidence to inform which populations are at risk (Mental Health Commission of Canada, 2009). Unfortunately, there are still several gaps in the literature to allow determining possible inequalities in depression in immigrants compared to non-immigrants. At an international level, the evidence is inconsistent, with some countries suggesting better mental health for immigrants, and others reporting the opposite. In Canada, several gaps in the literature were identified. First, the evidence of the existence of the HIE on major depression in Canada is outdated. With the exception of Kim and Chen (2011), and Patten et al. (2015), the other existing evidence is based on data from more a decade ago. Patterns of immigration (Citizenship and Immigration Canada, 2015), and immigration policies have changed in Canada in the past decade (Government of Canada, 2015).

In addition, new data is available to allow an update on the existence of the HIE on depression in Canada. Furthermore, some of the existing studies presented the estimates adjusted by age and other socio-demographic variables. However, the studies either failed to assess for effect measurement modification by age; or did not have the power to find one. Therefore, determining if the HIE on depression exist in Canada is still needed. Assessing for effect measurement modification by age in the analyses is required.

Second, the evidence that the HIE on depression disappears with time since immigration is inconclusive and requires further investigation. Some studies suggest that the HIE disappears with increased time since immigration. However, it is impossible to determine from the existing literature if the loss of the HIE with time since immigration follows a linear or a non-linear pattern. Moreover, there is also evidence suggesting that more recent immigrants have higher prevalence of depression; and other studies have found no effect of time immigration on depression.

Third, there is evidence that the association between immigration status and depression varies with country of birth. However, whether or not the pattern of the HIE with time since immigration is similar across immigrants' country of birth has not been explored. Determining this pattern would inform immigration and health care policy; and the determination of culture-specific programs to help immigrants retain their initial mental health advantage.

Fourth, whether or not the pattern of the HIE on depression by time since immigration is the same for males than for females have not been reported. Discerning if the pattern of the HIE on MDE by time since immigration differs by sex would indicate the need for gender-specific interventions and prevention programs based on immigrants' length of stay in Canada.

In summary, several questions remain to be answered in the literature to allow for properly addressing the reduction of inequalities in depression in Canada. This study was conducted to fill some of those gaps. The available data at the population level collected by Statistics Canada from 1996 to 2014, allow exploring those questions using data synthesis techniques. Also the volume of data at hand allows to increase power to detect possible effect modification by age.

1.3 Research Objectives

The original objective for this study was to explore the HIE on past-year major depressive episode (MDE) in Canada and its relationship to various potential determinants. However, because effect measure modification by age was found (see Chapter 3 for more detail), the aims of the study changed to: Explore the existence of the HIE on past-year MDE in Canada; and to further explore if the effect measurement modification by age found was also observed within strata defined by sex, country of birth, and time since immigration.

1.4 Thesis Outline

This thesis is organized in four chapters: The introductory chapter (chapter 1), followed by a methodology chapter, a manuscript, and a discussion chapter. Chapter 1 has presented an

overview of the research project, provided a summary of background literature on immigration and depression, and has presented a set of original research objectives that were subsequently modified during the analysis. Chapter 2 covers part of the methodology used in the study, providing material supplemental to that of the thesis' manuscript. Chapter 3 contains a manuscript that covers a summary of the literature reviewed in Chapter 1; a summary of the methodology described in Chapter 2 plus the statistical analysis; the main results of the study; and a brief discussion of findings. Chapter 4 presents an overall discussion of the main findings of the study; critical appraisal of the study; strengths and limitations; implications of the study; and recommendations for future research.

Chapter Two: Methodology

2.1 Study Design

This study is a cross-sectional analysis of data from a single cross-sectional cycle of the National

Population Health Survey (NPHS; Statistics Canada, 1995), seven cycles of the general health

Canadian Community Health Survey (CCHS) (i.e. 1.1; 2.1; 3.1; 2007/2008; 2009/2010;

2011/2012; and 2013/2014) (Statistics Canada, 2016), and both of the mental health-focused

Canadian Community Health Surveys (i.e., CCHS-1.2 and CCHS-MH) (Statistics Canada, 2003,

2013a).

2.2 Description of the Surveys

2.2.1 Overview of the Surveys

The NPHS was a longitudinal survey collected biennially from 1994 until 2011; however, the

first three cycles of the survey (i.e. 1994-1995, 1996-1997, and 1998-1999) were both

longitudinal and cross-sectional. This was made possible by the inclusion of sample buy-in from

some provinces in the first two cycles, refreshment of the longitudinal sample with new

immigrants and by inclusion of children included in the original NPHS cycle as young adults in

the third cycle (Brisebois et al., 2005). In addition, Statistics Canada recalculated the sample and

bootstrap weights to use when calculating cross-sectional estimates (Brisebois et al., 2005). The

three cross-sectional samples are not independent; therefore, only data from the 1996-1997

NPHS was used. This cycle provides the larger sample (81,804 participants) of the three

available cross-sectional data sets.

The general health CCHS is a cross-sectional survey program that started in 2000, and collected data biennially until 2007. After that, the survey has been conducted annually (Statistics Canada, 2016). The biennial sample consisted of approximately 130,000 participants; while the annual survey sample collects data from approximately 65,000 individuals (Statistics Canada, 2016). The data is collected on an annual basis, but in preparation and release of the datasets the cycle continues to reflect a two year period (i.e., 2007/2008; 2009/2010; 2011/2012; 2013/2014).

The CCHS-1.2 and CCHS-MH are cross-sectional surveys conducted in 2002 and 2012 respectively (Statistics Canada, 2003, 2013a). The surveys consisted of 36,984 and 25,113 participants, respectively.

2.2.2 Target Population

The target population for the surveys is all household residents living in the ten Canadian provinces (Statistics Canada, 1995, 2003, 2013a, 2016). The general health CCHS also included people living in the three territories (Statistics Canada, 2016). The surveys excluded fulltime military personnel; institutionalized persons; and those living on reserves, aboriginal settings, and some remotes areas in some provinces. The NPHS targeted residents of all ages. However, depression was only measured in those 12 years of age and over. The general health CCHS targeted population 12 years of age and over, while the mental-health focused surveys targeted population 15 years of age and over. For the purpose of this study, the analyses was restricted to individuals 15 years of age and over and residing in the ten provinces. The survey-specific overall number of participants 15 years of age and over is presented in Table 2.1.

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2.2.3 Sampling Strategy

To ensure representation of the target population, all the surveys used a multi-stage sampling

framework to select the subjects in the sample (Béland, 2002; Gravel & Béland, 2005; Tambay

& Catlin, 1995)**.** For the selection of the households, the three surveys used the area probability

frame designed for the Canadian Labour Force Survey (LFS; Statistics Canada, 1998) as primary

sampling frame. This area frame was complemented by other sampling frames to determine the

final sample of households (Béland, 2002; Gravel & Béland, 2005; Tambay & Catlin, 1995). The

LFS uses a multi-stage sampling strategy where the population in each province is first divided

in three areas (i.e. rural areas, larger cities, and smaller urban areas). Then, strata are formed

within each area based on geographic and/or socio-economic characteristics. Clusters are

selected within each stratum using probability proportional to size, where the size corresponds to

the number of households. Households are selected within each cluster (Statistics Canada, 1998).

The NPHS used two additional sampling frames to determine the samples of households

(Brisebois et al., 2005). In Quebec, the NPHS selected the sample from households who

participated in the 1992/1993 Enquête sociale et de santé (ESS). The ESS used a sampling

strategy similar to the one used by the LFS. The 1996-1997 cross-sectional datasets included a

buy-in sample from the provinces of Ontario, Manitoba, and Alberta (Brisebois et al., 2005). The

Random Digit Dialling (RDD) frame was used to select the sample (Brisebois et al., 2005). The

RDD frame starts with a list of all possible 100 contiguous ten-digit telephone numbers (i.e.,

bank), where at least one valid residential phone number exists. In these banks, the first eight-

digits of the telephone number are held constant. The banks are then regrouped into RDD strata.

Within each stratum, a bank is randomly selected, and a number between 00 and 99 is randomly generated to complete the ten-digit telephone number. These steps are repeated until the targeted sample size in each stratum is reached (Brisebois et al., 2005).

The general health CCHS complemented the LFS area frame with the use of two telephone sampling frames, the RDD approach and a list frame of telephone numbers (Béland, 2002; Statistics Canada, 2016). Statistics Canada uses as telephone list frame, an external list of telephone numbers that is updated twice a year. The list frame is stratified within the health regions using postal codes. Then, phone numbers are selected within stratum using simple random sampling (Statistics Canada, 2016). The percentage of the sample of household selected using each sampling frame varied in some cycles. In the first cycle (i.e. CCHS 1.1), 83% of the household sample was selected using the LSF area frame; 10% using the telephone list frame and 7% using the RDD frame. However, in subsequent cycles, between 50% to 58.5% of the sample of households was selected using the telephone frame, while only 1% or 2% of the sample was selected using the RDD frame (Statistics Canada, 2016). Buy-in samples from some provinces were present in all cycles. These buy-in samples were selected using either the LFS frame or the list frame of telephone numbers. For more detail on this refer to the documentation for each CCHS cycle provided by Statistics Canada (2016).

The mental-health focused CCHS surveys used the LFS area frame as primary strategy (Gravel & Béland, 2005). Buy-in samples from Ontario and Nova Scotia in the CCHS1.2 were selected using the LFS framework (Gravel & Béland, 2005).

Once the sample of households is determined, the surveys select an individual from each household to participate using various selection probabilities based on age and household composition (Béland, 2002; Gravel & Béland, 2005; Tambay & Catlin, 1995)**.** The selection probability used accounts for the over-representation of individuals in some specific age groups (for details on age categories oversampled in each survey see Béland, 2002; Gravel & Béland, 2005; Statistics Canada, 2003, 2016).

2.2.4 Data Collection

In all the surveys, data was collected by Statistics Canada trained interviewers using a computer-assisted interviewing (CAI) system (Béland, 2002; Gravel & Béland, 2005; Tambay & Catlin, 1995). The 1996-1997 NPHS collected data in four periods June/ July, August/September, October to December 1996; and February to April and June/July 1997. Approximately 92% of interviews were done by phone. The general health CCHS collected data starting in September and then continuously for one year. The percentage of interviews conducted in person and by phone also varies by cycle (for more detail see Statistics Canada, 2016). The CCHS1.2 cycle collected information in three periods: May to July, August to September, October to November, and was extended until the end of December 2002. Approximately 86% of the interviews were conducted in person (Statistics Canada, 2003). The CCHS-MH collected data between January and December 2012. Eighty seven percent of the interviews were conducted in person (Statistics Canada, 2013a).

2.2.5 Response Rates

For each survey, Statistics Canada calculates the response rates at the household level and at the individual level, and provides an estimate of the combined (Canadian level) response rate (Statistics Canada, 2003). The household-level response rates are calculated by dividing the number of responding households by the number of in-scope households (Statistics Canada, 2003). The response rates at the individual level are calculated by dividing the number of responding individuals by the total number of selected individuals (Statistics Canada, 2003). The combined response is the result of the multiplication of the household and the individual-level response rates (Statistics Canada, 2003). A summary of survey-specific Canadian-level response rates is presented in Table 2.1. The response rates vary across surveys, and survey cycles. Also, a decrease in the response rates over time can be observed.

2.2.6 Sampling Weights and Bootstrap Procedure

Statistics Canada calculates sample weights, and bootstrapping procedures in each survey to be used in estimation and in order to account for the complexities of sampling and survey design. These complexities include: clustering due to multi-stage approach to sampling; the use of multiple sampling frames; unequal distribution of sample size to provinces; unequal selection probability due to household composition, and to oversampling of some age groups; removal of out of scope units; non-response rates; etc. (Béland, 2002; Statistics Canada, 2013a). The use of sample weights allows for the estimate to be a representation of the target population and also supports correct standard errors for the estimates.

The bootstrapping procedure allows accurate calculation of standard errors and 95% confidence intervals (CI) of the estimates despite of the complex survey design. The bootstrap procedure used by statistics Canada involves the selection of a random sample of n-1 clusters and recalculating the sample weights for each individual. This procedure is repeated 500 times to obtain 500 bootstrap weights for each individual. The estimate is calculated 500 times using the bootstrap weights, and the variance of the estimate is determined by the variability among the 500 estimates (Statistics Canada, 2013a).

2.3 Measurements

2.3.1 Measurement of Past-year Major Depressive Episode

To measure MDE, the NPHS and the general health CCHS used the World Health Organization (WHO) Composite Diagnostic Interview Short Form Major Depression (CIDI-SFMD; Kessler et al., 1998), while the mental-health focused CCHS surveys used the Canadian adaptation of the World Mental Health Composite Diagnostic Interview (WMH-CIDI Version 2.1; Kessler & Ustun, 2004).

The CIDI-SFMD is a structured diagnostic lay-interview developed as a subset of items from the full WHO-CIDI to provide quick diagnoses of MDE based on the revised third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R; Kessler et al., 1998). The instrument was later updated to provide diagnoses of the MDE based on the DSM-IV. The CIDI-SFMD uses the same general stem and branch method as the WMH-CIDI to screen participants. Individuals are screened based on the answers to two questions that evaluate whether or not in

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the past year they have felt depressed mood or anhedonia for at least two weeks, most of the day, almost every day. Only those endorsing at least one of the questions are asked further questions to determine the presence of other diagnostic symptoms based on the DSM-IV criteria (Kessler et al., 1998). A computer algorithm creates a probability of diagnosis based on symptoms reported by individuals. A 90% probability of diagnosis of MDE in the past 12 months corresponds to reporting five of nine symptoms, at least one of which must be depressed mood or loss of interest (Kessler et al., 1998). This approximately corresponds to the symptoms of depression following criteria A of the DSM-III-R, DSM-IV and DSM-5. Some studies have assessed the validity of the CIDI-SFMD in comparison to other diagnostic tools. Patten et al. (2000) reported that compared to the full WHO-CIDI, the CIDI-SFMD has a positive predictive value of 75%. Aalto-SetÄLÄ et al. (2002) reported that compared to the Schedules for Clinical Assessment in Neuropsychiatry (SCAN), the CIDI-SFMD has a sensitivity of 71%, and a specificity of 82%. The CIDI-SFMD was an optional content in the general health CCH surveys, and it was not applied in all provinces in all survey cycles. This resulted on a number of participants not included in the study (see Table 2.1).

The WMH-CIDI is a fully standardized diagnostic lay-interview designed to measure mental disorders based on diagnostic criteria of the DSM-IV and the 10th revision of the International Classification of Diseases and Related Health Problems (ICD-10; Kessler & Ustun, 2004). Statistics Canada uses an adaptation of the WMH-CIDI in the surveys. The adjusted version of the WMH-CDI does not support the ICD-10 algorithm (Gravel & Béland, 2005). The diagnosis of MDE is based on a comprehensive set of questions that evaluate each symptom's associated

level of distress, severity, impairment and clinical significance based on the DSM-IV criteria

(Kessler & Ustun, 2004). Only respondents who meet the criteria for inclusion based on the two

pre-screening questions (see above) are asked the remaining questions to assess MDE.

Respondents are considered to meet the diagnostic criteria for MDE in the past 12 months if they

meet the criteria for lifetime MDE, have a MDE in the 12 months prior to the interview, and

have clinically significant distress or impairment in social, occupational or other important areas

of functioning (Statistics Canada, 2003).

For the purposes of this study, a participant is considered to have past year MDE if the

probability of diagnosis of MDE is 90% or higher in the CIDI-SFMD. For the mental-health

focused CCHS, participants are considered to have had a past year MDE if they met the

Canadian adapted WMH-CIDI criteria for WMH-CIDI MDE 12 months.

Table 2.1: Sample sizes for overall sample and included in the study, and response rates per survey.

Survey	Overall Sample: Respondents 15+ Years	Included in the Study: Respondents 15+ Years who Answered the CIDI[a]	Response Rates
NPHS 96-97	70,881	68,199	95.6%
CCHS 1.1	122,722	119,591	84.7%
CCHS 1.2- MH	36,983	36,788	77.0%
CCHS 2.1	125,688	45,533	80.7%
CCHS 3.1	124,255	65,224	78.9%
CCHS 07-08	123,315	43,006	77.6%
CCHS 09-10	116,517	54,020	72.3%
CCHS 11-12	117,615	25,174	68.4%
CCHS 12-MH	25,113	24,954	68.9%
CCHS 13-14	120,311	38,404	66.2%

[a] CIDI stands for: 1) the CIDI-SFMD used in the NPHS and the general health CCHS, and 2) the WMH-CIDI used in the CCHS 1.2MH and the CCHS 12MH

2.3.2 Measurement of Immigration Related Variables

In this section, I will provide information on how the variables relevant to immigration status, time since immigration and country of birth were measured in the surveys. These variables were measured using similar questions in all of the survey cycles.

In each survey, Statistics Canada derives a variable called "immigration flag" based on a set of questions that allow determining if a participant was Canadian-born; or foreign-born, but not Canadian by birth. A foreign-born person can be considered Canadian by birth under some circumstances (Citizenship and Immigration Canada, 2016). For example, children born outside Canada to Canadian parents before April 17, 2009; or those born to Canadian parents working in government jobs overseas are considered Canadian by birth. For a complete description of cases please see Citizenship and Immigration Canada (2016). The variable immigration flag corresponds to the variable immigration status in this study.

The variable time since immigration was derived by Statistics Canada, in each survey, by subtracting the year of immigration to the year when the interview was conducted for the survey. The minimum for this variable was set as zero, and the maximum was set as the current age of the individual. This variable was considered continuous. For the purpose of stratification in this study, two categorical variables were created using Canadian-born as one of the categories: Time since immigration (TSI) 1 (Canadian-born; 0-9 years); TSI2 (Canadian-born; 10+ years). The determination of the two categories was based on careful evaluation of prevalence of MDE and counts of immigrants in the nine initially determined categories of time since immigration (i.e.,

0-4 years, 5-9 years; 10-14 years; 15-19 years; 20-24 years; 25-29 years; 30-34 years; 35-39 years; and 40+ years).

For the variable country of birth, Statistic Canada asks respondents about their country of birth, and then assigns a code to each country. An additional question was asked to determine if the participant was Canadian by birth. In this study, we considered Canadian-born those who responded being born in Canada, plus those who were born outside of Canada but were Canadian-born by birth. This definition is consistent to the definition of Canadian-born used by Statistics Canada to derive the variable immigration flag. The Human Development Index (HDI; United Nations Development Programme, 2015) was used to classify immigrants based on their countries of birth. The HDI is an index used to rank countries in the world based on indicators of life expectancy, education, and income per capita (United Nations Development Programme, 2015). Countries are classified in four groups based on their scores: 1) very high HDI, 2) high HDI, 3) medium HDI, and 4) low HDI. Countries are further classified as either developed (i.e., very high HDI), or developing (i.e., high HDI, medium HDI, or low HDI). Based on the HDI, Canada is considered a developed country (United Nations Development Programme, 2015).

The 2014 HDI scores were used as a baseline to classify the codes of countries of birth in each survey. Some countries reported in the surveys do not have a score in the HDI; however, this corresponded to maximum of around 3% of the overall sample in some surveys. Initially, the variable country of birth was created using Canadian-born as a category, and four categories of country of birth (i.e., very high HDI; high HDI; medium HDI; and low HDI). However, because

of small number of depressed participants in some of the categories in some of the surveys, the final variable was created with three categories (i.e., Canadian-born; developed country; and developing country).

2.3.3 Measurement of Age and Sex

Information about age and sex was collected using similar questions in all of the surveys. Age was considered as continuous variable in most of the analyses. Two categorical variables were also derived and used in stratified analysis. A variable with four categories of age (i.e. 15-29; 30-44; 45-59; 60+) was used to assess for effect measurement modification by age. The categories of age in this variable were based on the quartiles of age for the CCHS 1.1 survey cycle. This survey is the largest survey that measured past-year major depression in all provinces. The quartiles of age on other surveys are very close to the ones defined in the variable. The other categorical variable used for age was (15-59 years; 60+years). This variable was defined based on the results from the stratified analysis using the variable with four categories. Small survey-specific sample size in some of the categories of the four categories of age variable also motivated this decision. Sex was defined as (male; female).

2.4 Pooling Techniques

2.4.1 Method Used for Pooling

This study used individual level data meta-analysis to pool the data at the survey level (Thomas et al., 2014). Two different approaches exist to pool the data: 1) the one-step approach, and 2) the two-step approach (Thomas et al., 2014). The one-step approach involves appending the data

from all the surveys into a single data file, and then re-scaling the survey weights (Thomas & Wannell, 2009). The two-step approach implies calculating the estimates in each survey first, and then pooling them using meta-analysis (Thomas et al., 2014). The two-step approach was the primary pooling technique used in this study. In this approach, the use of survey-specific sample and bootstrap weights to calculate the estimates, as well as random effects meta-analysis to pool the estimates allow to gain precision in the estimates while properly considering the influence of design effects. More detail on how the techniques were used is provided in the statistical analysis section in next chapter.

2.4.2 Considerations before Pooling

Statistics Canada provides a series of recommendations to consider before pooling data from different Statistics Canada surveys and survey cycles (Thomas & Wannell, 2009; Wendt, 2007). One of the consideration is how comparable are the samples in terms of sampling designs of different surveys and cycles (Wendt, 2007). As mentioned in the sampling strategy section, Statistics Canada uses similar sampling strategies to collect the data from the surveys. However, some variability exists between surveys in terms of the sampling frames used, the percentage of data that was collected in person or by phone, and the percentage of non-response, sample buy-ins, etc. However, these differences were accounted for at the analysis phase by: 1) using survey-specific sample and bootstrap weights to calculate all the estimates in the two-step approach; 2) using the re-scaled survey and bootstrap weights in the one-step approach; and 3) adding in the logistic regression models a variable that represent the survey cycle (Wendt, 2007). In addition,

heterogeneity due to methodological factors was also accommodated through the use of random effect models in the two-step analyses.

Another consideration is whether or not the estimates are similar across surveys (Wendt, 2007). Possible differences in the estimates across surveys could be attributed to possible changes in the population over time. This could contribute to heterogeneity; and it is a major concern when pooling survey results from different years. Whether or not the estimates vary across surveys was assessed in the two-step approach by visually inspecting the forest-plots, and by conducting a random effects meta-regression to check for temporal trends. To do this, a variable called time was created, using the NPHS 96-97 as baseline, and calculating the number of years since that survey as the data point for each consecutive survey. In the meta-regression, the baseline corresponds to the intercept of the meta-regression equation, and the slope term represent the changes in the estimates per year. Trends were considered observed if the Wald-test associated with the slope was significant at $p < 0.05$. In addition, some variability was expected due to the dynamic nature of immigration; therefore, a decision was made *a priori* the use of random effects meta-analyses in the two-step approach. The decision to pool the estimates was also conditioned to not observing temporal trends in the estimates.

A further consideration concerns the target population in the surveys and in the study (Wendt, 2007). As mentioned in the section above, the surveys differ slightly in their target populations. Differences in lower age range and whether or not the territories were included in the sample are

the main differences across surveys. To make the surveys comparable, the target population was limited to those 15 years of age and over and living in the 10 provinces.

An additional consideration is the comparability of the variables used in terms of how they were measured and whether or not they measure the same construct (Wendt, 2007). Careful consideration was taken when defining the variables for the study. As mentioned in the measurements section, there was consistency in most of the ways the variables were measured in the study. Some of the variables were recoded to make them similar across surveys. However, there is a major concern regarding the measurement of past-year MDE. This variable was measured using two different instruments (i.e., the CIDI-SFMD and the WMH-CIDI). Since there is evidence that compared to the WMH-CIDI the CIDI-SFMD tends to overestimate the prevalence of MDE (Patten et al., 2000), random effects meta-regression was conducted using the two-step approach to assess for this effect. To do this, a variable called instrument type was created assigning "0" to those surveys that used the CIDI-SFMD, and "1" to those who used the WMH-CDI. An effect of instrument type was considered to be present if the p-value of the meta-regression analysis was less than 0.05. Another issue with the measurement of MDE is that the CIDI-SFMD was not applied in all the provinces in all the surveys in the general health CCHS. To examine the effect of MDE not being measured in all provinces in all surveys, a measurement-option variable was created assigning "0" to those surveys that measured MDE in all provinces, and "1" to those who did not. A random-effects meta-regression including the measurement-option variable in the model was performed. An effect of measurement-option was considered to be present if the p-value of the meta-regression analysis was less than 0.05.

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This chapter provided an overview of important aspects of the methodology used in this study. However, to prevent duplication, aspects of the statistical analysis will be explained in the body of the manuscript presented in chapter 3 and were not described in this chapter.

Chapter Three: The Healthy Immigrant Effect on Major Depression in Canada Disappears with Age

3.1 Abstract

Purpose: Evidence that immigrants have lower prevalence of depression than non-immigrants (i.e. the healthy immigrant effect (HIE)) is inconclusive. This study aimed to explore the existence of the HIE on past-year major depressive episode (MDE) in Canada.

Methods: Data were from 10 surveys representative of the Canadian household population collected by Statistics Canada between 1996 and 2014. Survey-specific log odd ratios were estimated using logistic regression and these estimates were pooled using random effects meta-analysis and meta-regression.

Results: Evidence of the HIE was found (Pooled Crude OR: 0.7; 95% CI: 0.6, 0.7); however, another effect was also observed: a j-shaped pattern in relation to age, suggesting that the HIE on MDE disappears with age. This was observed overall and within strata defined by sex, country of birth, and by time since immigration. Compared to Canadian-born, older immigrants seem to have similar or higher odds of MDE regardless of sex, country of birth, or time since immigration.

Conclusions: The existence of a HIE may lead to an erroneous interpretation that all immigrants are at lower risk of MDE, but this was not confirmed by this study. These results suggest the need for more mental health programs and strategies to improve the mental health of older immigrants. Future research is needed to determine why older immigrants may be at higher risk of MDE.

Key words: Immigration, depression, major depressive episode, healthy immigrant effect, age

3.2 Introduction

In 2015, the number of immigrants in the world reached 244 million; a 41% increase since 2000 (United Nations et al., 2016). With an ageing population, and lower birth rates, immigrants represent an important source of population, and economic growth in some developed countries (United Nations et al., 2016). In Canada, net migration represented over 60% of population growth from 2011 to 2016 (Statistics Canada, 2017); and in 2006, immigrants accounted for 21.6% of the Canadian labour force (Statistics Canada, 2011a). These proportions are projected to grow to 80% (Statistics Canada, 2013b) and 33% (Statistics Canada, 2011a) respectively by the year 2031. Immigrants may be exposed to pre and post-migration stressors that can increase their risk of mental illnesses such as depression (Beiser, 1999; Bhugra, 2004; Hansson et al., 2012). This could affect both the individual and the economy since the 2015 Global Burden of Disease (GBD) study suggested that depressive disorders are considered the third leading cause of years lived with disabilities (YLD; Global Burden of Diease Disease Injury Incidence Prevalence Collaborators, 2016); and the 15th cause of disability adjusted life years (DALYs) worldwide (Global Burden of Disease DALYs HALE Collaborators, 2016). The burden of depressive disorders increased 18.2% from 2005 to 2015 (Global Burden of Disease DALYs HALE Collaborators, 2016). In 2006, the estimated annual cost of mental illness including depression in Canada is $51.6 billion Canadian dollars (Lim et al., 2008).

Studies on immigration and depression in the United States (Alegria et al., 2008; Budhwani et al., 2015; Gonzalez et al., 2010; Grant et al., 2004; Lau et al., 2013; Szaflarski et al., 2016; Vega et al., 2004), and in Canada (Akhtar-Danesh & Landeen, 2007; Ali, 2002; Patten et al., 2015; Wu

& Schimmele, 2005), have reported that immigrants have lower prevalence of depression than non-immigrants (i.e. the healthy immigrant effect (HIE)). However, studies in Europe (Beutel et al., 2016; Levecque et al., 2007; Missinne & Bracke, 2012; Sieberer et al., 2012; Tinghög et al., 2007; Wittig et al., 2008), and in Australia (Straiton et al., 2014) found no support for the HIE. Immigrants reported higher, or similar depressive symptomatology than non-immigrants. Differences in migration policies, as well as in study design, such as the characteristics of immigrants included in the studies, the definition of immigrants, and the instruments used to measure depression (i.e., diagnostic instruments in the US and in Canada; and symptom-based instruments in Europe and in Australia), might provide some explanation for the discrepancy in findings between North America; and Europe and Australia.

In the US and in Canada, there is evidence that the HIE tend to disappear with time since immigration, with immigrants converging to the native-born prevalence of depression with increased time since immigration (Ali, 2002; Cook et al., 2009; Szaflarski et al., 2016; Vega et al., 2004; Wu & Schimmele, 2005). However, higher levels of depression have been reported in recently arrived South Asian refugees (Beiser, 1999) and in recently arrived senior immigrants from China (Lai, 2004; Stokes et al., 2002). Also, some studies have not found an effect of time since immigration (Kim & Chen, 2011; Lai, 2005; Lai & Surood, 2008; Sedighdeilami, 2002). These later studies did not provide a non-immigrant comparison group, so that they were unable to assess the HIE. Additionally, the discrepancy in findings may be attributed to the different instruments used to measure depression.

It has also been suggested that the HIE depends on country of birth and immigrant class. For example, Ali (2002) found that compared to Canadian-born, immigrants from Europe and North America have similar prevalence of depression; while immigrants from other areas of the world have lower prevalence of depression than Canadian-born. Other studies have reported higher risk of depression in Iranian immigrants and refugees (Sedighdeilami, 2002); Ethiopian immigrants and refugees (Fenta et al., 2004); and Southeast Asian refugees (Beiser, 1999). These later studies did not provide a Canadian-born comparison group; they were based on samples in specific cities in Canada. Their results might not be generalizable to other immigrants in Canada, or in other countries. Similar to what has been found in Canada, studies in the US also indicate a variation of the HIE with country of birth (Alegria et al., 2008; Budhwani et al., 2015; Gonzalez et al., 2010; Szaflarski et al., 2016). No support for the HIE was found in US immigrants from Cuba (Alegria et al., 2008; Gonzalez et al., 2010), and Puerto Rico (Alegria et al., 2008; Gonzalez et al., 2010; Szaflarski et al., 2016).

An interesting finding on the HIE is that it may disappear with age. Gonzalez et al. (2010) found that immigrants have lower prevalence of major depression than US-born; but this was evident for younger but not for older individuals. The literature on depression in older immigrants seems to support the idea that older immigrants are at high risk of depression (Aichberger et al., 2010; Black et al., 1998; Gerst et al., 2010; González et al., 2001; Kim & Chen, 2011; Ladin & Reinhold, 2013; Lai, 2004, 2005; Lai & Surood, 2008; Lanari & Bussini, 2012; Lum & Vanderaa, 2010; Mui & Kang, 2006; Oh et al., 2002; Stanaway et al., 2010; Stokes et al., 2002). It could be argued that this is just the reflection of time since immigration, with older immigrants

also having higher time since immigration in the country. However, the evidence is inconclusive. Some studies reported higher levels of depression symptoms with increased time since immigration (Lanari & Bussini, 2012; Mui & Kang, 2006); while others reported no effect (Aichberger et al., 2010; Kim & Chen, 2011; Ladin & Reinhold, 2013; Lai, 2005; Lai & Surood, 2008), or higher levels of depression symptoms in recent immigrant seniors (Black et al., 1998; Lai, 2004; Stokes et al., 2002).

In conclusion, the literature on the HIE on depression is conflicting. Differences in study design, and instrument used to measure depression do not allow reconciliation of the findings. Most have used symptom-based rather than diagnostic instruments. In addition, most of the studies in Canada are based on data from over a decade ago, and since 1996, approximately 226,000 new immigrants have been accepted per year in Canada (Citizenship and Immigration Canada, 2015). Also, some of the existing literature has controlled for age, and other socio-demographic variables as possible confounders in the association between immigration status and depression. However, studies might have failed to assess for possible effect modification by those variables. Failing to check for such an effect can lead to erroneous interpretation of the association between immigration and depression, and to miss important issues regarding subgroups of the population (Patten, 2015). Additional studies are needed to help guide policy and the creation of programs to improve immigrants' mental health, which is a national priority (Mental Health Commission of Canada, 2009).

This study aimed to explore the existence of the healthy immigrant effect on past-year major depressive episode (MDE) in Canada. The original analysis plan included an assessment of whether the HIE for past year MDE changed with time since immigration. However, we found that the HIE varies with age, characterization of this effect became the focus of the study.

3.3 Methods

3.3.1 Data Sources and Target Population

This study used data from the 1996-1997 cross-sectional cycle of the National Population Health Survey (NPHS; Statistics Canada, 1995), seven cycles of the cross-sectional general health Canadian Community Health Survey (CCHS) collected between 2000 and 2014 (Statistics Canada, 2016), and the two cycles of the mental health-focused CCHS collected in 2002 and 2012 respectively (Statistics Canada, 2003, 2013a). The NPHS was a longitudinal survey; however, it produced a large cross-sectional sample in 1996-1997 that included the longitudinal sample plus sample buy-ins from three provinces (Brisebois et al., 2005).

The surveys used a multi-stage stratified cluster design for the selection of the households (Béland, 2002; Gravel & Béland, 2005; Tambay & Catlin, 1995) and in some cases a supplementary use of random digit dialing and a telephone list frame. An individual from each household is selected using various selection probabilities based on age and household composition (Béland, 2002; Gravel & Béland, 2005; Tambay & Catlin, 1995). To account for the complexities of sampling and survey design, Statistics Canada provides samples weights and 500

replicate bootstrap weights to be used in all the analyses (Béland, 2002; Statistics Canada, 2013a).

The target population differs slightly across surveys; therefore, to make the surveys comparable, this study limited the analyses to individuals 15 years of age and over and living in the ten provinces. The surveys excluded fulltime military personnel; institutionalized persons; and those living on reserves, aboriginal settings, and some remotes areas in some provinces. These exclusions correspond to less than 3% of the Canadian population (Statistics Canada, 1995, 2003, 2013a, 2016).

3.3.2 Measures

Statistics Canada uses two different fully structured diagnostic interviews to measure past-year major depressive episode (MDE): the World Health Organization (WHO) Composite Diagnostic Interview (CDI) Short Form Major Depression (CIDI-SFMD; Kessler et al., 1998), and the Canadian adaptation of the World Mental Health Composite Diagnostic Interview (WMH-CIDI Version 2.1;Kessler & Ustun, 2004). The WMH-CIDI was used in the two CCHS-Mental health focused surveys, and the CIDI-SFMD was used in the other surveys. The two instruments are comparable in that both of them use a DSM-based branching structure to determine an assessment of probable MDE (Kessler et al., 1998; Kessler & Ustun, 2004); and they both possess approximate face validity for the symptom-based criterion A of the DSM-III, DSM-IV; and DSM-5 (American Psychiatric Association, 2013). However, the CIDI-SFMD is based on a subset of symptoms (Kessler et al., 1998); and compared to the WMH-CIDI, it tends to over-

estimate the prevalence of MDE (Patten, 1997; Patten et al., 2000). In addition, the CIDI-SFMD was optional content in the general CCHS and it was not applied in all provinces in all surveys. We used sensitivity analyses and meta-regression to assess for possible biases resulting from those effects. In this study, participants were considered to have MDE if the probability of diagnosis of MDE was 90% or higher in the CIDI-SFMD; or if they meet the Canadian adapted WMH-CIDI criteria for MDE 12 months.

Immigration status was considered in three different forms based on whether immigrants were collapsed in an overall category (i.e., immigration status), or classified either by their country of birth, or by their time since immigration. The variable immigration status measures whether a participant is Canadian-born or immigrant (i.e., born outside of Canada and not Canadian citizen by birth). The variable country of birth contains a category for Canadian-born; and two categories for immigrants based on whether or not they were born in a developed or a developing country. A country was considered developed if it has a score of very high in the 2014 Human Development Index (HDI; United Nations Development Programme, 2015). A country was considered developing if it scores high, medium, or low in the 2014 HDI (United Nations Development Programme, 2015). For time since immigration, immigrants were classified based on two categories of time since immigration: 0-9 years; and 10+ years. To facilitate the analysis, two different variables were created each composed of two categories: Canadian-born; and one of the categories of time since immigration.

3.3.3 Statistical Analysis

As mentioned earlier, we found that age modified the association between immigration status and MDE; therefore, the initial analysis plan was not implemented. Instead, whether or not the modification by age was also observed within strata defined by sex, country of birth, and time since immigration was explored.

3.3.3.1 Pooling techniques

To pool the data from the 10 surveys, we used individual-level random-effects meta-analysis (Thomas et al., 2014). These techniques incorporate two approaches (i.e., one-step or two-step). For the main analyses, we used the two-step approach to combine data at the survey-level (Thomas et al., 2014). This involves the calculation of survey-specific estimates following classic epidemiological analysis (step one); then, pooling the survey-specific estimates (if appropriate) using meta-analytic techniques to gain precision (step two; Thomas et al., 2014) this is regarded as an individual level meta-analytic approach since the step one estimates can include adjustments for individual characteristics. A random effects meta-analysis was chosen *a priori* because some heterogeneity in the estimates between surveys was expected, despite the surveys' similarities in sampling and measurement. We used the one-step approach to determine the pattern of MDE by age. This technique involves pooling the ten surveys into a single data set; then, re-scaling the survey-specific sample weights and bootstrap replicates by a factor equal to the number of participants in the survey divided by the total number on the pooled data set (Thomas & Wannell, 2009). The decision to use the one-step approach was motivated by the small sample size in some surveys that did not allow for finer stratification by age groups.

3.3.3.2 Main analysis.

To explore the presence of the HIE on MDE, the survey-specific crude log odd ratios (LogOR) of MDE using immigration status as exposure were calculated (step-one). The survey-specific β-coefficient and standard error of the estimate were used as data points to pool using random-effects meta-analysis (step-two). Logistic regression modelling and stratified analysis was conducted to assess if age was a modifier. We created a cross-product (interaction term) of immigration status and age as continuous variable, and included age and the interaction term in the logistic regression model. The survey-specific β-coefficients and standard errors of the interaction term were pooled using random-effects meta-analysis. Age was considered to be a modifier if the pooled estimate of the interaction term was statistically significant at the $p < 0.05$ level. To explore possible non-linear patterns of the HIE of MDE by age, we investigated quadratic and cubic terms, but found that quadratic terms gave the best fit for the data. To assess for the robustness of the findings, we conducted the analysis within strata specified by country of birth, by time since immigration, and by sex. Survey-specific sample and bootstrap weights were used in all the analyses to account for differing sampling strategies and design effects.

In the two-step analyses, heterogeneity of the estimates (i.e., variability between the estimates that is not accounted by chance alone; Higgins & Thompson, 2002) was assessed visually using forest plots, and statistically using the I^2 statistic and its associated Q (χ^2) test of heterogeneity; and the τ^2 value of the random effect models. Since the I^2 depends on the precision of the estimates included in the meta-analysis (Rücker et al., 2008), the values of the I^2 and χ^2 were interpreted with caution, and more reliance was placed on the value of τ^2. Possible temporal

trends (i.e., changes on the estimates by survey cycle); the effect of different instrument used to

measure MDE (i.e., CIDI-SFMD versus WMH-CDI); and the effect of measurement option (i.e.,

MDE not being measured in all provinces in all surveys) were assessed statistically using random

effects meta-regression. However, the meta-regressions consistently indicated no temporal

trends, no effect of instrument used, and no effect of measurement option in all the analyses;

therefore, these results will not be further discussed. The analyses were conducted in the Prairie

Regional Data Center in Calgary using STATA 14. We used the STATA commands "*metan*",

and "*metareg*" in the analyses using the two-step approach. Based on Canadian ethical

guidelines, research conducted using Statistics Canada data is exempt from ethics approval

(Interagency Advisory Panel on Research Ethics, 2014).

3.4 Results

Table 3.1 provides a description of the sample. The overall sample size of the ten surveys was

983,400 participants 15 years of age and older. Out of those, 520,893 were assessed for MDE.

The missing data were mainly due to the depression module (CIDI-SFMD) being optional in

some surveys.

Pooled crude analysis indicated the existence of the HIE on MDE in Canada (Pooled Crude OR:

0.7; 95% CI: 0.6, 0.7; I^2= 39.4%; χ^2= 14.9; df = 9; p = 0.10; τ^2 = 0.01). However, the results

indicated that age modifies the association between immigration status and MDE (Pooled

$OR_{\text{interaction term}}$: 1.005; 95% CI: 1.001, 1.008; p = 0.02; I^2= 25.7%; χ^2= 12.1; df = 9; p = 0.20; τ^2 <

0.001). Stratified analyses by four categories of age (i.e., 15-29; 30-44; 45-59; 60+ years)

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confirmed the effect modification by age. These stratified analyses suggested that the HIE was

strongest in younger age groups and may not even exist in the older age group (see Figure 3.1),

and the age-specific ORs did not follow a monotonic pattern. This pattern was confirmed by

pooling the survey-specific β-coefficients and standard errors of the cross-product of

immigration status and age[2] in the model (Pooled OR interaction term: 1.001; 95% CI: 1.000, 1.001; p

< 0.001; $I^2 = 22.7\%$; $\chi^2 = 11.6$; $df = 9$; $p = 0.24$; $\tau^2 < 0.001$).

Table 3.1: Sample size, and characteristics of the sample, by overall and included in the study. Based on pooled data set.

	Overall Sample	Included in Study [a]
Respondents 15+ years of Age	983,400	520,893
	Mean / 95% CI	**Mean/ 95% CI**
Age (years)	44.7 (44.7-44.7)	44.1 (44.0-44.1)
	Proportion (%) / 95% CI	**Proportion (%) /95% CI**
Sex		
Male	49.2 (49.2-49.2)	49.2 (49.1-49.2)
Female	50.8 (50.8-50.8)	50.9 (50.8-50.9)
Immigration Status		
Canadian-born	77.4 (77.2-77.6)	80.5 (80.3-80.8)
Immigrant	22.6 (22.5-22.8)	19.5 (19.3-19.7)
Time Since Immigration		
Canadian-born	77.4 (77.2-77.6)	80.5 (80.3-80.8)
0-9 years	6.2 (6.1-6.3)	5.6 (5.4-5.7)
10+ years	16.4 (16.3-16.6)	13.9 (13.7-14.1)
Country of Birth [b]		
Canadian-born	78.4 (78.2-78.5)	81.4 (81.2-81.7)
Developed Country	9.6 (9.5-9.7)	8.8 (8.6-8.9)
Developing Country	12.0 (11.9-12.2)	9.8 (9.6-10.0)

Note: the mean and percentages are weighted and bootstrapped

[a] Respondents who answered the depression module (i.e., CIDI-SFMD; Canadian adaptation of the WMH-CIDI)

[b] A percentage of immigrants were not classified as either from developed or developing country due to their country of birth not being classified by the Human Development Index. This corresponds to approximately 0.7%.

Figure 3.1: Pooled crude odds ratios of past-year major depressive episode (MDE) stratified by age categories. From the two-step meta-analytic approach.
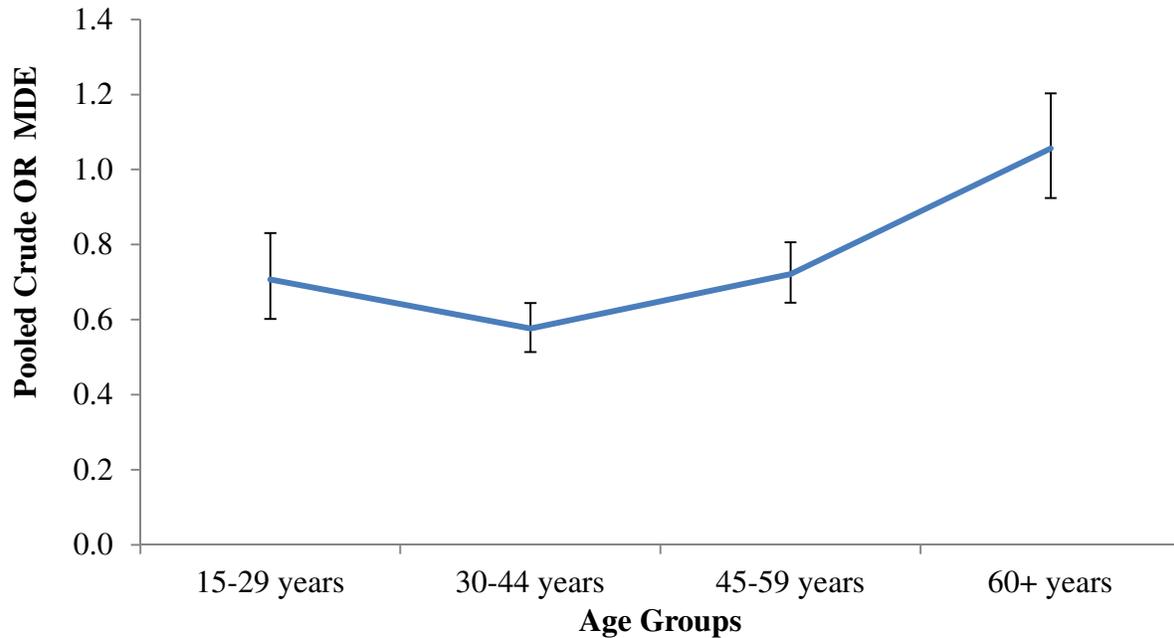
NB: Error bars are 95% confidence intervals from random effects meta-analysis of crude odds ratios of MDE from the 10 surveys.

Using the one-step approach, the prevalence of MDE by age (at 5 year intervals) for Canadian-born and immigrants indicated that between the ages of 15-59 years, immigrants have lower prevalence of MDE than Canadian-born (i.e. the HIE); however, older immigrants seem to have similar or higher prevalence of MDE than Canadian-born (see Figure 3.2). This is consistent with the results of the stratified analysis by age presented above.

A similar pattern of the HIE by age was observed within strata defined by country of birth, time since immigration, and by sex; suggesting the robustness of the effect modification by age found overall (see Appendix for a detailed summary of these results).

Figure 3.2: Prevalence of past-year major depressive episode, presented in 5-year age groups, for Canadian-born and immigrants. From the pooled data set (one-step approach).
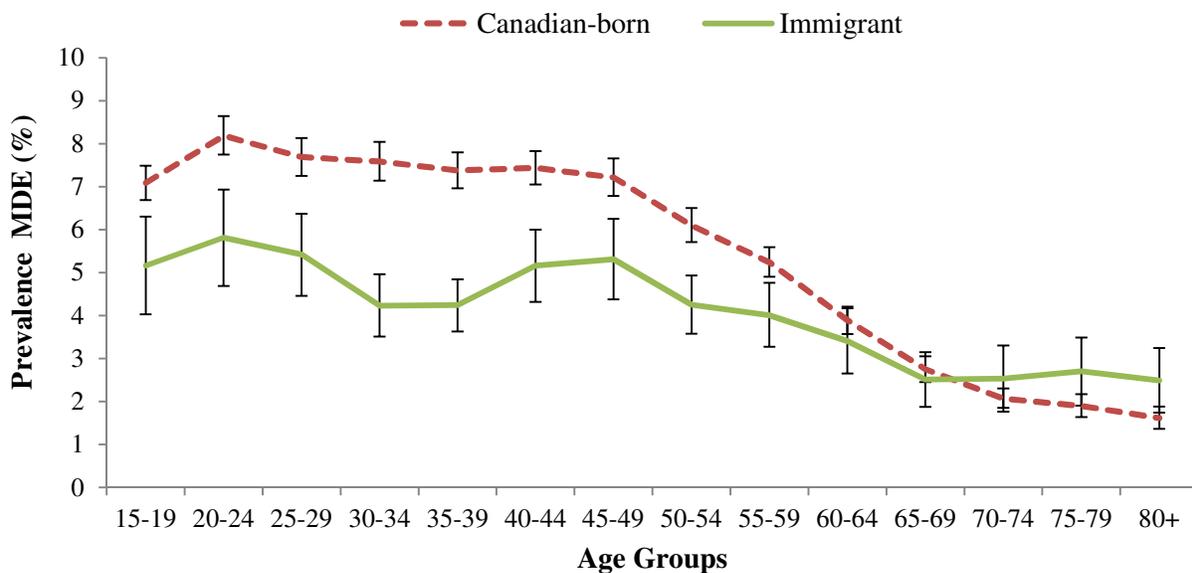
NB: Error bars represent 95% confidence intervals.

3.5 Discussion

We aimed to explore the existence of the HIE on past-year major depressive episode (MDE) in Canada using data representative of the national Canadian population. We found that the HIE varies with age in a non-linear way. This effect modification by age was evident by the differing pattern of prevalence of MDE by age for Canadian-born and immigrants and in ORs that differed by age group. The results suggest that immigrants between 15-59 years of age have lower

prevalence of MDE than their Canadian-born counterparts. However, in older age groups, the pattern of MDE is reversed, suggesting that immigrants may have similar or higher prevalence of MDE than Canadian-born. Further exploratory analysis indicated that the effect modification by age was observed within strata specified by sex, country of birth and time since immigration (see Appendix), indicating the robustness of the modification by age. Overall, the results suggest that older immigrants may be more burdened by MDE than Canadian-born people of similar age.

This is the first study to report that the HIE on MDE in Canada varies with age. Gonzalez et al. (2010), using a representative sample of the US population; and a measurement of depression similar to the one used in our study, found a similar overall pattern of the HIE by age. In addition, studies on depression in older immigrants in the US (Black et al., 1998; Gerst et al., 2010; González et al., 2001; Lum & Vanderaa, 2010; Mui & Kang, 2006; Stokes et al., 2002), Australia (Stanaway et al., 2010), Europe (Aichberger et al., 2010; Ladin & Reinhold, 2013; Lanari & Bussini, 2012), and in specific ethnic groups in Canada (Kim & Chen, 2011; Lai, 2004, 2005; Lai & Surood, 2008), have reported high prevalence of depression in older immigrants compared to older native-born. These results are similar to those found in our study and in Gonzalez et al. (2010) study.

We draw on different conceptual frameworks and on existing literature to find plausible explanations for the variation of the HIE by age observed in this study. First, the two widely accepted reasons in the literature to explain the HIE, i.e., the positive self-selection theory (Jasso et al., 2004) and immigration policies might explain, in part, the existence of the HIE on MDE

between 15 and 59 years of age. The positive self-selection theory implies that the healthier, and wealthier individuals with a drive to succeed in the new environment are the ones who decide to immigrate (Jasso et al., 2004). The decision to immigrate is made based on a cost-benefit analysis where the benefits associated with immigration outperform the risks (Jasso et al., 2004). On the other hand, Canada's immigration policies and medical examination, especially those applied to economic immigrants (the largest immigrant class), favour younger, highly educated, healthier, and with high possibilities to contribute to the Canadian economy (Government of Canada, 2015; Gushulak, 2010). Some of these characteristics have been associated with lower prevalence of depression (Patten et al., 2015).

The literature suggests that the HIE on MDE disappears with time since immigration (Ali, 2002; Cook et al., 2009; Szaflarski et al., 2016; Wu & Schimmele, 2005). However, our results suggest a variation of the HIE by age within time since immigration. This might indicate that factors associated with an individual's particular life course (Elder, 2000); their cost-benefit analysis premigration (Jasso et al., 2004); and their intentions and planning to migrate (Bhugra, 2004) might also play a role in explaining why the HIE is observed in immigrants 15 – 59 years of age despite of immigrants being exposed to inequalities in employment (Desjardins & Cornelson, 2011), income (Desjardins & Cornelson, 2011; Picot et al., 2009), and to other stressors associated with immigration (Beiser, 1999; Bhugra, 2004). We speculate that immigrants in that age group are at a stage of life that are trying to fulfill their goals of education, marriage, work, or raising their families (Elder, 2000), and are concentrating in thriving in their new environment (Bhugra, 2004). Their intentions to succeed, and the benefits that they perceived to be associated

with migration, may foster resilience against the stressors encountered post-migration, leading to lower risk of depression (Bhugra, 2004).

At an older age, Gonzalez et al. (2010) and Gerst et al. (2010), based on theoretical frameworks and with support in the literature, speculated that the socio-economic disadvantages and other stressors faced by immigrants at early age accumulate and may affect their physical and psychological health, increasing their risk for depression. The above explanation may be also plausible within the Canadian context. Some Canadian immigrants are exposed to inequalities in employment and income (Desjardins & Cornelson, 2011), as well as to other post-migration stressors at early ages (Beiser, 1999; Nangia, 2013). It could be that these inequalities in life might have created cumulative stress that impact immigrants' physical and mental health putting them at higher risk for depression than Canadian-born at older age (Ferraro & Shippee, 2009). In addition, inequalities in employment and income at early ages may explain why immigrant seniors, on average, have lower levels of income than Canadian-born (Picot et al., 2009; Turcotte & Schellenberg, 2007). While this is true for immigrants who immigrated to Canada on their working years; it could also apply to immigrants who immigrated later in life in the family reunification category. These immigrants are exposed to low income and dependency for a long period of time (Picot et al., 2009), which may have a cumulative effect on their health. A recent literature review on immigrant seniors' health in Canada suggested that financial situation was the most important factor associated with immigrants' physical and mental illness, including depression (Lai, 2012) .

Besides the above mentioned explanation, patterns of emigration could explain the difference in levels of MDE between immigrants and Canadian-born seniors. Such factor would not be evident in cross-sectional data collected from household populations, as reported here. There is evidence that immigrant seniors tend to emigrate from Canada (Michalowski, 1993). If the self-selection theory is at play, it could be that healthier immigrants are the ones who decide to emigrate, and those who are depressed tend to stay in Canada. This could help explain in part the higher level of MDE found in immigrant seniors compared to Canadian-born. However, more research needs to be done to confirm this, since the evidence of patterns of emigration is from more than two decades ago, and older immigrants' migration patterns might have changed.

We made an attempt to identify some of the most plausible mechanisms behind the effect modification by age found; however, we recognize that the proposed mechanisms might be too simplistic, and might not reflect thoroughly the variation of the HIE with age. Cross-sectional data is not able to distinguish between these possibilities. Since the impact of immigration on health is multifactorial (Beiser, 1999; Bhugra, 2004), more research is needed to clarify this effect.

3.5.1 Strengths and Limitations

The main strength of this study is the use of almost two decades of population health data representative of the Canadian population, which allowed the evaluation of the HIE on MDE in about 520,000 individuals. Also, the meta-analytic techniques used to pool the data constitute another novelty for this study. The two-step approach used in the main analyses allows improved

precision in the estimates while accounting for survey-specific design effects that could influence the results. This study however, has some limitations. First, the cross-sectional nature of it does not allow to determine causation. Even though, this is not a big concern in our study since our goal was not to determine etiology. Second, the variation of the HIE by age presented here may be influenced by cohort and period effects; therefore, the results from this study should be taken with caution. Third, Statistics Canada did not collect data on immigrants classified by their immigration category (i.e., economic immigrants; family class; and refugees). Considering immigrants as a homogeneous group could mask differing patterns of the HIE on MDE. Furthermore, even though this study had a large sample size overall, the sample size in some surveys was too small to allow further stratification by age groups to confirm the existence of the effect modification by age within strata defined by country of birth and by time since immigration. The fact that we considered age as a continuous variable, makes it difficult to interpret the results based on the magnitude and confidence intervals of the interaction term. Therefore, the results from these analyses should be taken with caution. Further limitations are related to the use of two different instruments to measure MDE, and to MDE not being measured in all provinces in all surveys. These could have introduced bias in the estimates. However, we assessed for it using sensitivity analyses and random effects meta-regression, and we found no indication of an effect of those factors.

3.5.2 Conclusions

The results from this study contribute to the knowledge of inequalities in mental health in Canada by providing a different perspective on the HIE on MDE. The results highlight the

importance of assessing for effect modification by age when studying the association between immigration status and MDE. The possible loss of the HIE at advanced age not only raises a red flag for mental health services and programs needed for older immigrants; but also questions about the possible influence of cumulative stressors and disadvantages during the life course that could lead to the deterioration of physical and mental health later in life. Given that the population is aging and immigrants represent approximately 30% percent of the total population of seniors in Canada (Turcotte & Schellenberg, 2007) more research is necessary to understand the factors that predict high risk of MDE on senior immigrants.

3.6 Funding

3.7 Acknowledgements

Chapter Four: Discussion

4.1 Summary of Main Findings

This study was originally conceived to gain a better understanding of possible inequalities in mental health in Canada by exploring at a population level how immigrants differ from Canadian-born in their levels of past-year major depressive episode (MDE). More specifically, exploring the existence of the healthy immigrant effect (HIE) on MDE in Canada; and to determine if the pattern of the HIE on MDE by time since immigration followed a linear or nonlinear trend; whether or not this trend was similar for male and for females, and by country of birth. However, effect measurement modification (EMM) by age was found and this changed the approach to the analysis. The results provide a different perspective on the HIE as it pertains to MDE in Canada, and raise important questions for further research.

In summary, the results support the existence of the HIE on MDE in Canada as previously reported (Akhtar-Danesh & Landeen, 2007; Ali, 2002; Patten et al., 2015; Wu & Schimmele, 2005). However, this effect varies with age in a non-linear way. This replicates previous findings in the US that immigrants' mental health advantage disappears with age (Gonzalez et al., 2010). The pattern of prevalence of MDE by age for Canadian-born and immigrants (see Figure 3.2) resembles the pattern found by Gonzalez et al. (2010) for US-born and US immigrants. Both studies indicated that older immigrants are more burdened by major depression that their non-immigrants counterparts. This later statement is in line with the literature on immigration and depression in the elderly (Aichberger et al., 2010; Black et al., 1998; Gerst et al., 2010; González et al., 2001; Kim & Chen, 2011; Ladin & Reinhold, 2013; Lai, 2004, 2005; Lai & Surood, 2008; Lanari & Bussini, 2012; Lum & Vanderaa, 2010; Mui & Kang, 2006; Oh et al., 2002; Stanaway

et al., 2010; Stokes et al., 2002); and it confirms the conclusion made by the Canadian Task Force on Mental Health Issues Affecting and Refugees (1998) that regarding mental illness, immigrant seniors seem to be a vulnerable population.

To assess the robustness of the EMM by age found, the analyses was repeated within strata defined by sex, country of birth, and time since immigration (see Appendix). Sex is an important risk factor for MDE (Patten et al., 2015); and it has been reported in the general population that the pattern of MDE with sex differs by age (Patten et al., 2016); therefore, I explored if the EMM by age found for the association between immigration status and MDE was also found within strata defined by sex. The results indicated that when compared to their corresponding Canadian-born counterparts, both male and female immigrants' pattern of the HIE on MDE follow a j-shaped curve similar to the one found overall. Similar to what was suggested overall, the HIE on MDE seems to exist only for those between 15 to 59 years of age; and it seems to disappear at older ages (see Appendix). Comparison of these results with extant literature is not possible, since this is the first study to assess variation of the HIE on MDE by age within strata defined by sex. In addition, the existing literature on the HIE on MDE by sex is scarce and inconclusive. In Canada, studies have evaluated primarily how the HIE on MDE for males and females varies by time since immigration (Beiser, 1999); and by time since immigration and income (Smith et al., 2007).

Country of birth seems to be an important factor in the association between immigration status and MDE (Alegria et al., 2008; Ali, 2002; Budhwani et al., 2015; Gonzalez et al., 2010;

Szaflarski et al., 2016); therefore, the analysis was conducted dividing immigrants based on their countries of birth, categorized, for reasons of precision, at two levels: developed; developing. The results indicated the existence of the j-shaped pattern of the HIE on MDE by age in both groups (see Appendix). Again, this has not previously been examined. Low power to detect an EMM by age could explain the lack of reporting of effect modification by age.

Another important aspect that was examined in this study was time since immigration. To improve statistical power, immigrants were classified in two categories based on their time since immigration (i.e., 0-9 years; 10+ years); Canadian-born was considered the referent category in the analyses. The results suggest that the EMM by age observed overall is also observed when immigrants are classified based on their time since immigration (see Appendix). However, the results should be interpreted with caution since this is the first study that examines the pattern of HIE on MDE by age stratified by time since immigration. In addition, small sample size in some of the survey did not allow further stratification by age categories to confirm the existence of the EMM by age. More research is needed to disentangle the possible correlated effects of age and time since immigration.

Taking it all together, the above mentioned results suggest that the EMM by age found seems to be a robust finding and not an artifact of other variables. The results also suggest that compared to older Canadian-born, older immigrants are at higher risk of MDE independent of sex, time since immigration, and country of birth. More research is needed to replicate these findings.

4.1.1 Mechanisms that Might Explain the Effect Measurement Modification by Age

As mentioned in chapter three, existing literature and different theoretical frameworks are helpful for providing plausible explanations for the existence of effect modification. We recognize that multiple interconnected factors might be at play to explain the variation of the HIE on MDE by age, and trying to summarize them in a few mechanisms might result on an oversimplification of the phenomenon.

In summary, one may speculate that the existence of the HIE on MDE between 15-59 years is due to a series of factors that are embedded in the context of the immigration process and may also be related to an individual's specific stage in his/her life course. Immigrants' characteristics pre-migration (Jasso et al., 2004), their goals and motivations to migrate (Bhugra, 2004); paired with Canada's migration process (Citizenship and Immigration Canada, 2012; Gushulak, 2010), and the roles in life that immigrants' want to fulfil at that age (Elder, 2000) could create a "buffer" against all the stressors encountered post-migration (Bhugra, 2004), putting them at lower risk of MDE. At older age, as suggested by Gerst et al. (2010); and by Gonzalez et al. (2010) the effect of the cumulative exposure to unequal economic opportunities (Desjardins & Cornelson, 2011; Picot et al., 2009), and other stressors post-migration (Beiser, 1999; Bhugra, 2004), might contribute to the inequalities in physical and mental health at older age (Ferraro & Shippee, 2009), which can contribute to increase the risk of developing depression in immigrants compared to non-immigrants. In addition, senior immigrants' patterns of emigration (Michalowski, 1993) might help explain in part the high prevalence of MDE observed in older Canadian immigrants compared to older Canadian-born. This is possible specifically if

immigrants who are non-depressed are the ones who emigrate. More research is needed to determine why immigrants lose their mental health advantage at older age.

4.2 Assessment of Study Validity

The assessment of accuracy of a study parameter implies assessing the extent to which the estimated parameter is free from error (Oleckno, 2008). Two types of errors can threaten the accuracy of a study: Systematic error and random error (Oleckno, 2008). In the next sections, I will discuss some possible mechanisms by which this study might have been vulnerable to these types of errors.

4.2.1 Systematic Error

Systematic error is due to flaws in study design, specifically related to the way the sample was determined (i.e., selection bias; Patten, 2015); and the method used to collect information on the variables of interest (i.e. missclassification bias; Patten, 2015). It also refers to whether or not the possible effect modification was assessed; and possible confounding was controlled in the study (Patten, 2015).

4.2.1.1 Selection bias

This study used data from population-based national surveys collected by Statistics Canada, and theoretically, the possibility of selection bias due to sampling strategies used is minimal. The survey-specific sampling weights and bootstrap procedures provided by Statistics Canada are designed to mitigate possible bias resulting from complex sampling design, non-response rates,

out of scope units, unequal selection probabilities due to household composition, etc., making the estimates representative of the target population.

However, one possibility of selection bias occurs by the fact that the CIDI-SFMD was optional content in some surveys and not all provinces applied it. Since the probability of selection affects both Canadian-born and immigrants; and the OR of MDE was the measure of interest in most of the analyses, the possibility of bias due to selection is minimized. Whereas selection bias could affect the odds ratio, it is difficult to see that it would affect the pattern of the OR by age, which is the main effect reported in this study. Random effects meta-regression was used in all the analyses to assess for a possible effect of the CIDI-SFMD not being measured in all provinces in all surveys. The results indicated no effect, which could lead to the conclusion that the pooled estimates are not affected by this possible selection bias.

Another possible source of selection bias in the study is the exclusion of institutionalized individuals. Djernes (2006) found that depression is higher in those who are institutionalized than those in the general population. If a higher percentage of elderly Canadian-born than elder immigrants is living in institutions, this could lead to an overestimation of the OR of MDE. This bias could explain the difference found in levels of MDE between immigrant and Canadian-born seniors in this study. However, in 2006, only 1.4% of seniors in Canada aged 65-74 years, and 12% of seniors 75 years of age and over was living in institutions (Canadian Institute for Health Information, 2011); therefore, the likelihood that this bias accounted for those results is minimal.

In addition, since the target population is household residents, this kind of concern is really an issue of generalizability.

4.2.1.2 Misclassification bias

One possibility of misclassification bias in this study arises as a result of two versions of the CIDI being used to measure MDE in the surveys. Even though, the two versions of the CIDI have similar face validity to symptom criteria A of the DSM-IV and DSM-5, there is evidence that the CIDI-SFMD tends to overestimate the prevalence of MDE compared to the full CIDI; probably due to low specificity (Patten, 1997; Patten et al., 2000). The inability of the CIDI-SFMD to assess the clinical significance of symptoms as they relate to other causes such as chronic physical conditions, medication use, etc., results in a high proportion of false positives (Patten, 1997; Patten et al., 2000). The measurement of the association in this study was the OR. Therefore, the application of the CIDI-SFMD might have misclassified both immigrants and Canadian-born, leading to a non-differential misclassification, and a bias towards the null. If misclassification is greater in more elderly age groups, this could result in a dilution of the odds ratio representing the HIE with increasing age. This however, this cannot explain the pattern reported in this study.

Another possibility of misclassification bias is that the CIDI in general has not been validated in some countries. The CIDI may not be sensitive enough to correctly classify individuals from those countries as having MDE. For example, a study on the validity of the full CIDI in Eastern Africa concluded that the CIDI underestimates the prevalence of depression (Gelaye et al.,

2013). Low sensitivity seems plausible in immigrant groups for whom English may not be their first language. This could lead to a more false negative misclassification and an underestimation in the OR of MDE especially in immigrants from countries that are not similar to Canada and the US. Since the percentage of immigrants from developing countries is increasing, this could lead to lower OR of MDE overall, explaining in part the existence of the healthy immigrant effect on MDE. However, this does not explain the fact that older immigrants have similar or higher levels of MDE than Canadian-born.

4.2.2 Effect Measurement Modification and Confounding

Effect measurement modification (EMM) is present when the effect of an exposure on the outcome variable varies by levels of another variable (Oleckno, 2008). This study assessed for EMM by age, and found that the HIE varies with age in a non-linear way. Since EMM by age was found, controlling for the effect of other variables that could confound the estimate has to be done within strata defined by age. However, adjustment for confounding is more important in analytical studies where assessment of causality is the main goal. This study is exploratory in nature, and had the main goal of describing the pattern of HIE by age, to help generate hypothesis for further research, and to quantify burden of illness in population subgroups. Therefore, controlling for confounding was not deemed critical at this point.

4.2.3 Random Error

Random error refers to the variability of the estimates due to chance (Patten, 2015). It is associated with sample size. When the sample size increases, the precision of the estimates

increases, and the probability of random error decreases (Patten, 2015). Also, increasing sample

size increases power and decreases the probability of type II error (Patten, 2015). In this study,

the possibility of random error was observed in some of the survey-specific estimates. This was

evident by the wide confidence intervals for those estimates. However, after pooling the

estimates using the two step meta-analytic technique, precise estimates were obtained in all of

the analyses. Another possibility of random error exist when stratifying by age; especially for the

category of 60 years of age and older. It could be that the survey-specific sample size for this

category of age is too small and we do not have enough power to detect a difference, indicating

the possibility of type II error. However, the pattern of prevalence of MDE by age for Canadian-

born and immigrants, and the predictied pattern of MDE by age determined using the one-step

approach in which age was treated as a continuous variable provided support for the finding of

EMM by age, and the possibility that older immigrants to be at a similar or higher risk of MDE

than Canadian-born of the same age.

4.3 Strengths and Limitations of the Study

A summary of the strengths and limitations of the study were provided in chapter three (see

section 3.4.1); therefore, there will not be further discussed here.

4.4 Generalizability of the Results

The results of this study could be generalized to the Canadian household residents living in the

ten provinces. The restriction of the sample in this study, as well as the inclusion criteria used by

Statistics Canada in the surveys, means that the results are not generalizable to those living in the

three territories, on First Nation Reserves and settlements, or military personnel, or those residing in institutions. Additional research must be done to determine if the patterns observed here in the household population apply also to those populations.

The fact that a similar pattern of the HIE on MDE by age has been reported in the US (see Gonzalez et al., 2010); and that there is consistent evidence around the world (Aichberger et al., 2010; Black et al., 1998; Gerst et al., 2010; González et al., 2001; Ladin & Reinhold, 2013; Lanari & Bussini, 2012; Lum & Vanderaa, 2010; Mui & Kang, 2006; Oh et al., 2002; Stanaway et al., 2010; Stokes et al., 2002) of high prevalence of depression in senior immigrants compared to non-immigrants of the same age, suggest that the association between immigration status and depression is age dependent in general. Therefore, further studies on immigration and depression in Canada, and in other countries, should assess for effect modification by age.

4.5 Implication of Study Findings

The results from this study have important implications for the understanding of inequalities in mental health in immigrants, which is one of the priorities of the Mental Health Strategy of Canada (Mental Health Commission of Canada, 2009). Based on the findings from this study, it appears that immigrant seniors are a vulnerable population and special attention should be made to reduce their risk of major depression. The belief that immigrants in general have a lower prevalence of major depression than Canadian-born may have concealed a need for mental health services in senior immigrants. Therefore, policy makers should pay particular attention to programs for prevention, diagnosis, and treatment of major depression in this population.

Creating funding opportunities, and encouraging more research on the risk factors of major depression in immigrant seniors will help to further the understanding of their needs for services.

Current research, even though scarce and based on specific groups of immigrants, reveals that immigrants' financial situation is an important factor associated with the decline of both physical and mental health of immigrants at an older age (Lai, 2012). Compared to Canadian-born seniors, immigrant seniors are more likely to report low income (Turcotte & Schellenberg, 2007). This might be the result of inequalities in labour opportunities and wages between immigrants and Canadian-born during their working years (especially for those who immigrated early in their lives; Desjardins & Cornelson, 2011; Picot et al., 2009). In addition, immigrant seniors who come to Canada under the parents and grandparents category face low income and financial dependency for a long period of time as a result of Canadian immigration, and pension policies (Picot et al., 2009; Turcotte & Schellenberg, 2007). Initiatives to improve the recognition of foreign credentials, and the reduction of the income gap between immigrants and Canadian-born might help improve immigrants' retirement income (Picot et al., 2009). Also, reducing the numbers of years in Canada to get access to the old age security (OAS) pension, and the guaranteed income supplement (GIS), could help improve the financial situation of immigrants who come under the parent and grandparents category (Picot et al., 2009).

4.6 Future Directions

The findings from this study reveal important gaps in the literature: 1) Why immigrant seniors seem to be at higher risk of depression than their non-immigrants counterparts is not well

understood; 2) the contribution of patterns of emigration to explain the higher prevalence of depression in immigrant seniors compared to Canadian-born seniors requires further exploration; 3) whether or not the pattern of the HIE by age is the same across all categories of immigration has not been explored; 4) the findings on the existence of the effect modification by age within strata defined by country of birth and by time since immigration requires confirmation.

First, the results from this study, and from Gonzalez et al. (2010) study suggest that older immigrants are at higher risk of MDE than non-immigrants. Research on depression in older immigrants in Europe (Aichberger et al., 2010; Ladin & Reinhold, 2013; Lanari & Bussini, 2012), the US (Black et al., 1998; Gerst et al., 2010; González et al., 2001; Lum & Vanderaa, 2010), and in Australia (Stanaway et al., 2010) provide an insight of some socio-demographic and post-migration related factors that may be contributing to the higher risk of depression in older immigrants compared to their non-immigrants counterparts of the same age. However, the evidence is inconsistent. In Canada, the current evidence is limited to immigrants from China (Lai, 2004), Taiwan (Lai, 2005), Korea (Kim & Chen, 2011), and South Asia (Lai & Surood, 2008), and it might not be possible to generalize these estimates to the other older Canadian immigrant populations. Also, those studies did not include a Canadian-born referent group making it impossible to determine the relative prevalence or risk, let alone to determine whether this changes over time. In addition, there is an indication at the population level that older Canadian-born and older immigrants share some similarities, and differ on some of the social determinants of health that are associated with depression (Turcotte & Schellenberg, 2007); but, it is not possible to determine from that evidence how these similarities/ differences contribute to

the inequalities in MDE at old age suggested in this study. Therefore, further studies are still needed to clarify this.

A population-based prospective cohort study design is needed to better understand the etiology of depression among immigrant seniors and how it compares to Canadian-born seniors. It would also allow determining whether financial stress is an important causal determinant in the association between immigration status and depression at older age. Oversampling immigrants is necessary to gain power. Also, collecting information on immigrants' category of immigration is important to fill existing gaps in the literature. In addition to collecting socio-demographic and health related data; selecting a random sample of immigrant and Canadian-born seniors, from the sample collected, and conducting focus groups would allow gaining more insight on factors that predict/ help reduce the risk of depression in seniors.

Second, to better understand how senior immigrants' pattern of emigration could explain the higher prevalence of MDE in older immigrants compared to non-immigrants, I suggest, if possible, linking administrative data to the data used by Aydemir and Robinson (2006). The authors used two different data sources to determine patterns of return and onward migration in Canada: 1) used data form immigrants' landing records, and the Census; and 2) used data from the landing records and the annual information on tax returns (Aydemir & Robinson, 2006). Both methods yielded similar results regarding the pattern of migration (Aydemir & Robinson, 2006). However, the second set of data allows determination of immigrants' class which is not available in the Census (Aydemir & Robinson, 2006). Linking the data files with administrative health

data, would allow a better understanding of characteristics of senior immigrants who emigrate;
and whether or not they have lower levels of depression than those who stay.

The third, and fourth gaps identified relate to the pattern of the HIE by age. Specifically,
determining whether or not the pattern of the HIE on MDE by age differs by immigration
categories (i.e., economic class, family class, and refugees); and replicating the findings found on
this study stratified by country of birth, sex, and time since immigration. Conducting a
prospective cohort study using a representative sample of the Canadian population will help
clarify the pattern of the HIE by age. Oversampling immigrants is necessary to gain power, and
to allow finer stratification by categories of country of birth and by time since immigration. In
addition, it is important to collect data on immigrants' class, and on factors such as stigma,
coping styles, and resilience. The longitudinal study design will also allow determining which
risk factors are involved in the transition from lower risk of MDE to a high risk compared to
Canadian-born, and when this transition happens.

4.7 Conclusion

This study is the first Canadian study to report that the HIE on MDE disappears with age. The
findings from this study replicate previous findings in the US (Gonzalez et al., 2010) that suggest
that the HIE on MDE varies with age. The fact that this effect was found in both countries
despite of differences in their immigration policies, health care services, and the characteristics
of immigrants, indicates the importance of paying close attention to senior immigrants' mental
health. The reasons why the HIE on MDE disappears with age need to be explored, and policies

and programs need to be implemented to help immigrants maintain their mental health

advantage.

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APPENDIX A: ADDITIONAL RESULTS

Overview of Results Presented in the Appendix

The results in this Appendix correspond to the exploratory analyses conducted to assess the robustness of the variation of the HIE with age. Results are presented within strata defined by country of birth, time since immigration, and by sex. For each of the analyses, the following is provided: 1) Forest plots of pooled analysis of survey-specific age squared interaction terms; 2) the predictive pattern of the HIE by continuous age; and 3) a summary of the coefficients used to determine the predictive pattern of the HIE by continuous age for Figures 3.4, 3.6, and 3.9. For the analyses conducted within strata defined by sex, additional results are presented: Bar graphs for the pooled crude OR of MDE for males and for females, stratified within 2 age groups (see Figure 3.8).

Analysis Stratified by Country of Birth

Forest plots of the interaction term between immigration status and age squared for each

category of country of birth

Figure 3.3: Pooled analysis of survey-specific, and pooled estimate of interaction terms between immigration status and age squared. Immigrants classified as developed (a) and developing country (b).
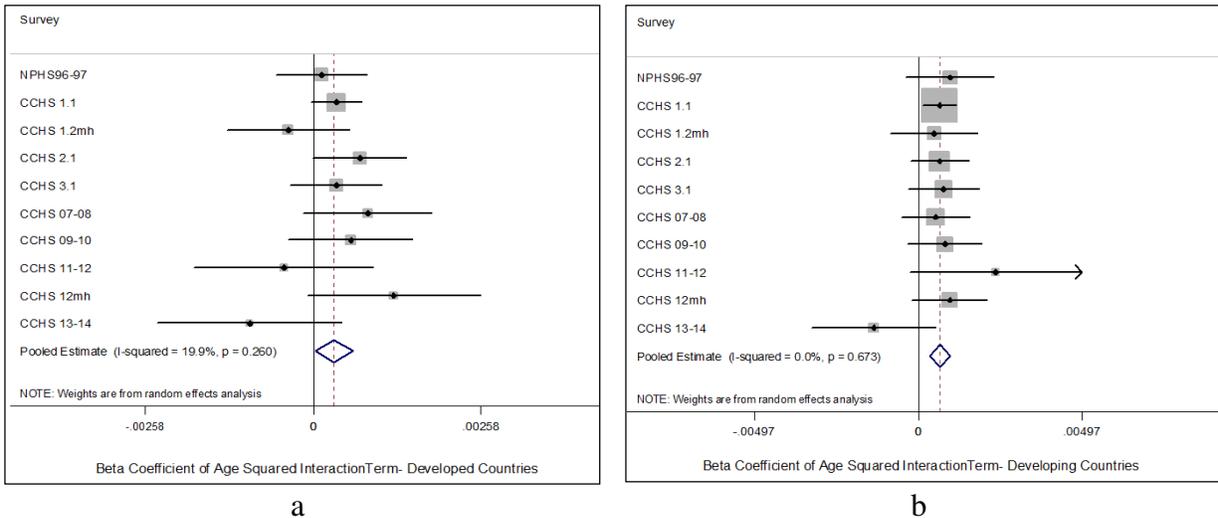
a   b

NB: The black squares are survey-specific coefficients from the model, *error bars* are 95% CIs. The rhombus is the pooled estimate. The width of the rhombus corresponds to the 95% CI of the pooled estimate.

Predictive pattern of the HIE by age stratified by country of birth

Figure 3.4: Predictive pattern of odds ratios (OR) of past-year major depressive episode (MDE) by continuous age; stratified by immigrants' country of birth. Based on the pooled data set.
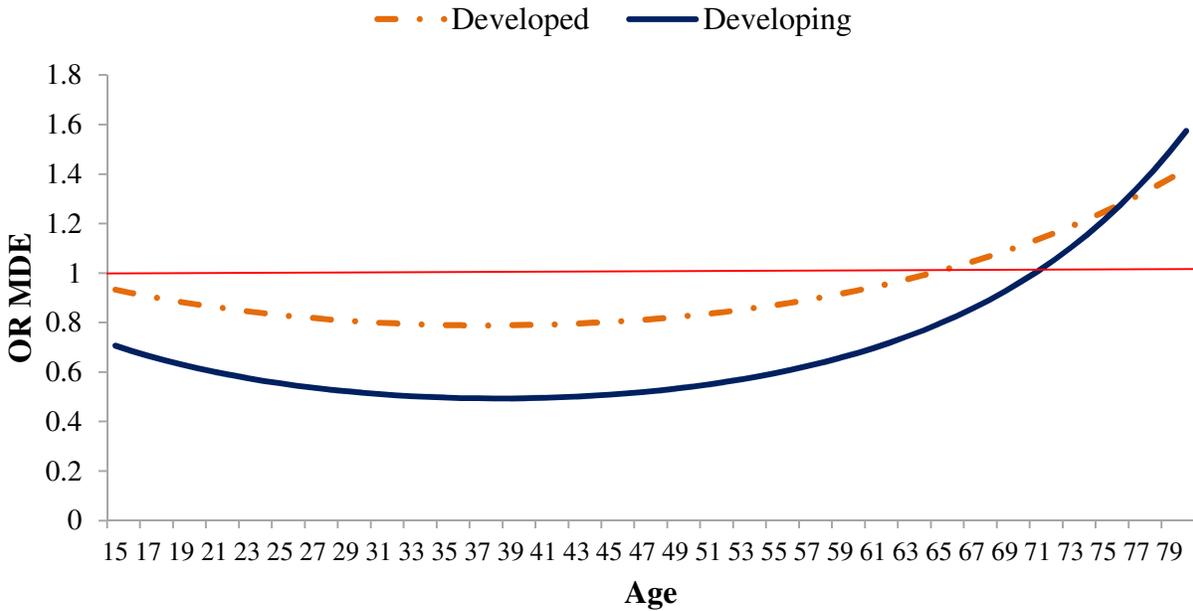
NB: Lines correspond to fitted values from models with age^2 interaction term. The horizontal line represents the null value (i.e., OR=1).

Coefficients used to predict pattern of HIE by age stratified by country of birth

Table 3.2: Coefficients used to predict the pattern of HIE by age stratified by country of birth. Based on the pooled data set.

	Developed Country Coefficient*	Developing Country Coefficient*
Constant (α)	-3.455214	-3.441638
Immigration Status (β₁)		
Canadian-born	Referent	Referent
Immigrant	0.227007	0.265178
Age (Continuous) (β₂)	0.043257	0.043241
Age Squared (continuous) (β₃)	-0.000712	-0.000712
Immigration Status Age Interaction (β₄)	-0.024684	-0.050838
Immigration Status Age Squared Interaction (β₅)	0.000333	0.000665

*Coefficients from the model: Log odds (MDE): $\alpha+\beta_1E+\beta_2Age+\beta_3Age^2+\beta_4E*Age+\beta_5E*Age^2$. E represents the exposure immigration status (i.e., Canadian-born; Immigrant). Immigrants classified based on their country of origin (i.e., Developed; Developing)

Analysis Stratified by Time Since Immigration

Forest plots of the interaction term between immigration status and age squared for each

category of time since immigration

Figure 3.5: Pooled analysis of survey-specific, and pooled estimate of interaction terms between immigration status and age squared. Immigrants classified based on time since immigration (TSI) (a) TSI: 0-9 years; (b) TSI: 10+ years.
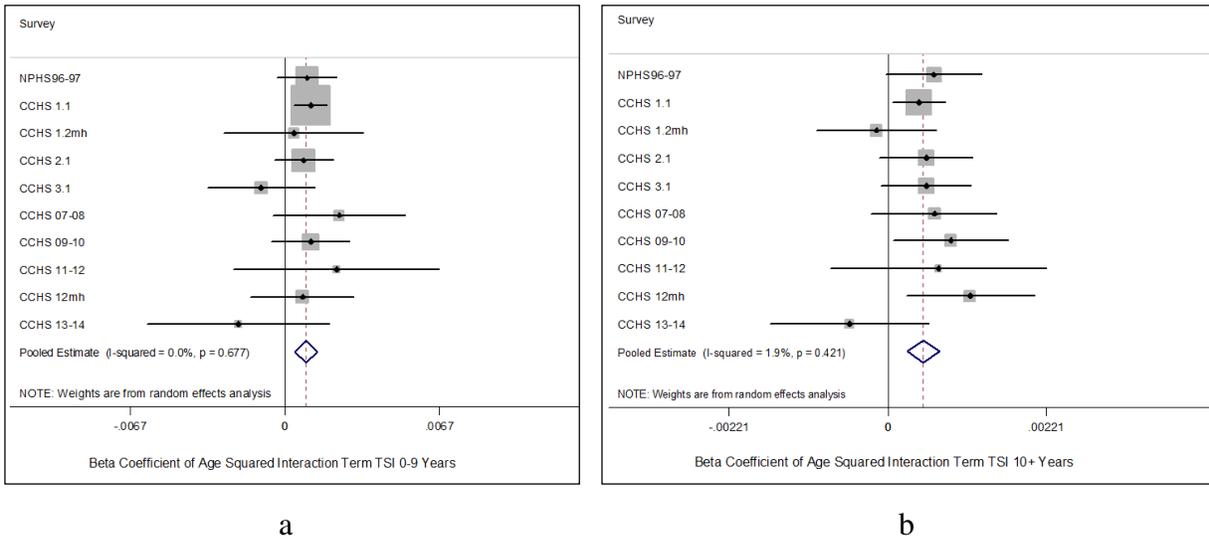
a   b

NB: The black squares are survey-specific coefficients from the model, *error bars* are 95% CIs. The rhombus is the pooled estimate. The width of the rhombus corresponds to the 95% CI of the pooled estimate.

Predictive pattern of the HIE by age stratified by time since immigration

Figure 3.6: Predictive pattern of odds ratios (OR) of past-year major depressive episode (MDE) by continuous age; stratified by time since immigration. Based on the pooled data set.
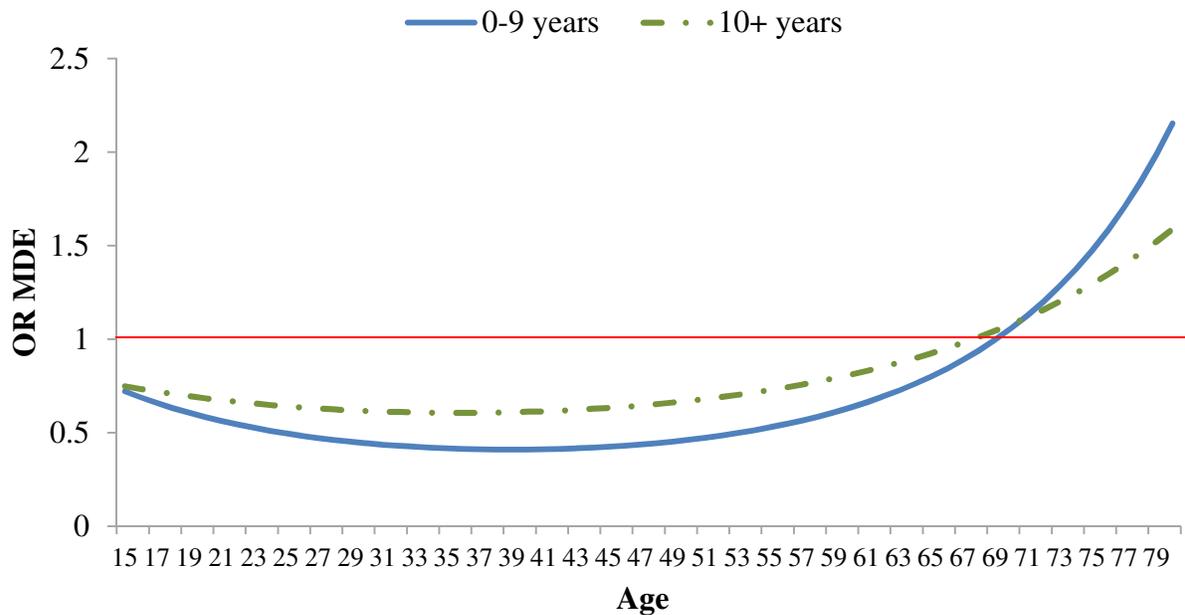
NB: Lines correspond to fitted values from models with age^2 interaction term. The horizontal line represents the null value (i.e., OR=1)

Coefficients used to predict pattern of HIE by age

Table 3.3: Coefficients used to predict the pattern of HIE by age stratified by time since immigration. Based on the pooled data set.

	TSI1: 0-9 years	TSI2:10+ years
	Coefficient*	Coefficient*
Constant (α)	-3.441671	-3.448277
Immigration Status (β1)		
Canadian-born	Referent	Referent
Immigrant	0.586774	0.127050
Age (Continuous) (β2)	0.043236	0.043220
Age Squared (continuous) (β3)	-0.000712	-0.000711
Immigration Status Age Interaction (β4)	-0.075947	-0.035068
Immigration Status Age Squared Interaction (β5)	0.000971	0.000491

*Coefficients from the model: Log odds (MDE): $\alpha+\beta_1 E +\beta_2 Age +\beta_3 Age^2+\beta_4 E*Age+\beta_5 E*Age^2$.
E represents the exposure immigration status (i.e., Canadian-born; Immigrant).
Immigrants classified based on their time since immigration (i.e., TSI1: 0-9 years; TSI2: 10+ years).

Analysis Stratified by Sex

Forest plots of the interaction term between immigration status and age squared for males and
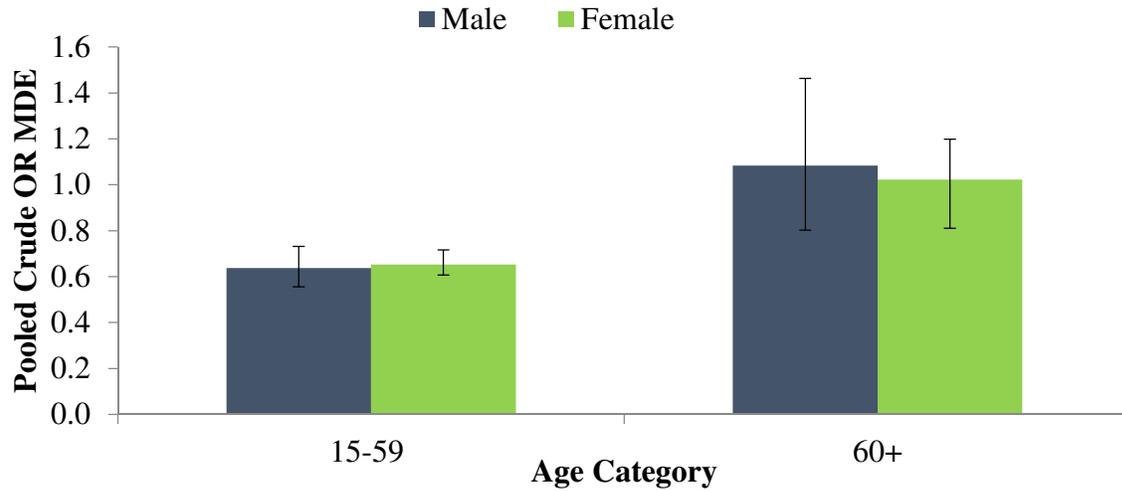
females

Figure 3.7: Pooled analysis of survey-specific, and pooled estimate of interaction terms between immigration status and age squared. Results for (a) males; and (b) females.
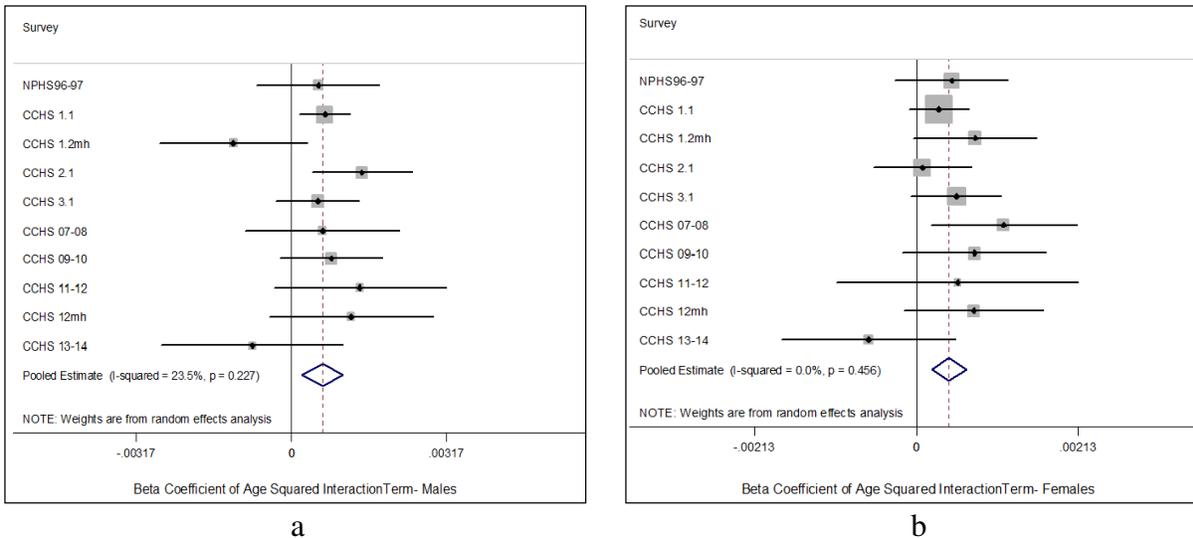
a   b

NB: The black squares are survey-specific coefficients from the model, *error bars* are 95% CIs. The rhombus is the pooled estimate. The width of the rhombus corresponds to the 95% CI of the pooled estimate

*Stratified analysis by age categories for males and females*

Figure 3.8: Pooled crude odd ratios (OR) of past year major depressive episode (MDE) stratified by age categories for males and for females. From the two-step meta-analytic approach.

NB: Canadian-born used as referent category in the analyses. *Error bars* are 95% CIs from random effects meta-analysis of crude OR of MDE from 10 surveys.

Predictive pattern of the HIE by age for males and females

Figure 3.9: Predictive pattern of odds ratios (OR) of past-year major depressive episode (MDE) by continuous age, for males and females. Based on the pooled data set.
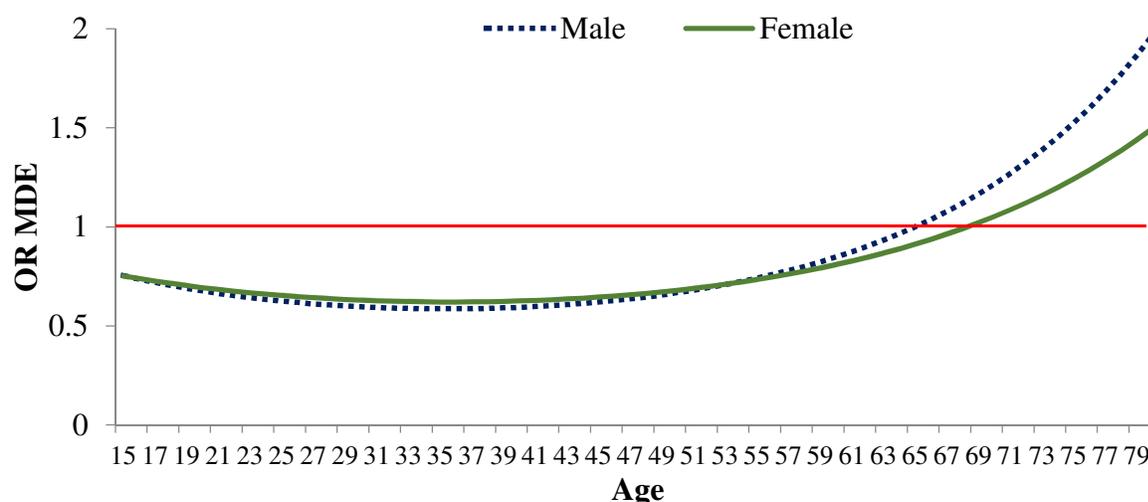
NB: Lines correspond to fitted values from models with age^2 interaction term. The horizontal line represents the null value (i.e., OR=1)

Coefficients used to predict pattern of HIE by age for males and females

Table 3.4: Coefficients used to predict the pattern of HIE by age for males and for females. Based on the pooled data set.

	Males Coefficient*	Females Coefficient*
Constant (α)	-3.752641	-2.672008
Immigration Status (β₁)		
Canadian-born	Referent	Referent
Immigrant	0.226108	0.094902
Age (Continuous) (β₂)	0.057550	0.036991
Age Squared (continuous) (β₃)	-0.000861	-0.000659
Immigration Status Age Interaction (β₄)	-0.042984	-0.032056
Immigration Status Age Squared Interaction (β₅)	0.000608	0.000449

*Coefficients from the model: Log odds (MDE): $\alpha+\beta_1 E +\beta_2 Age +\beta_3 Age^2+\beta_4 E*Age+\beta_5 E*Age^2$.
E represents the exposure immigration status (i.e., Canadian-born; Immigrant)