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Patterns of multimorbidity among immigrants to Canada: an analysis of the CCHS-IMDB

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Abstract

Background: Multimorbidity is a growing public health concern and is associated with reduced quality of life and adverse health outcomes, yet investigation of multimorbidity among the immigrant population is limited in the Canadian context.

Objectives: To assess the prevalence and correlates of multimorbidity among immigrants to Canada 18 years of age or older.

Methods: Data from the 2007 to 2014 Canadian Community Health Survey linked to the Longitudinal Immigration Database were used. Statistical analysis included descriptive statistics and multivariable regressions.

Results: Among immigrants, 3.5% had multimorbidity. Immigration factors such as recency of immigration, birth region, immigration category as well as age, marital status, income, employment, physical activity and smoking status were associated with multimorbidity.

Conclusion: Immigration related factors are important considerations when studying multimorbidity among immigrants. Although significant correlates were identified, additional research is required to better understand the nature of the relationship between these factors and multimorbidity.

Keywords

Summary for Lay Audience

Multimorbidity occurs when an individual has two or more chronic health conditions. These conditions can include cancer, diabetes, cardiovascular diseases, chronic respiratory diseases and mood and/or anxiety disorders. The negative impacts of multimorbidity include, but are not limited to impaired quality of life, increased disability and adverse health outcomes.

Over 20% of Canada's current population consists of immigrants. International migration accounts for over 80% of Canada's population growth, with this number predicted to grow, and by the early 2030s Canadian population growth is predicted to rely exclusively on immigration.

Despite the growing public health concerns of multimorbidity, there has been little research of co-occurring chronic conditions among the Canadian immigrant population. To address this gap in the literature this study aimed to assess the proportion of immigrants with multimorbidity and assess the relationship between multimorbidity and immigration factors, sociodemographic factors and health related behaviours among immigrants 18 years of age or older.

Using data from the 2007 to 2014 cycles of the Canadian Community Health Survey linked to the Longitudinal Immigration Database, this study found that 3.5% of immigrants had multimorbidity. Recency of immigration, birth region, immigration category, older age, employment status, marital status, income, physical activity and smoking status were associated with multimorbidity.

These findings indicate that immigration related factors are important considerations when investigating multimorbidity among immigrants and can inform public health initiatives aimed at prevention and care of chronic health conditions.

Co-Authorship Statement

Chapter 2 of this thesis is an integrated article, which will be submitted for publication to a peer-reviewed journal. The co-authorship details for the article are presented below.

Chapter 2: Lalva, T., Nicholson, K., Stranges, S., & Wilk, P. Prevalence and risk factors for multimorbidity among migrants to Canada: a scoping review. Prepared for submission to an academic journal.

The study design, data extraction, analysis and interpretation of data and writing the first and subsequent drafts was conducted by Tasneem Lalva with support from Drs. Kathryn Nicholson, Saverio Stranges and Piotr Wilk. All authors provided intellectual content, reviewed, edited, and amended the manuscript

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Chapter 1

1   Introduction

1.1   Multimorbidity

Chronic diseases such as diabetes, cancer, cardiovascular diseases and respiratory diseases are on the rise in Canada and across the globe (PHAC, 2021; WHO, 2016). Multimorbidity is commonly defined as the co-existence of two or more chronic health conditions in an individual and is a growing public health concern (Johnston et al., 2019). In addition to placing strain on the healthcare system, individuals burdened with multimorbidity are at an increased risk of disability, impaired quality of life, poor quality of care, polypharmacy, adverse health outcomes and premature death (Calderón-Larrañaga et al., 2012; Nguyen et al., 2019; PHAC, 2020; WHO, 2016). It is estimated that 8.9% of the Canadian population suffer from multiple chronic conditions (Varin et al., 2019), with this number increasing to 36% among those aged 65 years or older (PHAC, 2020).

1.2   Health of immigrants in Canada

Immigrants represent over 20% of the Canadian population (Statistics Canada, 2022). This number is expected to increase, as by the early 2030s, Canadian population growth will rely exclusively on immigration (Immigration Refugees and Citizenship Canada [IRCC], 2021). Currently, international migration accounts for over 80% of Canada's population growth, and in 2019 alone, 341,180 permanent residents were admitted to Canada and 30,087 refugees were resettled, the highest number of any state worldwide (IRCC, 2020).

Many studies have reported a "healthy immigrant effect" where immigrants tend to enjoy a health advantage compared to the native-born population; however, with increased length of stay in their new country, the health status of the immigrants tends to align with levels observed in the native-born population (Gushlak et al., 2011; Kennedy et al., 2015; Lu & Ng, 2019; Markides & Rote, 2019; Vang et al., 2015). This deterioration in health

is suggested to be a consequence of the stress of acculturation to the new country and the adoption of health and lifestyle behaviours of the host country (Markides et al., 2019; Vang et al., 2015). The initial health advantage among immigrants is a result of various factors. Firstly, immigration is often a result of positive self-selection, where healthier individuals are more likely to migrate. Secondly, the Canadian immigration points system favours individuals with higher human capital such as post-secondary education and language skills for economic applicants. Thirdly, Canadian immigration legislation requires all permanent residents to undergo medical screening which determines admissibility into the country (Gushlak et al., 2011; Vang et al., 2015).

However, because of the heterogeneous nature of the migrant population to Canada, there are some pronounced health differences in this population. Heterogeneity in place of birth and reason for migration contribute to disparities in access to care and the presentation of health conditions in this population. Such disparities have implications for preventative care and health services (Gushlak et al., 2011; Lu & Ng, 2019; Vang et al., 2015).

Despite multimorbidity being a growing public health concern, there has been considerably little research of this topic among the immigrant population. In Canada, only one multimorbidity study has considered heterogeneity of the immigrant population related to place of origin and reason for migration (Rouhani, 2021). To our knowledge, our study is the first study which has examined the association of immigration factors, sociodemographic factors and health related behaviours with multimorbidity among immigrants in Canada.

1.3 Study objectives

This study intended to examine if immigration related factors are associated with multimorbidity among the adult immigrant population in Canada using cross-sectional data from the 2007 to 2014 cycles of the Canadian Community Health Survey (CCHS) linked retrospectively to the Longitudinal Immigration Database (IMDB). The specific objectives of this thesis were:

1) To assess the prevalence of multimorbidity among categories of immigrants (economic class, family class, refugees) to Canada.

2) To identify immigration factors, sociodemographic factors and health behaviours associated with multimorbidity among immigrants and to assess whether or not the effects of these risk factors depend on immigration recency.

1.4   Thesis overview

This thesis is presented in five chapters. Chapter 1 presents a brief overview of the present study. Chapter 2 provides a literature review on multimorbidity among immigrants to Canada. Chapter 3 provides the methodology used in this study. Chapter 4 reports the results of this study and Chapter 5 presents the implications and conclusions that can be derived from the findings.

Chapter 2

2 Prevalence and risk factors for multimorbidity among migrants to Canada: a scoping review

2.1 Abstract

Background: Multimorbidity, the presence of two or more co-occurring chronic conditions, is a growing clinical and public health concern. It has been associated with poorer quality of life, increased disability and mortality for patients, and increased health service use and costs. Little is known about how multimorbidity impacts the foreign-born population in Canada. This scoping review summarizes the available literature on prevalence and risk factors of multimorbidity in Canada and identifies gaps in the knowledge base. **Methods:** A search of articles was conducted in EMBASE, Medline, PsychINFO, Web of Science, and ProQuest Theses and Dissertation databases. Reference lists of included articles were examined for relevant studies. Articles pertaining to multimorbidity (two or more chronic health conditions) in the adult foreign-born population in Canada were retained. **Results:** Seven studies met the inclusion criteria. Each study used different definitions of multimorbidity in terms of the types and the numbers of chronic conditions included, which ranged from nine to twenty-four. The composition of the foreign-born population also varied across included studies. Migrants had a lower prevalence of multimorbidity compared to the native-born population, and immigrants residing in Canada for more than 10 years had a greater prevalence compared to more recent immigrants. Refugee status, birth region, older age, female sex, lower income and being single were associated with an increased risk of multimorbidity. Gaps in current knowledge include inconsistent operational definitions of multimorbidity, reliance on cross-sectional data, small sample sizes of immigrant population and focus on individual determinants of health. **Conclusions:** There is a lack of research on multimorbidity in the adult foreign-born population in Canada. Further research is needed using longitudinal designs and larger sample sizes. Additionally, the role of migrant characteristics and social determinants of health should be explored.

Keywords: immigration, migrants, multimorbidity, multiple chronic conditions

2.2   Introduction

Multimorbidity is the co-occurrence of multiple chronic conditions within the same individual (van den Akker et al., 1998). It has quickly become a growing clinical and public health concern as the Canadian population ages and the prevalence of chronic conditions such as type II diabetes and hypertension continue to rise (Feely et al., 2017; Pefoyo et al., 2015; van den Akker et al., 2001). Among a sample of middle-aged and older adults in Canada (n=30,011), it was estimated that approximately 30% had multimorbidity when using the list of nine chronic conditions from the public health definition of multimorbidity, while this estimate rose to approximately 70% when using the list of 17 chronic conditions from the primary care definition of multimorbidity (Nicholson et al., 2020).

Multimorbidity is a significant driver of healthcare usage and costs, which increases dramatically with the number of conditions present in an individual (Griffith et al., 2019). Living with multiple chronic conditions has been associated with poorer quality of life, increased disability, and mortality (Barnett et al., 2012; Boyd & Fortin, 2010; Canadian Institute for Health Information, 2011; Fortin et al., 2006; Wolff et al., 2002). Multimorbidity has also been associated with certain social determinants of health including sex, age and socioeconomic status (Academy of Medical Sciences, 2018; Barnett et al., 2012; Roberts et al., 2015). Additionally, a lack of clear guidelines on managing patients with multimorbidity complicates providing appropriate care as health systems generally tend to utilize a single disease approach (Guthrie et al., 2012; Muth & Glasziou, 2015; Sinnige et al., 2015). Owing to these negative consequences, multimorbidity research has received considerable attention and has become a growing priority (Academy of Medical Sciences, 2018).

International migration accounts for over 80% of Canada's population growth (Immigration, Refugees and Citizenship Canada, 2020). Over six million immigrants have been admitted into the country since 1990 with the majority immigrating from countries such as India, China, Philippines, Pakistan and the USA (Gushulak et al., 2011; Immigration, Refugees and Citizenship Canada, 2020). In 2019, Canada accepted over 341,180 permanent residents, the largest number in recent history and resettled 30,807

refugees, the highest number of any state worldwide (Immigration, Refugees and Citizenship Canada, 2020). It is expected that Canada's population growth will rely exclusively on immigration by the early 2030s (El-Assal & Fields, 2018; IRCC, 2021). This trend of immigration-based population growth makes it increasingly important to prioritize migrant health.

Although the available literature posits that at the time of their arrival immigrants, in general, tend to be healthier than the Canadian born population, this effect tends to diminish overtime. This phenomenon is known as the healthy immigrant effect (Vang et al., 2017). Studies have found this effect to be consistent with multimorbidity, where the risk of multiple chronic conditions among immigrants increases with duration of stay in the new country (Diaz et al., 2015; Gimeno-Feliu, 2017; Jatrana, 2014; Huh, 2008). Despite this, there has been a lack of investigation on the prevalence and underlying risk factors of multiple chronic conditions among migrants to Canada. To our knowledge, there are currently no scoping or systematic reviews that could assist in understanding the extent of the burden of multimorbidity among immigrants. The objective of this scoping review was to identify and summarize health research pertaining to multimorbidity among the migrant population in Canada. Specifically, this review explored the prevalence and risk factors of multimorbidity among adult migrants to Canada and identified the gaps in multimorbidity research among migrants to Canada. This study focused on the Canadian context as migration related policies and programs vary from country to country, contributing to significant variations in migrant population characteristics (Sweetman, 2017; United Nations, 2017).

2.3 Methods

2.3.1 Study design

The scoping review method was selected as it matches the main objectives of the study, which are to provide an overview of the available literature and to identify any knowledge gaps regarding multimorbidity research among migrants to Canada. The review was conducted according to the standardized methods outlined by the Joanna Briggs Institute Methods Manual for scoping reviews (Peters et al., 2020). To increase

the transparency of the search process, the objectives, selection criteria, and methods were specified in a protocol registered with the Open Science Framework (Lalva, 2020).

2.3.2   Search strategy

The search strategy was developed in consultation with a librarian to identify relevant databases and keywords to describe the population, setting, exposure and outcomes of interest. The literature was searched using the following electronic databases: EMBASE, Medline (Ovid) and PsychInfo. The grey literature was searched using Web of Science and the ProQuest Thesis and Dissertation database. Search terms included variants of three topics: multimorbidity (e.g., comorbidity, multiple chronic conditions); immigration (e.g., migrants, refugees, transients); and Canada, which were combined to comprise the search strategy.

2.3.3   Eligibility criteria

The citation manager Mendeley was used for records management, including the removal of duplicates. During the first level of screening, all titles and abstracts were evaluated by the reviewer (TL). Any papers which focused exclusively on children under the age of 18 years and second-generation immigrants were removed, as well as studies that did not involve immigrants to Canada. The studies that examined the health status of immigrants or the healthy immigrant effect were retained in the case that multimorbidity was analysed. During the second level of screening, full text articles were evaluated for inclusion by the reviewer (TL). At this stage, studies that did not analyze at least two or more chronic conditions were removed. No other restrictions such as type of publication, time period, or language were placed on the selection criteria.

2.3.4   Data extraction

Data were extracted into an Excel spreadsheet, which was created *a priori*. The form was pilot tested then used by the reviewer (TL) to extract descriptive and quantitative data relevant to the objectives of the scoping review. The extracted elements included: study characteristics (e.g., study design, objectives, target population, comparison groups); population characteristics (e.g., inclusion criteria, sample size); exposure characteristics

(e.g., time since migration, reason for emigration); outcome characteristics (e.g., definition of multimorbidity used); key findings relating to the review, such as multimorbidity prevalence and risk factors, as well as gaps in research (e.g., directions for future research).

2.4 Results

A comprehensive search was performed in October 2021 and retrieved 3764 studies. After removing duplicate studies, the remaining 2028 studies underwent level one title and abstract screening. A total of 1907 studies were removed based on the exclusion criteria outlined above. The remaining 121 studies underwent level two full text screening, after which six studies were included in the review. Backwards citation tracing of the selected studies led to the inclusion of one additional study not previously identified through the electronic databases. In total, seven studies were included for data extraction. All steps of the search, screening, and extraction were performed by one team member (TL). An overview of the scoping review process is illustrated in the Preferred Reporting Items for Systematic Review and Meta Analysis - Scoping Review extension (PRISMA-Scr) flow diagram (Figure 2.1). The characteristics of the included studies are summarized in Table 2.1.

Figure 2.1 PRISMA diagram of study identification and selection for scoping review
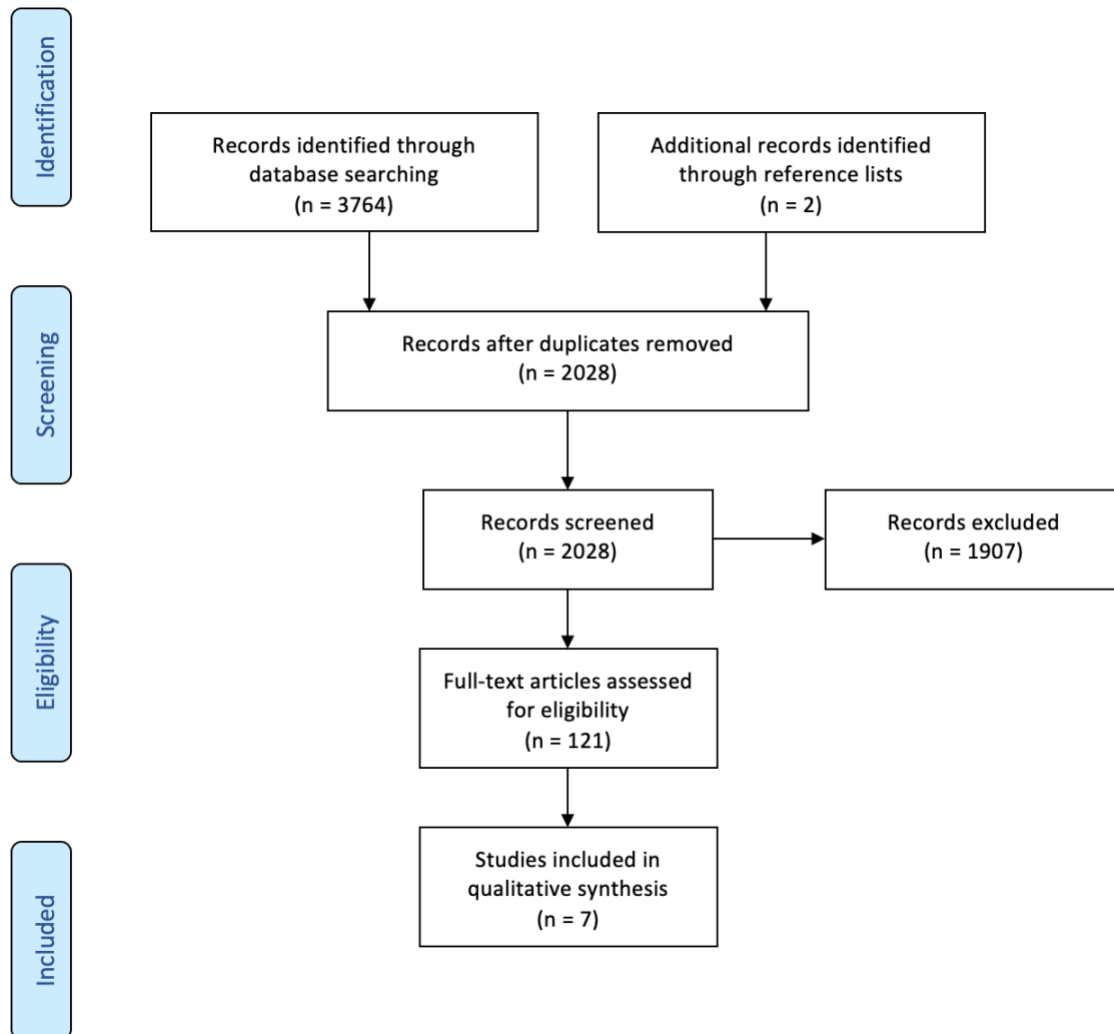
Table 2.1 Summary of included studies (n=7)

Study	Setting	Study Design	Observational Period	Source of Sample	Total Sample Size (# immigrants)	Number of Males (%)	Population	Comparison Group	Multimorbidity Data Presentation	Multimorbidity Definition: Number of Conditions Included	Ethnicities Reported	Time since Migration
Chiu et al., 2009	Toronto, ON	Cross-sectional	2004 to 2005	Survey of Homeless individuals	1189 (377)	642 (54%)	Homeless individuals	Canadian-born homeless	2 conditions, 3+ conditions	Count of chronic conditions from a list of 9	White, Black, First Nations, Others	>10 years, ≤ 10 years
Davison et al., 2020	Canada	Cross-sectional	2010 to 2015	CLSA	26991 (4733)	13300 (49.9%)	Respondents aged 45 to 85 years old	Canadian-born	2 conditions, 3 conditions	NR	Not described	NR
De Maio, 2010	Canada	Systematic review	1990 to 2010				Immigrants					
Lai et al., 2007	Major Canadian cities	Cross-sectional	2001 to 2002	Health and Well-Being of Chinese in Canada Survey	2272 (2236)	1004 (44.2%)	Ethnic Chinese aged 55 years and older		Mean number of chronic conditions	List of 24 health problems (conditions not described)	Chinese	Mean: 19.0 years
Qureshi et al., 2021	Ontario, Canada	Retrospective cohort	2007 to 2010	LTC waitlist	56031 (1694)	18878 (34.7%)	Ontario residents aged 65 or older	Longstanding resident (Canadian born/citizenship before 1985)	Count of chronic conditions	Count of 17 chronic conditions	NR	NR
Rouhani, 2021	Ontario, Canada	Retrospective cohort	1995 to 2016	Various linked databases	2312244 (1156122)	NR	Ontario residents aged 18 to 70	Longstanding resident (Canadian born/citizenship before 1985)	2 + conditions, 3+ conditions	Count of chronic conditions from a list of 9	World Area of Origin	NR
Sun et al., 2009	Canada	Cross-sectional	2003	CCHS	134072 (17287)	71192 (50.3%)	Respondents to CCHS	Native residents, recent/non-recent immigrants	3 to 5 diseases, 5+ diseases	Count of 18 chronic conditions	Asian and other	>10 years, ≤ 10 years

Abbreviations:
CCHS= Canadian Community Health Survey
CLSA= Canadian Longitudinal Study on Ageing
LTC= Long-term care
NPHS= National Population Health Survey
NR= Not reported
SD= standard deviation

2.4.1 Study characteristics

Seven articles were included in the review. The observational periods ranged from 1995 to 2016, with the majority of the studies using data from the early 2000's (Chiu et al., 2009; Lai et al., 2007; Qureshi et al., 2021. Sun et al., 2009). The studies were conducted at the national level (n=3) (Davison et al., 2020; DeMaio, 2010; Sun et al., 2009), at the provincial level (n=2) (Qureshi et al., 2021; Rouhani, 2021), in major metropolitan areas (n=1) (Lai et al., 2007), and in the city of Toronto, Ontario (n=1) (Chiu et al., 2009). Most studies undertook a cross-sectional design (n=4) (Chiu et al., 2009; Davison et al., 2020; Lai et al., 2007; Sun et al., 2009), while the others used retrospective cohort design (n=2) (Qureshi et al., 2021; Rouhani, 2021), and a systematic review (De Maio, 2010). The sources of data included the Canadian Community Health Survey (CCHS) (n=1) (Sun et al., 2009), the Health and Well-Being of Chinese in Canada (n=1) (Lai et al., 2007), database of Ontario residents on the long-term care (LTC) waitlist (n=1) (Qureshi et al., 2021), linked immigration and health databases (n=1) (Rouhani, 2021) and a survey conducted in homeless shelters and meal programmes (n=1) (Chiu et al., 2009). Only one study was designed with the primary objective of evaluating multimorbidity among migrants (Rouhani, 2021).

2.4.2 Study population

The target populations varied across the studies. Populations included the homeless (Chiu et al., 2009), ethnic Chinese immigrants (Lai et al., 2007), Ontario residents (Rouhani, 2021), Ontario residents placed on the LTC waitlist (Qureshi et al., 2021) and the general Canadian population (Davison et al., 2020; Sun et al., 2009). Age related inclusion criteria also varied across the studies, which included respondents aged 45 to 85 years old (Davison et al., 2020), 55 years and older (Lai et al., 2007), 65 years and older (Qureshi et al., 2020), 18 to 70 years old (Rouhani, 2021) and respondents aged 12 years and older (Sun et al., 2009). In three studies, the reference group used to compare the health of immigrants was the Canadian-born population (Chiu et al., 2009; Davison et al., 2020; Sun et al., 2009). Sun et al. (2009) considered a comparison between recent and non-recent immigrants (living in Canada for more than 10 years) Rouhani (2021) compared

refugees, family and economic class immigrants to longstanding residents (landed before 1985 or born in Canada) and Qureshi et al. (2021) compared recent immigrants (granted permanent residency or citizenship between 1985 and 2010) to long-standing residents (landed before 1985 or were born in Canada). The ethnicities examined by Chiu et al. (2009) included Whites, Blacks, First Nations, and a broad "other" category, while Lai et al. (2007) reported on ethnic Chinese respondents from various countries. A study conducted by Sun et al., (2009) focused on Asian immigrants, but did not specify any ethnicities. Rouhani (2021) examined the role of region of origin which was categorized into eight major regions. Time since migration was reported as the number of years of residence in Canada (Lai et al., 2007) or dichotomized as greater or less than 10 years of residence (Davison et al., 2020; Sun et al., 2009).

2.4.3   Defining multimorbidity

According to the systematic review conducted by De Maio (2010), most of the studies included in the review dichotomized the assessment of chronic conditions (i.e., present or not present), while some studies examined key chronic conditions such as asthma and diabetes separately (De Maio, 2010). In the current review, among the studies that did consider the number of conditions, a wide range of categorizations were used to identify individuals living with multimorbidity. Chiu et al. (2009), Davison et al. (2020) and Rouhani (2021) grouped individuals as either having two conditions or three or more conditions. Sun et al. (2009) grouped individuals as either reporting three to five conditions or reporting five or more conditions. In one study, a mean value for the number of chronic diseases was presented for individuals reporting at least one chronic condition (Lai et al., 2007). In another study, a count of chronic conditions was presented for up to five conditions (Qureshi et al., 2021).

Among the five studies that included their definition of multimorbidity, the number of potential conditions included in the definition ranged from nine to 24 conditions (Chiu et al., 2009; Lai et al., 2007; Qureshi et al., 2021; Rouhani, 2021; Sun et al., 2009). Of the four studies listing the specific conditions used in their definition, the common conditions listed were arthritis, hypertension, diabetes, and heart disease (Chiu et al., 2009; Qureshi

et al., 2020; Rouhani, 2021; Sun et al., 2009). Only two of the three studies considered mental health in the definition of multimorbidity (Qureshi et al., 2021; Sun et al., 2009).

2.4.4 Prevalence and correlates of multimorbidity

Among the included studies, prevalence of multimorbidity among migrants ranged from 3.6% to 36.5%. When comparing nativity, a study that examined immigration status in relation to multimorbidity found that in a sample of respondents aged 45 to 85 years old, foreign-born individuals had a slightly lower prevalence of two (21.7% vs 22.7%) and three co-occurring morbidities (26.3% vs 28.1%) compared to Canadian-born individuals (Davison et al., 2020). Another study found that after age standardization, Asian immigrants had a lower rate of more than five chronic conditions (3.6% vs. 5.3%) compared to non-immigrants, but no significant difference for three to five conditions (Sun et al., 2009). One study of Ontario residents 18 years or older investigated prevalence by immigration category and found greater prevalence of two or more conditions among refugees (8.4%) and family class immigrants (8.1%) compared to long-term residents (6.8%), while economic class immigrants (5.4%) were found to have lower prevalence compared to long-term residents (Rouhani, 2021).

Prevalence by length of residency was analyzed in three of the included studies (Chiu et al., 2009; Lai et al., 2007; Sun et al., 2009). Two of these studies found that recent immigrants had a lower prevalence of multiple chronic conditions compared to non-recent immigrants residing in Canada for more than 10 years (Chiu et al., 2009; Sun et al., 2009). A study of Ontario residents aged 65 and older on the LTC waitlist found that recent immigrants, granted residency or citizenship after 1985, had a lower prevalence of four (18.5% vs 20.0%) and more than five chronic conditions (36.5% vs 41.6%), but a greater prevalence of two (15.9% vs 13.0%) and three conditions (20.3% vs 18.8%), compared to longstanding residents (Qureshi et al., 2021).

Two primary research studies investigated a limited number of sociodemographic factors (e.g., immigration category, birth region, age, sex) associated with multimorbidity (Lai et al., 2007; Rouhani, 2021). One Ontario study investigating the risk of multimorbidity by immigration categories found that after adjusting for age, sex and income, refugees had

the greatest risk of developing two or more chronic conditions compared to long-term residents. Further investigation by birth region revealed that, compared to longstanding residents, Caribbean and South Asian immigrants had greater risks of multimorbidity, while East Asian and the Pacific, Eastern European and Central Asian immigrants had lower risks, across all immigration categories (i.e., refugee, family and economic class). The risk of developing three or more conditions was greater among refugees from North Africa and the Middle East and refugees and family class immigrants from South Asia, compared to long-term residents (Rouhani, 2021). A study of Chinese immigrants examined cultural factors and found that older age, being female, originating from Hong Kong, Taiwan, practicing a religion, and adhering to Chinese health beliefs were associated with increased risk of chronic conditions, while being married, having greater financial adequacy, and greater monthly income were considered as protective factors (Lai et al., 2007).

2.5 Discussion

This scoping review found that foreign-born adult immigrants tend to have a lower prevalence of multimorbidity when compared to the Canadian-born population (Davison et al., 2020; Sun et al., 2009). However, when examining migrants by immigration category, this pattern was not observed for refugees and family class immigrants (Rouhani, 2021). In terms of immigration recency, non-recent immigrants were found to have a greater prevalence of multimorbidity compared to recent immigrants (Chiu et al, 2009; Sun et al., 2009).

Overall, these findings seem to corroborate the "healthy immigrant effect", a phenomenon where immigrants are generally healthier than the native-born population upon arrival to their new country (Chen et al., 1996; Kennedy et al., 2006; Lu & Ng, 2019). This occurrence is possibly related to rigorous immigration policies, where healthier individuals tend to immigrate to Canada (Gushlak & Williams, 2004; Lu et al., 2017). However, with increasing length of stay, the health of migrants begins to deteriorate (Chiu et al. 2009, Newbold 2006; Sun 2009). This is consistent with findings from studies of migrants outside of Canada which indicated a greater burden of

multimorbidity among those who resided in the host country for more than five years (Gimeno-Feliu et al., 2017; Gimeno-Feliu et al., 2020).

It has been suggested that deteriorating migrant health may be a consequence of the stress of acculturation, where discrimination and inequality drive negative health transitions (De Maio & Kemp, 2010). Another explanation is an increase in the utilization of health care services with increasing duration of residency, which can subsequently result in greater likelihood of detection and diagnosis of existent health conditions (Newbold 2005; Setia et al., 2011).

Although overall, immigrants were found to be healthier than the Canadian-born population, refugees and family class immigrants did not experience this advantage (Rouhani, 2021). This observation may be a consequence of Canada's rigorous immigration policies for economic immigrants, which gives preference to applicants with greater human capital. Refugees are often faced with economic deprivation, which may exacerbate negative health outcomes (Gushlak et al., 2011). Although multimorbidity research of immigration categories is limited, one Norwegian study has found that among immigration categories, refugees had the greatest risk of multimorbidity, followed by family reunification immigrants (Diaz et al., 2015). One Danish study reported higher risks of multimorbidity for refugees, but a lower risk for family reunification immigrants compared to the Danish born population (Taleshan et al., 2018).

In this review, the sociodemographic factors found to be associated with multimorbidity among migrants included older age, female sex, financial adequacy, being married and cultural factors. The association between older age and multimorbidity has been reported in studies of migrant populations outside of Canada (Gimeno-Feliu et al., 2017; Jackson et al., 2018). Age adjusted findings have shown that females immigrants face a greater burden of multimorbidity compared to male migrants (Diaz et al., 2015; Gimeno-Feliu et al., 2020). This may be due to differences in utilization of health services, where women tend to access care more than men, leading to greater likelihood of detection and diagnosis of existent health conditions (Galdas et al., 2005; Wang et al., 2013). The finding of income being associated with multimorbidity is consistent with research

conducted among the general Canadian population (Agborsangaya et al., 2012; Mondor et al., 2018; Roberts et al., 2015).

Health-related factors such as housing, food security, fruits and vegetable intake, and physical activity may be compromised for individuals with lower income, adversely influencing their health outcomes and contributing to chronic disease (Canadian Institute for Health Information, 2016; Lynch et al., 2000; WHO, 2010). Among the general population, being single has been associated with a greater risk of multiple chronic conditions (Aminisani et al., 2020; Mondor et al., 2018; Park et al., 2018). Although it is not clearly known how marital status influences health outcomes, studies suggest the protective effects against chronic conditions among those in a relationship may be attributed to improved social support (Averett et al., 2013; Bao et al., 2019).

2.5.1   What are the gaps in the literature?

This review highlights a number of gaps and limitations in the literature. First, there was lack of consistency and clarity in the definition and measurement of multimorbidity resulting in a deficiency of reliable prevalence estimates. The types and numbers of conditions used varied between studies, as did the operational definitions of multimorbidity. The selection criteria for the conditions were not stated in the original studies, and in some cases, the lists of the conditions were not presented. Variations were also found in the minimum number of health conditions included. Lack of a common approach in defining multimorbidity is problematic, as it results in marked variations in prevalence estimates (Academy of Medical Sciences, 2018; Fortin et al, 2012). For example, in this review the prevalence ranged from 3.6% to 36.5%. Explicitly stating the operational definition for multimorbidity is suggested to allow for comparability of studies and to assess if the definition used is appropriate for the population under investigation (Nicholson et al., 2019; Stewart et al., 2013).

Second, all of the original studies included in the current review except one utilized a cross-sectional design, preventing any causal inferences from being made. The lack of longitudinal data makes it difficult to assess the effect of length of stay in Canada on multimorbidity. Longitudinal studies are needed to better understand health transitions of

migrant populations by comparing health at the time of migration to health after migration. Such studies can provide a clearer picture of the changes in health status of the migrant population and the factors associated with increased risk of multimorbidity within this population. Studies should also consider investigating cohort effects as differences between recent and non-recent migrants could reflect not only the duration of stay in Canada but also compositional differences in socio-demographic factors (e.g., education, income, region of origin), global patterns of disease, more rigorous screening for immigration, and changes to migration related policies.

Third, this review suggests that there is lack of publicly available data sources that collect health related information on the immigrant population. Reliance on surveys, such as the CCHS, limits the types of research questions that can be investigated, since researchers are often confined to the limited number of self-reported immigration related variables. For example, the role of immigration category was only investigated in one of the studies as it is not available in most surveys (Rouhani, 2021). Prior research has noted health disparities by migration categories (Lu & Ng, 2019; Robert & Gilkinson, 2012), likely due to significant variations in conditions upon which each migrant class enters the country. As such, there is a need for better quality longitudinal data on immigrants to Canada in order to address health differences among immigrants.

Another consequence of reliance on surveys are the small sample size of migrants, which often restrict researchers to study the migrant population as a whole rather than investigate various migrant sub-populations. Most studies in this review did not investigate ethnicity and in the cases where ethnicity was explored, the categorizations were quite broad. For example, Chiu et al. (2009) included Blacks, Whites, and an "other" category, while Sun et al. (2009) used Asians and an "other" category. These "other" categories are quite diverse and cannot be used to effectively identify and target health disparities. Only one study was able to categorize migrants into eight categories based on world region of origin (Rouhani, 2021). Non-Canadian studies have found ethnic background to be associated with multimorbidity, where certain populations present varying trends such as earlier age of onset and faster rate of progression (Gimeno-Feliu et al., 2017; Quiñones et al., 2019). Identification of such health disparities can

inform targeted disease prevention efforts. Small sample sizes also limit categorization of migrants as recent or non-recent. Some studies indicated that recent migrants were not captured well, as sample sizes of newer migrants residing in Canada for less than ten years were much smaller compared to migrants residing in Canada for more than ten years (Davison et al., 2020; Chiu et al., 2019). Davison et al. (2012) stated that less than one percent of the study's migrant population had migrated in the ten years preceding the baseline survey. Studying length of residence is an important factor for examining the healthy immigrant effect, as migrant health tends to deteriorate with length of residency in the host country.

Lastly, rather than limiting the scope of studies to individual characteristics, researchers should aim to investigate the impact of broader levels of risk factors (WHO, 2010). The studies included in this review focused on a limited number of factors such as length of stay, sex, age and marital status. Investigation of multi-level factors such as neighborhood income inequality and public policies focused on immigrants can further our understanding of the complex pathways leading to migrant health outcomes, such as multimorbidity.

2.6 Limitations

Limitations to this scoping review should be considered when interpreting its results. The studies in the review had marked variations in the populations, study designs, and measurements used to assess multimorbidity. This made it difficult to compare findings related to prevalence and risk factors across studies. There were also variations in the types of factors related to multimorbidity that were adjusted for, while in some studies only unadjusted analyses related to the research question were available. Furthermore, most studies used a cross-sectional design, which does not allow for inferences relating to temporality between migrating to Canada and multimorbidity. Almost all of the studies used self-report to identify chronic conditions, which could be a potential source of misclassification. It is also important to note that migration policies have changed overtime, so the composition of cohort of migrants can vary over the years. This is especially important to consider when comparing recent migrants to non-recent migrants who may originate from different countries, may belong to different immigration

categories, and may have undergone more rigorous immigration screening. It is also possible that participation in surveys may have been impacted by language barriers, so responses may not be completely representative of the Canadian foreign-born population.

2.7 Conclusions

This scoping review has found that there is a scarcity of research on prevalence and risk factors of multimorbidity among the migrant population in Canada. Immigrants were found to have lower prevalence of multimorbidity compared to those born in Canada and long-standing residents (landed before 1985). Among immigrants, non-recent immigrants had a greater prevalence of multimorbidity compared to more recent immigrants. The risk of multimorbidity may be associated with refugee status, female sex, older age, financial inadequacy, marital status and various cultural factors. This review has also highlighted gaps in the evidence base regarding migrant health research. Future directions to advance knowledge in this area should consider longitudinal study designs, more detailed data on the heterogeneous backgrounds of migrants including immigration related factors, ethnicity, immigration recency and use of a consistent definition of multimorbidity. Future research should also consider the investigation of multiple levels of social determinants of health, beyond individual characteristics. Given the aging population in Canada, the high rate of migration, and the limited evidence found in this review, more research on multimorbidity among the migrant population is highly recommended.

2.8 Conflicts of interest

The authors have declared no conflict of interest.

2.9 Funding

None.

2.10 Acknowledgements

Chapter 3

3   Methods

This study was conducted to analyze immigrant related factors associated with multimorbidity among the adult immigrant population in Canada. To gain a more comprehensive picture of multimorbidity among the immigrant population, the objective of this study was to compare the association between multimorbidity and factors associated with multimorbidity among different categories of immigrants. This chapter details the methodology used to assess the prevalence and correlates of multimorbidity among the study population. Section 3.1 presents a description of the data source, the Canadian Community Health Survey linked to the Longitudinal Immigration Database (CCHS-IMDB), including an overview of the sampling design and data collection. Section 3.2 provides details on the outcome variable and its correlates used in the analysis and how they were measured. Section 3.3 describes the statistical analysis. Section 3.4 describes important statistical considerations such as the application of sampling weights and methods used to handle missing data.

3.1   Data source

Data for this study were derived from the CCHS-IMDB. This data set is a linkage of the CCHS Annual Components for the periods from 2003 to 2014 to the IMDB of immigration and income (tax) data from 1980 to 2013 (Statistics Canada, 2018). The CCHS is a national cross-sectional survey conducted by Statistics Canada for the purpose of health surveillance and population health research. The survey collects information from representative samples of the non-institutionalized Canadian population aged 12 years and older (Statistics Canada, 2020). The IMDB is a collection of administrative immigration and income tax files produced by Immigration, Refugees and Citizenship Canada (IRCC) and is provided to Statistics Canada on an annual basis (Statistics Canada, 2018). A person is included in the IMDB if they have obtained permanent residence status in Canada since 1980. The linkage between the CCHS and IMDB was conducted as a collaboration between Statistics Canada and IRCC to allow for broader research on immigrant health that is not possible by using the CCHS alone. The CCHS-

IMDB data set was accessed through Statistics Canada's Research Data Centre at Western University and the University of Waterloo.

3.1.1　Content of data source

The specific objective of the linked CCHS-IMDB is to better understand the health, social, and economic outcomes of immigrants from different immigration categories. The CCHS component provides information on health status, health care utilization and health determinants. This includes Annual Components for the periods from 2003 to 2014, CCHS Focus Content for 2002 (Mental Health and Well-being) and 2012 (Mental Health) (Statistics Canada, 2020).

The IMDB component is a database which combines the Immigrant Landing File (ILF) with Canadian tax files. The ILF is an administrative census of landed immigrants for all years from 1980 to 2014. It provides information on immigration characteristics at the personal level such as demographics (e.g., age, sex, country of birth, education and knowledge of official languages), program (e.g., immigrant admission category) and other characteristics at the time of admission to Canada (Statistics Canada, 2018). The IMDB links the ILF to annual tax files in Canada since 1982. The ILF used in the linked dataset used in the current study includes all immigrants who have landed in Canada between 1980 to 2013, including tax filers and non-tax filers. Both the ILF and the IMDB do not include any health-related information (Statistics Canada, 2018).

3.1.2　Pooling CCHS cycles

The present analysis used data from the 2007 to 2014 Annual Components of the CCHS. Due to the redesign of the CCHS survey in 2007 (Statistics Canada, 2016), cycles prior to 2007 were excluded from this study. The annual cycles from 2007 to 2014 were pooled together to obtain a large sample of immigrants to allow for robust analyses to assess the association of immigration factors, sociodemographic factors and health behaviours with multimorbidity.

Important considerations before pooling annual cycles of CCHS include changes in content of the questionnaire, coverage, geography and mode of data collection (Thomas & Wannell, 2009). It was feasible to pool cycles 2007 through 2014 of the CCHS because the methodologies, sampling frame and mode of data collection were similar in each cycle. The questions and coverage in each cycle were almost identical, with a few minor exceptions. For instance, in the cycles from 2010 to 2014, the variable measuring chronic obstructive pulmonary disorder (COPD) referred to the presence of chronic bronchitis, emphysema or COPD. Cycles prior to 2010 measured these conditions separately, and the 2007 cycle did not capture data on the presence of bronchitis. In addition, prior to 2010, the maximum household income category response option was "$100,000 or more", but in subsequent cycles this category was replaced with two categories, "$100,000 to $150,000" and "$150,000 or more". For analysis purposes, these two variables were recoded to be as consistent as possible across cycles.

3.1.3   CCHS-IMDB sampling design

The target population of the CCHS are individuals 12 years and older living in the ten provinces and three territories (Statistics Canada, 2020). Each of the 2007 to 2014 CCHS surveys used in this study provide a sample of approximately 65,000 respondents on an annual basis. Persons excluded from the survey's coverage include persons living on reserves and other Aboriginal settlements, full-time members of the Canadian-Forces, the institutionalized population, children living in foster care and persons residing in the Quebec health regions of Région du Nunavik and Région des Terres-Cries-de-la-Baie-James. In the territories, the sampling frame for the CCHS covers 92% of the target population in Yukon, 96% in the Northwest Territories and 93% in Nunavut. Prior to 2013, the coverage of Nunavut's target population was 71% as the survey covered only the 10 largest communities. These exclusions represent account for about 3% of the Canadian population aged 12 years and over (Statistics Canada, 2020a).

A multi-stage sampling allocation strategy was used to give importance to two levels of geography, the health region and province. The first two sampling stages allocated the sample sizes of the provinces and territories according to their population size and the

number of health regions in the province. The third step allocated each provincial sample among its health regions proportionally to the square root of the population in each health region (Statistics Canada, 2015). The three sampling frames used by the CCHS to select households were an area frame designed for the Canadian Labour Force Survey, a list frame of telephone numbers and a Random Digit Dialling sampling frame. After contacting the household, a potential respondent was selected using various age-based and household composition selection probabilities. Responses to the questionnaire were voluntary and data were collected directly from respondents using computer assisted personal and telephone interview software.

The IMDB is a census of immigrants to Canada with a longitudinal design, therefore no sampling was conducted. It provides coverage of administrative immigration records and annual tax files of all immigrants who landed in Canada since 1980 and filed their taxes at least once since 1982.

3.1.4   Linkage of the CCHS to the IMDB

CCHS and ILF records were linked to the Derived Record Depository (DRD), a dynamic relational database of basic personal identifiers, using both deterministic and probabilistic linkage methods. Overall, 85% of immigrants from the ILF (N=5,854,949) were linked to the DRD. Of CCHS respondents who agreed to share their data (706,689), 95.4% were linked the to the DRD. In total, 39,420 CCHS respondents were linked to the ILF, and thus the IMDB, through the DRD. Among CCHS respondents who self-reported as immigrants who landed in Canada since 1980 (46,903), 80.2% (37,608) were linked to an ILF record (Statistics Canada, 2017).

3.1.5   Study population

For the purpose of this study, the study population was limited to immigrants from the 2007 to 2014 cycles of the CCHS whose CCHS records were linked to the IMDB, who were 18 years of age or older at the time of the CCHS interview. This sample represents immigrants who have landed between 1980 and 2013. Overall, 23,024 immigrants were included in the final study population.

3.2   Measurements

The following sections present each of the variables used in the analysis and how they were measured.

3.2.1   Multimorbidity

Multimorbidity was the main outcome of interest in this study. Multimorbidity was defined as having two or more of the five major groups of chronic diseases, based on the recent definition proposed by the Public Health Agency of Canada (Roberts et al., 2015; Varin et al., 2019). These groups include cancer (ever had), diabetes, cardiovascular disease (heart disease and/or stroke), chronic respiratory diseases (asthma and/or chronic pulmonary disease) and mood and/or anxiety disorders. Responses to the presence of these conditions were captured in the chronic disease module of the CCHS, which asked respondents if they have been diagnosed by a health professional with any of these conditions that is expected to last or has lasted for six months or more. Response categories included "yes", "no", "don't know" and "refusal" for each chronic condition. Respondents with missing data on one or more chronic condition variables were excluded from the analysis. Multimorbidity was operationalized as a binary variable, the presence of which was measured by reporting at least two of the five groups of chronic conditions.

3.2.2   Immigration category

Data pertaining to categories of immigrants were obtained from the IMDB. The four major immigration groups or categories provided by the IMDB are economic immigrant, immigrant sponsored by family, refugee and other (Statistics Canada, 2019). Economic immigrants are further broken down into worker programs, business programs and provincial and territorial nominees. The business program and skilled workers of the worker programs are further split into the federal or Quebec streams. Immigrants who are sponsored by family are further broken down into the six groups describing their relationship to the sponsor. These are spouse/partner, parent/grandparent, child, intercountry adopted child, public policy or humanitarian and compassionate case

sponsored by family and immigrant sponsored by family not included elsewhere (Statistics Canada, 2019).

In this study, economic immigrants were separated into principal applicants and spouses/dependents, since the principal applicants are assessed for their ability to contribute to the Canadian economy, while their spouses/dependents are not assessed for this ability (Statistics Canada, 2020b). Thus, for the purpose of this study, this analysis used four immigration categories of "economic immigrant-principal applicant", "economic immigrant-spouse/dependent", "family class" , "refugee/other". These four broad immigration categories were used to provide large number of observations within each category, which prevents unstable estimates and allows for increased statistical efficiency (Wielenga, 2007).

3.2.3   Immigration related characteristics

3.2.3.1   Immigration recency

Studies which have examined the relationship between length of residence in the host country and multimorbidity among immigrant populations have found that independent of age, an increasing duration of stay in the host country was associated with a greater burden of having multiple chronic conditions (Chiu et al., 2009; Gimeno-Feliu et al., 2017; Gimeno-Feliu et al., 2020; Sun et al., 2009). To assess the impact of length of residency in Canada, information on immigration recency was derived by taking the difference between the landing year recorded in the IMDB and the CCHS survey year. To indicate the recency of immigration, immigrants who were in the pre-landing stage or landed less than six years before the CCHS survey were categorized as "recent" immigrants, those who have landed six to ten years before the survey were categorized as "midterm" immigrants and those who have landed more than ten years before the survey were categorized as "non-recent" immigrants. A cut-off point of 10 years was used since previous research has suggested immigrants report a distinctive sense of comfort and familiarity with the host country after approximately a decade of residency in the host country (Dunn & Dyck, 2000). For the purpose of this study, an additional cut-off point

of five years was used to further explore the relationship between duration of stay and multimorbidity. It was possible for immigrants who resided in Canada as a permanent resident to have been interviewed by the CCHS before being formally registered in the IMDB as landed immigrants. Such cases could include foreign students studying at a Canadian educational institution or foreign employees working in Canada who later applied and successfully obtained permanent residency. To account for these types of respondents, those who were included in the survey during the pre-landing stage were included as "recent immigrants" in the immigration recency variable.

3.2.3.2   Birth region

A study investigating the association between country of origin and multimorbidity has found lowest odds of multimorbidity among Asians, Eastern Europeans and the highest odds for Latin Americans (Gimenou-Feliu et al., 2017). To assess the role of country of birth in this study, the IMDB categorizations for birth regions were used in this study. These regions are "Europe", "Africa or Middle East", "South Asia", "East Asia, Oceania or other Asia", "South or Central America" and "USA or other miscellaneous".

3.2.3.3   Knowledge of official languages

Previous research has suggested that limited proficiency of the official languages among immigrants may be related to poorer self-reported health status (Ng et al., 2011; Zhao et al., 2010). The CCHS is available in both official languages of English and French. Additionally, to remove language barriers, the CCHS employs interviewers with a wide range of language competencies (Statistics Canada, 2020a). To assess the association of language with multimorbidity, self-reported proficiency in English or French at the time of the CCHS interview was included in the analytical model. The categories used to capture this information were "neither" and "English and/or French".

3.2.4   Health related behaviours

Variables pertaining to health behaviours were derived from the CCHS and were measured at the time of the CCHS interview.

3.2.4.1   Smoking status

Studies suggest that smoking may be a risk factor for multimorbidity (Fortin et al., 2014; Khorrami et al., 2020). Smoking status was measured in the CCHS by whether the participant was a current smoker or not a current smoker. This variable was measured in this study as being a "current smoker", "former smoker" or having "never smoked".

3.2.4.2   Physical activity

There have been mixed findings from Canadian studies assessing the relationship of physical activity with multimorbidity. Some studies suggested no relationship between physical activity and multimorbidity (Hudon et al., 2008; Sakib et al., 2019), while one study has suggested that those with multimorbidity are more likely to be inactive (Keats et al., 2017). The CCHS derives a measure of the level of physical activity using the total number of minutes of moderate to vigorous activity over the past week. The derived variable represents physical activity levels defined by the Canadian Physical Activity Guidelines of having at least 150 minutes of moderate to vigorous intensity aerobic physical activity per week, in bouts of 10 minutes or more. In this study, levels of physical activity were categorized as being "regular", "occasional" and "infrequent".

3.2.4.3   Fruit and vegetable intake

Evidence from previous research on the association between multimorbidity and fruit and vegetable intake has produced inconsistent findings. While some studies have suggested an association of lower fruit and vegetable intake with multimorbidity (Dhalwani et al, 2016; Ruel et al., 2014), other studies have not found evidence to support this association (de Almeida et al., 2020; Fortin et al, 2014). The CCHS measured fruits and vegetable consumption by calculating the number of times per day fruits and vegetables were consumed by the respondent. This was achieved through a series of questions regarding daily consumption (number of times) of: fruit juice, other fruit, green salad, potatoes, carrots and other vegetables. The frequency of fruit and vegetable consumption was then defined by the CCHS as either consuming fruits and vegetables "fewer than five times per day" or "five to ten times per day" or "more than ten times per day". These categorizations were used in this study.

3.2.4.4   Alcohol consumption

Recent studies have found alcohol consumption to be associated with a decreased risk of having multimorbidity (Sakib et al., 2019; Wister et al., 2020). To assess the relationship of consuming alcohol with the presence of multimorbidity among immigrants, alcohol consumption was measured as type of drinker. These categories taken from the CCHS derived variable included "regular drinker", "occasional drinker", or "non-drinker", based on alcohol consumption over the past 12 months. Data on former drinking habits were not available and thus were not included in the study.

3.2.5   Sociodemographic factors

Variables pertaining to sociodemographic factors were derived from the CCHS and were measured at the time of the CCHS interview.

3.2.5.1   Sex

Sex was included in this study as the literature largely agrees that multimorbidity varies by sex in both the general and immigrant populations, where females often face a greater burden of having multiple chronic conditions (Barnett et al., 2012; Diaz et al., 2015; Fortin et al., 2010; Gimeno-Feliu et al., 2020; Marengoni et al., 2008; Roberts et al., 2015;Sakib et al., 2019). In the CCHS, sex is reported as a binary variable of "male" or "female" and was coded accordingly in this analysis.

3.2.5.2   Age

The CCHS reports respondents' age in years by asking both their age and date of birth. Age is included in the analysis as older age is considered to be a risk factor for multimorbidity (Gimeno-Feliu et al., 2017; Hu et al., 2019; Jackson et al., 2018; Marengoni et al., 2011; Roberts et al., 2015). In this analysis age was categorized into the following groups: "18 to 34", "35 to 49", "50 to 64", "65 to 79" and "≥80".

3.2.5.3   Marital status

Previous research has suggested that being married is associated with lower risk of multimorbidity (Gao et al., 2020; Rai et al., 2021). Data on marital status was collected by the CCHS by asking respondents is they were either married, living common-law, widowed, separated, divorced or single, never married. In this study marital status was defined as two categories: "married or common-law" and "single, widowed, separated, or divorced".

3.2.5.4   Employment status

Studies investigating the relationship between employment status and multimorbidity have found unemployed immigrants to face a greater burden of multimorbidity (Akhavan, 2004; Yildiz et al., 2020). Employment status was measured in the CCHS by asking respondents if they have worked at a job or business in the past week, including part-time jobs, seasonal work, contract work, self-employment, baby-sitting and any other paid work, regardless of the number of hours worked. In this study employment status was categorized as being "employed", "unemployed" or "not in the labour force".

3.2.5.5   Education

Lower educational attainment has been found to be associated with higher risk of multimorbidity (Basham, 2020; Roberts et al., 2015). In the CCHS, education is reported as the highest level of education acquired by respondent. The four possible levels are: less than secondary school graduation, secondary school graduation, post-secondary certificate diploma or university degree. For this analysis, education was dichotomized into two categories "post-secondary diploma/degree" or "secondary school diploma or less" to measure the highest level of education acquired by the respondent.

3.2.6   Family level characteristics

3.2.6.1   Household income

Having a lower income has been associated with a greater burden of multimorbidity (Roberts et al., 2015; Sakib et al., 2019). Household income was measured in the CCHS by requesting income information for all household members before taxes and deductions from all sources, including wages and salaries, income from self-employment, dividends and interest, employment insurance, worker's compensation, benefits from Canada or Quebec pension plan, retirement pensions, superannuation and annuities, RRSP/RRIF, Old Age Security and Guaranteed Income Supplement, provincial or municipal social assistance or welfare, Child Tax Benefit or family allowances, child support, alimony, or other sources such as rental income or scholarships. In this analysis, household income before taxes and deductions was categorized into quintiles.

3.3   Statistical analysis

3.3.1   Descriptive statistics

Descriptive statistics by sex were generated to present an overview of the basic characteristics of the 2007 to 2014 CCHS-IMDB respondents who were included in the study. Frequency distributions were computed for all study variables from the CCHS-IMDB linked datasets: age, sex, marital status, education, income, employment status, smoker type, drinker type, level of physical activity, fruit and vegetable consumption, immigration recency, immigration category, birth region, knowledge of official languages, multimorbidity, as well as for groups of chronic conditions used to derive the measure of multimorbidity: diabetes, respiratory disease, cancer (ever had) and mental health.

3.3.2   Analyses for objective 1

The first objective of this study was to assess the prevalence of multimorbidity among categories of immigrants (economic class-principal applicant, economic immigrant-spouse/dependant, family class, refugees, other) to Canada aged 18 years or older by sex,

using the 2007 to 2014 CCHS-IMDB. To address this objective a table of frequencies was generated to determine the proportion of respondents with multimorbidity by immigration category.

3.3.3   Analyses for objective 2

The second objective of this study was to identify immigration factors, sociodemographic factors and health behaviours associated with multimorbidity among immigrants aged 18 years or older and to assess whether or not the effects of selected risk factors depend on immigration recency, using the 2007 to 2014 CCHS-IMDB. To address this objective, two multivariable logistic regressions were conducted to assess the following: 1) if the likelihood of multimorbidity among immigrants is associated with selected predictors of multimorbidity by sex, and 2) if the association between multimorbidity and immigration recency depend on immigration category

Specifically, in the first model the correlates entered into the regression model included immigration variables related to: immigration category, immigration recency, birth region and knowledge of official languages, the second model included the addition of sociodemographic variables related to: age, marital status, education, income and employment status, and the third model additionally included health behaviour variables related to: smoking, alcohol consumption, physical activity and fruits and vegetable consumption. The analyses in these first three models are provided separately by sex. This sequential approach was utilized to observe the effects of adjusting for each additional group of variables (i.e., sociodemographic factors and health behaviours). In the fourth model an interaction term was entered into the model to test for possible interaction between immigration recency and immigration category. Statistical significance was defined as p-value < 0.05.

3.4   Other statistical considerations

3.4.1   Sample weights

Sample weights were applied to all statistical tests carried out in this study to ensure the generated results are representative of the Canadian immigrant population. A unique survey weight is assigned to each CCHS respondent in the final sampling frame, corresponding to how many people in the population each respondent represents. Special share-link weights were created for the linked version of the CCHS to adjust for respondents who did not provide their permission to link their CCHS survey responses. These adjustments were performed using a non-response scoring approach creating a new class of non-respondents (those who did not agree to share data) within provinces and territories. A final post-stratification analysis was conducted by health region, age and sex to obtain the final share link weights (Statistics Canada, 2017). These sample weights were rescaled to represent the size of the selected sample.

3.4.2   Software

All statistical analyses were completed using SAS software version 9.4 (SAS Institute Inc., 2022).

Chapter 4

4 Results

This chapter presents the findings of this study. Section 4.1 presents missing data patterns for the dataset used in this study. Section 4.2 provides a description of the study sample. Section 4.3 examines the prevalence of multimorbidity by selected characteristics. Section 4.4 presents the results from the multivariable regression that assessed the relationship of various immigration factors, sociodemographic factors and health behaviours with multimorbidity.

4.1 Missing data

Missing data patterns were analyzed for the 2007 to 2014 CCHS-IMDB for respondents who immigrated to Canada and were 18 years or older at the time of the CCHS interview. These results are presented in Table 4.1. For the variables of interest, 93.9% of respondents had valid data for all survey questions. The variable with the most missing data points was income (6.5% total, 5.7% males, 7.2% females), followed by employment status (3.4% total, 3.0% males, 3.7% females) and level of physical activity (2.0% total, 1.8% males, 2.2% females). Listwise deletion was used to address the missing data in this study, given the relatively small percentage of missing data. In listwise deletion, an observation is not used in the analysis if it has one or more missing data points.

Table 4.1 Missingness in study variables for immigrants aged 18 years or older in the 2007 to 2014 CCHS-IMDB in total sample and by sex

	All (N=23024)		Males (N=10565)		Females (N=12459)	
	N Valid	N (%) Missing	N Valid	N (%) Missing	N Valid	N (%) Missing
Sociodemographic factors						
Age	23024	0 (0)	10565	0 (0)	12459	0 (0)
Sex	23024	0 (0)	10565	0 (0)	12459	0 (0)
Marital status	23001	23 (0.1)	10553	12 (0.1)	12448	11 (0.1)
Education	22821	203 (0.9)	10463	102 (1.0)	12358	101 (0.8)
Household income	21621	1403 (6.5)	9997	568 (5.7)	11624	835 (7.2)
Employment status	22273	751 (3.4)	10259	306 (3.0)	12014	445 (3.7)
Health behaviours						
Smoker type	22979	45 (0.2)	10539	26 (0.2)	12440	19 (0.2)
Drinker type	22961	63 (0.3)	10524	41 (0.4)	12437	22 (0.2)
Level of physical activity	22566	458 (2.0)	10378	187 (1.8)	12188	271 (2.2)
Fruits and vegetable consumption	23024	0 (0)	10565	0 (0)	12459	0 (0)
Immigration factors						
Immigration recency	23024	0 (0)	10565	0 (0)	12459	0 (0)
Immigration category	23019	5 (0)	10565	0 (0)	12454	5 (0)
Birth region	23024	0 (0)	10565	0 (0)	12459	0 (0)
Knowledge of official languages	23003	21 (0.1)	10557	8 (0.1)	12446	13 (0.1)

Table 4.1 (continued)

	All (N=23024)		Males (N=10565)		Females (N=12459)	
	N Valid	N (%) Missing	N Valid	N (%) Missing	N Valid	N (%) Missing
Chronic conditions						
Diabetes	23001	23 (0.1)	10555	10 (0.1)	12446	13 (0.1)
Respiratory disease	22971	53 (0.2)	10546	19 (0.2)	12425	34 (0.3)
Cardiovascular disease	22983	41 (0.2)	10548	17 (0.2)	12435	24 (0.2)
Cancer	22696	328 (1.4)	10441	124 (1.2)	12255	204 (1.7)
Mental health illness	22977	47 (0.2)	10547	18 (0.2)	12430	29 (0.2)

Source: CCHS-IMDB

CCHS-IMDB: Canadian Community Health Survey linked to the Longitudinal Immigration Database

4.2 Sample characteristics

The 2007 to 2014 CCHS-IMDB had 23,024 respondents 18 years of age or older who immigrated to Canada and had valid survey responses. The specific characteristics of the 2007 to 2014 CCHS-IMDB respondents are presented in Table 4.2. These characteristics (age, marital status, education, income, employment, smoking, drinking, physical activity, fruits and vegetable intake, immigration recency, immigration category, birth region and knowledge of official languages) were selected based on previous literature indicating these factors are associated with multimorbidity.

Among the total sample, 32.3% of respondents were 18 to 34 years old, 37.6% were 35 to 49 years old, 20.8% were 50 to 64 years old, 7.4% were 65 to 79 years old and 1.9% were 80 years or older. About two thirds of the sample were married or in a common-law relationship (66.1%), while the remaining were either single, widowed, divorced, or separated (33.9%). Majority of the sample had obtained a post-secondary diploma or degree (71.7%) while the remainder had a secondary school diploma or less (28.3%). Most respondents were employed (66.7%), while others were unemployed (31.5%) or not in the labour force (1.8%).

A small percentage of respondents were current smokers (13.8%), while the rest of the sample had never smoked (57.1%) or were former smokers (29.1%). Many respondents were regular drinkers of alcohol (48.5%) while others were only occasional drinkers (17.8%) or non-drinkers (33.6%). Regarding physical activity, majority of respondents were regularly active (61.6%), while a smaller proportion were infrequently (22.3%) or occasionally (16.1%) active. Among the sample it was most common to consume fruits and vegetables less than five times per day (52.3%), followed by five to ten times per day (39.8%) and more than ten times per day (5.9%).

Regarding immigration related factors, 56.1%, were non-recent immigrants, 24.7% were recent immigrants and 19.2% were mid-term immigrants. Family class was the largest immigration category (32.9%), followed by economic class-principal applicants (26.8%), economic class-spouse or dependent (25.6%) and refugee or other (14.7%). Most

immigrants were born in Europe (26.2%), followed by East Asia, Oceania or other Asia (25.9%), Africa or Middle East (16.2%), South or Central America (13.8%), South Asia (13.1%) and USA or other areas (4.9%). Majority of the sample had knowledge of English or French (94.2%), with only a small minority who did not have knowledge of either language (5.8%).

There were some notable differences between the characteristics of males and females within the sample. A larger proportion of females were unemployed; 39.3% of females stated they were unemployed, compared to only 22.4% of males. Smoking status varied greatly between males and females. Among males, 20.0% of the sample reported being a daily or occasional smoker, while among females, this value was only 8.6%. A similar trend was observed with alcohol consumption; 60.9% of males reported drinking regularly, whereas only 38.1% of females reported drinking regularly. There was also a difference between males and females within the immigration categories. Among males, 36.2% were economic immigrants, 20.0% were spouse or dependent of economic immigrant, 27.8% were family class immigrants and 16.2% were refugees. Whereas among females, 19.0% were economic immigrants, 30.3% were spouse or dependent of economic immigrant, 37.3% were family class immigrants and 13.4% were refugees.

Table 4.2 Distribution of selected characteristics of immigrants aged 18 or older in the 2007 to 2014 CCHS-IMDB in the total sample and by sex

	All (N=23024) N (%)	Males (N=10565) N (%)	Females (N=12459) N (%)
Sociodemographic factors (at the time of CCHS interview)			
Age (years)			
18 to 34	7431 (32.3)	3284 (31.1)	4147 (33.3)
35 to 49	8666 (37.6)	4065 (38.5)	4601 (36.9)
50 to 64	4788 (20.8)	2246 (21.3)	2542 (20.4)
65 to 79	1694 (7.4)	791 (7.5)	903 (7.3)
≥ 80	445 (1.9)	179 (1.7)	266 (2.1)
Marital status			
Single, widowed, divorced, or separated	7787 (33.9)	3465 (32.8)	4322 (34.7)
Married or common-law	15214 (66.1)	7088 (67.2)	8126 (65.3)
Education			
Secondary school diploma or less	6463 (28.3)	2880 (27.5)	3583 (29.0)
Post-secondary diploma/degree	16358 (71.7)	7583 (72.5)	8775 (71.0)
Household income (quintiles)			
Q 1 (lowest)	4492 (20.8)	1830 (18.3)	2662 (22.9)
Q 2	4323 (20.0)	1970 (19.7)	2353 (20.2)
Q 3	5434 (25.1)	2537 (25.4)	2897 (24.9)
Q 4	2320 (10.7)	1120 (11.2)	1200 (10.3)
Q 5 (highest)	5052 (23.4)	2540 (25.4)	2512 (21.6)
Employment status			
Not in labour force	404 (1.8)	160 (1.6)	244 (2.0)
Unemployed	7021 (31.5)	2295 (22.4)	4726 (39.3)
Employed	14848 (66.7)	7804 (76.1)	7044 (58.6)
Health behaviours (at the time of CCHS interview)			
Smoker type			
Never	13123 (57.1)	4533 (43.0)	8590 (69.1)
Former	6679 (29.1)	3903 (37.0)	2776 (22.3)
Current	3177 (13.8)	2103 (20.0)	1074 (8.6)
Drinker type (past 12 months)			
Non-drinker	7723 (33.6)	2597 (24.7)	5126 (41.2)
Occasional	4096 (17.8)	1518 (14.4)	2578 (20.7)
Regular	11142 (48.5)	6409 (60.9)	4733 (38.1)

Table 4.2 (continued)

	All (N=23024) N (%)	Males (N=10565) N (%)	Females (N=12459) N (%)
Health behaviours (at the time of CCHS interview)			
Level of physical activity			
Infrequent	5033 (22.3)	2132 (20.5)	2901 (23.8)
Occasional	3628 (16.1)	1763 (17.0)	1865 (15.3)
Regular	13905 (61.6)	6483 (62.5)	7422 (60.9)
Fruits and vegetable consumption (times per day)			
> 5	12500 (52.3)	6346 (60.1)	6154 (49.4)
5 to 10	9162 (39.8)	3590 (34.0)	5572 (44.7)
>10	1362 (5.9)	629 (6.0)	733 (5.9)
Immigration factors			
Immigration recency (years)			
Recent (pre-landing to 5)	5694 (24.7)	2546 (24.1)	3148 (25.3)
Mid-term (6 to 10)	4416 (19.2)	2037 (19.3)	2379 (19.1)
Non-recent (>10)	12914 (56.1)	5982 (56.6)	6932 (55.6)
Immigration category			
Economic class-principal applicant	6167 (26.8)	3805 (36.0)	2362 (19.0)
Economic class-spouse/dependent	5891 (25.6)	2115 (20.0)	3776 (30.3)
Family class	7581 (32.9)	2938 (27.8)	4643 (37.3)
Refugee/other	3380 (14.7)	1707 (16.2)	1673 (13.4)
Birth region			
Europe	6034 (26.2)	2897 (27.4)	3137 (25.2)
Africa or Middle East	3736 (16.2)	1855 (17.6)	1881 (15.1)
South Asia	3004 (13.1)	1438 (13.6)	1566 (12.6)
East Asia, Oceania or other Asia	5951 (25.9)	2538 (24.0)	3413 (27.4)
South or Central America	3176 (13.8)	1415 (13.4)	1761 (14.1)
USA or other miscellaneous	1123 (4.9)	422 (4.0)	701 (5.6)
Knowledge of official languages (at the time of CCHS interview)			
Neither	1331 (5.8)	462 (4.4)	869 (7.0)
English and/or French	21672 (94.2)	10095 (95.6)	11577 (93.0)

Table 4.2 (continued)

	All (N=23024) N (%)	Males (N=10565) N (%)	Females (N=12459) N (%)
Chronic conditions (at the time of CCHS interview)			
Diabetes	1323 (5.8)	668 (6.3)	655 (5.3)
Respiratory disease	1283 (5.6)	522 (5.0)	761 (6.1)
Cardiovascular disease	790 (3.4)	420 (4.0)	370 (3.0)
Cancer	532 (2.3)	187 (1.8)	345 (2.8)
Mental health illness	1578 (6.9)	572 (5.4)	1006 (8.1)

Source: CCHS-IMDB; unweighted statistics
CCHS-IMDB: Canadian Community Health Survey Linked to the Longitudinal Immigration Database
CCHS: Canadian Community Healthy Survey

4.3 Prevalence of multimorbidity

The estimates for the prevalence of multimorbidity was generated for the total sample and by sex to address the first objective of this study. Unweighted prevalence of multimorbidity by selected characteristics (age, marital status, education, income, employment, smoking, drinking, physical activity, fruits and vegetable intake, immigration recency, immigration category, birth region and knowledge of official languages) for the study sample is presented in Table 4.3. The categories of variables pertaining to income, immigration recency and immigration category were collapsed into fewer response categories to meet confidentiality rules set by Statistics Canada.

The results from the analyses indicated that 3.5% of the total sample, 3.4% of males and 3.6% of females reported having two or more chronic conditions at the time of the CCHS interview. A similar percentage of married men (3.5%) and non-married men (3.4%) had multimorbidity, whereas among females, a greater proportion of unmarried respondents (5.2%) had multimorbidity compared to married respondents (2.7%). Multimorbidity was more common among respondents who reported having a secondary school diploma or less (4.6% total, 3.8% males, 5.3% females) compared to those with a post-secondary diploma or degree (3.0% total, 3.2% males, 2.9% females). Regarding employment status, a large proportion of respondents who were not in the labour force had multimorbidity (24.8% total, 30.0% males, 21.3% females), while a smaller proportion of those who were unemployed (4.5% total, 5.5% males, 4.0% females) and only 1.7% (total sample, 1.7% males, 1.7% females) of those who were employed had multimorbidity.

There was a smaller proportion of respondents who had never smoked (2.7% total, 2.3% males, 3.0% females) with multimorbidity compared to former smokers (5.0 % total, 5.0% males, 5.0% females) and current smokers (3.5% total, 2.7% males, 5.2% females). Overall, a greater proportion of respondents with multimorbidity were non-drinkers of alcohol (4.6% total, 4.9% males, 4.4% females), compared to occasional (3.3% total, 3.6% males, 3.1% females) and regular (2.8% total, 2.7% males, 3.0% females) drinkers. Respondents reporting occasional physical activity (2.4% total, 2.5% males, 2.4% females) had a lower prevalence of multimorbidity compared to respondents reporting

infrequent (5.3% total, 4.6% males, 5.7% females) or regular levels of physical activity (2.9% total, 3.0% males, 2.7% females). Multimorbidity was most common among respondents who consumed fruits and vegetables more than ten times per day (7.0% total, 6.8% males, 7.1% females), while it was less common among those who consumed fruits and vegetables less than five times per day (3.5% total, 3.2% males, 3.8% females) or five to ten times per day (3.0% total, 3.1% males, 2.9% females).

In regards to immigration related factors, there was a greater prevalence of multimorbidity among non-recent immigrants (5.0% total, 4.8% males, 5.1% females) compared to recent immigrants (1.7% total, 1.5% males, 1.8% females). Economic immigrants had the lowest prevalence of multimorbidity (2.6% total, 2.7% males, 2.5% females), whereas family class immigrants (4.5% total, 3.9% males, 4.8% females) and refugee or other class (4.7% total, 4.9% males, 4.4% females) had a greater prevalence of multimorbidity. USA and other areas (8.5% total, 7.1% males, 9.3% females) was the birth region where multimorbidity was much more common compared to Europe (4.2% total, 4.0% males, 4.4% females), Africa or Middle East (2.8% total, 2.6% males, 3.0% females), South Asia (3.5% total, 3.6% males, 3.4% females), East Asia, Oceania or other Asia (2.3% total, 2.6% males, 2.0% females), and South or Central America (3.5% total, 3.1% males, 3.9% females). Those who had knowledge of the official languages had a much lower prevalence of multimorbidity (3.2% total, 3.2% males, 1.7% females) compared to those who did not have knowledge of the official languages (8.0% total, 7.1% males, 5.5% females).

Table 4.3 Prevalence of multimorbidity among immigrants 18 years or older in the 2007 to 2014 CCHS-IMDB in the total sample and by sex

	All (N=807) N (%)	Males (N=358) N (%)	Females (N=449) N (%)
Sociodemographic factors (at the time of CCHS interview)			
Age (years)			
18 to 40	80 (0.7)	30 (0.6)	50 (0.8)
41 to 59	311 (3.8)	143 (3.7)	168 (4.0)
60 to 79	330 (11.5)	152 (11.3)	178 (11.6)
≥ 80	86 (19.3)	33 (18.4)	53 (19.9)
Marital status			
Single, widowed, divorced, or separated	345 (4.4)	120 (3.5)	225 (5.2)
Married or common-law	461 (3.0)	238 (3.4)	223 (2.7)
Education			
Secondary school diploma or less	300 (4.6)	110 (3.8)	190 (5.3)
Post-secondary diploma/degree	494 (3.0)	240 (3.2)	254 (2.9)
Household income (quartiles)			
Q 1 (lowest)	322 (7.2)	120 (6.6)	202 (7.6)
Q 2	177 (2.8)	94 (3.3)	83 (2.4)
Q 3	140 (2.5)	66 (2.4)	74 (2.5)
Q 4 (highest)	117 (2.3)	59 (2.3)	58 (2.3)
Employment status			
Not in labour force	100 (24.8)	48 (30.0)	52 (21.3)
Unemployed	317 (4.5)	127 (5.5)	190 (4.0)
Employed	252 (1.7)	130 (1.7)	122 (1.7)
Health behaviours (at the time of CCHS interview)			
Smoker type			
Never	360 (2.7)	105 (2.3)	255 (3.0)
Former	332 (5.0)	194 (5.0)	138 (5.0)
Current	112 (3.5)	56 (2.7)	56 (5.2)
Drinker type (past 12 months)			
Non-drinker	352 (4.6)	127 (4.9)	225 (4.4)
Occasional	135 (3.3)	54 (3.6)	81 (3.1)
Regular	315 (2.8)	174 (2.7)	141 (3.0)

Table 4.3 (continued)

	All (N=807) N (%)	Males (N=358) N (%)	Females (N=449) N (%)
Health behaviours (at the time of CCHS interview)			
Level of physical activity			
Infrequent	265 (5.3)	99 (4.6)	166 (5.7)
Occasional	88 (2.4)	44 (2.5)	44 (2.4)
Regular	398 (2.9)	195 (3.0)	203 (2.7)
Fruits and vegetable consumption (times per day)			
< 5	438 (3.5)	205 (3.2)	233 (3.8)
5 to 10	274 (3.0)	110 (3.1)	164 (2.9)
>10	95 (7.0)	43 (6.8)	52 (7.1)
Immigration factors			
Immigration recency (years)			
Recent (pre-landing to 10)	167 (1.7)	70 (1.5)	97 (1.8)
Non-recent (>10)	640 (5.0)	288 (4.8)	352 (5.1)
Immigration category			
Economic class-principal applicant/spouse/dependent	311 (2.6)	159 (2.7)	152 (2.5)
Family class	338 (4.5)	115 (3.9)	223 (4.8)
Refugee/other	158 (4.7)	84 (4.9)	74 (4.4)
Birth region			
Europe	254 (4.2)	117 (4.0)	137 (4.4)
Africa or Middle East	104 (2.8)	48 (2.6)	56 (3.0)
South Asia	106 (3.5)	52 (3.6)	54 (3.4)
East Asia, Oceania or other Asia	136 (2.3)	67 (2.6)	69 (2.0)
South or Central America	112 (3.5)	44 (3.1)	68 (3.9)
USA or other miscellaneous	95 (8.5)	30 (7.1)	65 (9.3)
Knowledge of official languages (at the time of CCHS interview)			
Neither	106 (8.0)	33 (7.1)	73 (5.5)
English and/or French	699 (3.2)	324 (3.2)	375 (1.7)

Source: CCHS-IMDB; unweighted statistics
CCHS-IMDB: Canadian Community Health Survey Linked to the Longitudinal Immigration Database
CCHS: Canadian Community Healthy Survey

4.4   Correlates of multimorbidity

Multivariable logistic regressions were modelled to address the second objective of this study, which was to identify factors associated with multimorbidity among immigrants to Canada. The first regression model assessed the association of immigration related factors such as immigration recency, immigration category, birth region and knowledge of official languages with the outcome of multimorbidity. The second model assessed the association between multimorbidity and immigration related factors, with the addition of social demographic factors including age, marital status, education, income, and employment status. The third model included the addition of health behaviours of smoking, alcohol consumption, physical activity and fruits and vegetable intake. All regression models were weighted using CCHS survey weights.

Table 4.4 presents the results of the first regression model. Among the total sample, those who had immigrated to Canada between six to ten years ago (OR: 1.43, 95% CI: 1.03 – 2.00), and more than ten years ago (OR: 3.45, 95% CI: 2.56 – 4.32) were more likely to have multimorbidity compared to those who immigrated five years ago or less, controlling for other variables in the model. Immigrants who arrived as dependents or spouses of economic class immigrants were less than half as likely to have multimorbidity compared to economic class immigrants (OR: 0.43, 95% CI: 0.31 – 0.54). When compared to immigrants who were born in Europe, immigrants born in Africa and the Middle East (OR: 0.69, 95% CI: 0.50 – 0.88), East Asia, Oceania or other Asia (OR: 0.53, 95% CI: 0.40 – 0.66) and South and Central America (OR: 0.71, 95% CI: 0.52 – 0.90) were less likely to experience multimorbidity, whereas immigrants from the USA and other world areas were more than twice as likely to experience multimorbidity (OR: 2.22, 95% CI: 1.38 – 3.06). Those immigrants who knew the official languages of English or French at the time of the CCHS survey were less likely to have multimorbidity compared to immigrants who did not have knowledge of the official languages (OR: 0.33, 95% CI: 0.24 – 0.41).

Among male respondents, those who had immigrated six to ten years (OR: 2.68, 95% CI: 1.18 – 4.19), or more than ten years ago (OR: 6.26, 95% CI: 3.26 – 9.27) had greater odds of multimorbidity compared to males who had immigrated less than six years ago.

Those who immigrated as a spouse or dependent of an economic class immigrant were less likely to experience multimorbidity compared to economic class immigrants (OR: 0.40, 95% CI: 0.26 – 0.61). Compared to males born in Europe, males born in Africa and the Middle East (OR: 0.64, 95% CI: 0.39 – 0.88), East Asia, Oceania or other Asia (OR: 0.54, 95% CI: 0.30 – 0.74) and South and Central America (OR: 0.52, 95% CI: 0.30 – 0.74) had lower odds of multimorbidity, whereas immigrants born in the USA and other areas had more than twice the odds of multimorbidity (OR: 2.36, 95% CI: 1.00 – 3.72). Men who reported knowledge of the official languages were less likely to have multimorbidity compared to those who did not report knowledge of the official languages (OR: 0.39, 95% CI: 0.24 – 0.55).

Among female respondents, those who arrived in Canada over ten years ago were more than twice as likely to have multimorbidity compared to those who had been in Canada for five years or less (OR: 2.38, 95% CI: 1.64 – 3.11). Those who arrived as a spouse or dependent of an economic class immigrant were much less likely to experience multimorbidity compared to economic class immigrants (OR: 0.42, 95% CI: 0.28 – 0.61). Compared to women born in Europe, those women whose birth region was Eastern Asia, Oceania or other Asia were half as likely to have multimorbidity (OR: 0.52, 95% CI: 0.34 – 0.70), whereas immigrants from USA or other birth regions were more than twice as likely to have multimorbidity (OR: 2.19, 95% CI: 1.09 – 3.30). Those who reported having knowledge of the official languages were much less likely to have multimorbidity compared to immigrants who did not report knowledge of the official languages (OR: 0.29, 95% CI: 0.21 – 0.38).

Table 4.4 Weighted odds ratios of multimorbidity associated with immigrant related factors among immigrants 18 years or older in the 2007 to 201 CCHS-IMDB in the total sample and by sex

	All (N=23024)	Males (N=10565)	Females (N=12459)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Immigration factors			
Immigration recency (years)			
Recent (pre-landing to 5)	REF	REF	REF
Mid-term (5 to 10)	1.43 (1.03, 2.00)**	2.68 (1.53, 4.70)**	0.97 (0.62, 1.50)
Non-recent (>10)	3.44 (2.66, 4.44)*	6.26 (3.88, 10.12)**	2.37 (1.74, 3.24)**
Immigration category			
Economic class-principal applicant	REF	REF	REF
Economic class-spouse/dependent	0.42 (0.32, 0.56)**	0.40 (0.26, 0.61)**	0.42 (0.28, 0.61)**
Family class	0.92 (0.75, 1.14)	0.93 (0.69, 1.25)	0.88 (0.64, 1.20)
Refugee/other	0.98 (0.77, 1.25)	1.13 (0.82, 1.55)	0.79 (0.54, 1.16)
Birth region			
Europe	REF	REF	REF
Africa or Middle East	0.69 (0.52, 0.91)**	0.64 (0.43, 0.94)*	0.77 (0.54, 1.16)
South Asia	0.91 (0.70, 1.17)	0.96 (0.67, 1.36)	0.85 (0.58, 1.22)
East Asia, Oceania or other Asia	0.53 (0.42, 0.68)**	0.54 (0.38, 0.76)**	0.52 (0.37, 0.73)**
South or Central America	0.71 (0.54, 0.92)*	0.52 (0.34, 0.79)**	0.91 (0.63, 1.30)
USA or other miscellaneous	2.22 (1.52, 3.24)**	2.36 (1.33, 4.20)**	2.19 (1.33, 3.62)**

Table 4.4(continued)

	All (N=23024)	Males (N=10565)	Females (N=12459)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Immigration factors			
Knowledge of official languages (at the time of CCHS interview)			
Neither	REF	REF	REF
English and/or French	0.33 (0.26, 0.42)**	0.39 (0.26, 0.59)**	0.29 (0.22, 0.40)**

*p<.05, **p<.01
Source: CCHS-IMDB
CCHS: Canadian Community Healthy Survey
CCHS-IMDB: Canadian Community Health Survey Linked to the Longitudinal Immigration Database

Table 4.5 presents the results of the second regression model for the effect of immigration related factors which controls for sociodemographic factors measured at the time of the CCHS survey. Among the total sample, those who immigrated more than ten years ago were more likely to have multimorbidity compared to those who immigrated less than six years ago (OR: 1.77, 95% CI:1.26 – 2.27). Respondents who arrived as a spouse or dependent of an economic class immigrant were less likely to have multimorbidity compared to economic class immigrants (OR: 0.70, 95% CI: 0.51 – 0.89). Compared to those born in Europe, immigrants born in East Asia, Oceania or other Asia were less likely to have multimorbidity (OR: 0.57, 95% CI: 0.42 – 0.72), while immigrants born in the USA or other regions were more than twice as likely to have multimorbidity (OR: 2.13, 95% CI: 1.48 – 2.78). Compared to the youngest age group of 18 to 40 years old, immigrants in other age categories had greater odds of multimorbidity: (1) 41 to 59 years (OR: 2.50, 95% CI: 1.61 – 3.40), (2) 60 to 79 years (OR: 7.59, 95% CI: 4.97 – 10.21) and (3) 80 years or older (OR: 10.53, 95% CI: 6.57 – 14.49). Those who reported being married at the time of the CCHS survey had lower odds of multimorbidity compared to those who reported being widowed, divorced, separated or single (OR: 0.79, 95% CI: 0.64 – 0.94). Compared to immigrants reporting income among the lowest quintile, those reporting higher incomes had lower odds of multimorbidity: (1) income quintile 2 (OR: 0.69, 95% CI: 0.51 – 0.86), (2) income quintile 3 (OR: 0.64, 95% CI: 0.47 – 0.80), (3) income quintile 4 (OR: 0.67, 95% CI: 0.44 – 0.90), (4) income quintile 5 (OR: 0.65, 95% CI: 0.47 – 0.83). Immigrants who were unemployed (OR: 0.29, 95% CI: 0.21 – 0.37) or employed (OR: 0.15, 95% CI: 0.21 – 0.37) had lower odds of multimorbidity compared to those who were not in the labour force.

Among males, those who immigrated more than ten years ago had greater odds of multimorbidity compared to those who immigrated less than six years ago (OR: 3.48, 95% CI: 1.44 – 5.52). Immigrants born in East Asia, Oceania or other Asia were less likely to experience multimorbidity compared to immigrants born in Europe (OR: 0.65, 95% CI: 0.38 – 0.91). Compared to the youngest age group respondents who were 60 to 79 years old (OR: 6.70, 95% CI: 2.79 – 10.60) and 80 years or older (OR: 10.95, 95% CI:

3.92 – 17.99) had higher odds of multimorbidity. Compared to respondents reporting income within the lowest quintile, those reporting an income in the third quintile had lower odds of multimorbidity (OR: 0.60, 95% CI: 0.33, 0.86). Men who were unemployed (OR: 0.17, 95% CI: 0.08 – 0.25) or employed (OR: 0.07, 95% CI: 0.03 – 0.10) had lower odds of multimorbidity compared to those who were not in the labour force.

Among females, those who arrived as a spouse or dependent of an economic immigrant had lower odds of multimorbidity compared to economic immigrants (OR: 0.57, 95% CI:0.33 – 0.81). Those women born in East Asia, Oceania or other Asia (OR: 0.65, 95% CI: 0.38 – 0.92) had lower odds of multimorbidity compared to women born in Europe, while female immigrants born in USA and other areas (OR: 3.15, 95% CI: 1.32 – 4.97) had greater odds. Compared to females in the youngest age group, all other age groups had significantly greater odds of multimorbidity: (1) 41 to 59 years (OR: 2.03, 95% CI: 1.03 – 3.04), (2) 60 to 79 years (OR: 5.12, 95% CI: 2.61 – 7.62), and (3) 80 years or older (OR: 8.00, 95% CI: 3.52 – 12.47). Respondents who reported they were married (OR: 0.70, 95% CI: 0.49 – 0.91) had lower odds of multimorbidity compared to those who reported being widowed, separated, divorced or single. Immigrants reporting income in the third (OR: 0.64, 95% CI: 0.39 – 0.90) and fourth quintile (OR: 0.52, 95% CI: 0.22 – 0.83) had lower odds of multimorbidity compared to those reporting income within the lowest quintile. Those who were unemployed (OR: 0.17, 95% CI: 0.10 – 0.24) or employed (OR: 0.10, 95% CI: 0.05 – 0.15) had lower odds of multimorbidity compared to those who were not in the labour force.

Table 4.5 : Weighted odds ratios of multimorbidity associated with immigration and sociodemographic factors among immigrants 18 years or older in the 2007 to 2014 CCHS-IMDB in the total sample and by sex

	All (N=23024) OR (95% CI)	Males (N=10565) OR (95% CI)	Females (N=12459) OR (95% CI)
Immigration factors			
Immigration recency (years)			
Recent (pre-landing to 5)	REF	REF	REF
Mid-term (5 to 10)	1.31 (0.92, 1.85)	1.80 (0.91, 3.56)	0.92 (0.56, 1.53)
Non-recent (>10)	1.77 (1.33, 2.35)**	3.48 (1.93, 6.26)**	1.34 (0.91, 1.98)
Immigration category			
Economic class-principal applicant	REF	REF	REF
Economic class-spouse/dependent	0.70 (0.54, 0.92)*	1.04 (0.63, 1.72)	0.57 (0.37, 0.86)**
Family class	0.89 (0.71, 1.11)	0.83 (0.57, 1.21)	0.77 (0.53, 1.11)
Refugee/other	1.13 (0.88, 1.45)	1.26 (0.86, 1.84)	0.70 (0.45, 1.10)
Birth region			
Europe	REF	REF	REF
Africa or Middle East	0.83 (0.63, 1.10)	0.68 (0.44, 1.07)	0.95 (0.59, 1.52)
South Asia	1.22 (0.92, 1.62)	1.35 (0.89, 2.05)	1.20 (0.77, 1.88)
East Asia, Oceania or other Asia	0.57 (0.44, 0.74)**	0.64 (0.43, 0.97)*	0.65 (0.43, 0.98)*
South or Central America	0.91 (0.69, 1.20)	0.70 (0.43, 1.13)	0.94 (0.60, 1.47)
USA or other miscellaneous	2.13 (1.57, 2.89)**	1.76 (0.84, 3.69)	3.14 (1.76, 5.61)**
Knowledge of official languages (at the time of CCHS interview)			
Neither	REF	REF	REF
English and/or French	0.86 (0.62, 1.18)	1.16 (0.65, 2.05)	0.70 (0.46, 1.07)

Table 4.5 (continued)

	All (N=23024)	Males (N=10565)	Females (N=12459)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sociodemographic factors (at the time of CCHS interview)			
Age (years)			
18 to 40	REF	REF	REF
41 to 59	2.50 (1.75, 3.58)**	1.76 (0.95, 3.24)	2.03 (1.24, 3.33)**
60 to 79	7.59 (5.37, 10.72)**	6.70 (3.74, 12.00)**	5.11 (3.13, 8.35)**
≥ 80	10.53 (7.23, 15.33)**	10.95 (5.76, 20.81)**	8.00 (4.57, 13.99)**
Marital status			
Single, widowed, divorced, or separated	REF	REF	REF
Married or common-law	0.79 (0.65, 0.96)*	0.90 (0.62, 1.32)	0.70 (0.51, 0.95)*
Education			
Secondary school diploma or less	REF	REF	REF
Post-secondary diploma/degree	1.01 (0.83, 1.23)	1.17 (0.84, 1.62)	1.09 (0.80, 1.48)
Income (quintiles)			
Q 1 (lowest)	REF	REF	REF
Q 2	0.69 (0.53, 0.88)**	1.22 (0.80, 1.87)	0.73 (0.49, 1.08)
Q 3	0.64 (0.49, 0.82)**	0.60 (0.38, 0.94)*	0.64 (0.43, 0.96)*
Q 4	0.67 (0.47, 0.94)*	1,07 (0.63, 1.82)	0.52 (0.29, 0.94)*
Q 5 (highest)	0.65 (0.49, 0.86)**	1.01 (0.65, 1.58)	0.71 (0.46, 1.10)

Table 4.5 (continued)

	All (N=23024)	Males (N=10565)	Females (N=12459)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sociodemographic factors (at the time of CCHS interview)			
Employment status			
Not in labour force	REF	REF	REF
Unemployed	0.29 (0.22, 0.38)**	0.17 (0.10, 0.28)**	0.17 (0.11, 0.26)**
Employed	0.15 (0.11, 0.20)**	0.07 (0.04, 0.11)**	0.10 (0.06, 0.16)**

*p<.05, **p<.01
Source: CCHS-IMDB
CCHS: Canadian Community Healthy Survey
CCHS-IMDB: Canadian Community Health Survey Linked to the Longitudinal Immigration Database

Table 4.6 presents the results of the third regression model for the effect of immigration factors which controls for sociodemographic factors, and health behaviours as well. Among the total sample, those who immigrated more than ten years ago were more likely to experience multimorbidity compared to those who immigrated less than six years ago (OR: 1.85, 95% CI: 1.25 – 2.45). Immigrants arriving as a spouse or dependent of an economic immigrant were less likely than principal economic immigrants to have multimorbidity (OR: 0.71, 95% CI: 0.49 – 0.93). Compared to immigrants born in Europe, immigrants born in Eastern Asia, Oceania or other Asia had lower odds of experiencing multimorbidity (OR: 0.69, 95% CI: 0.48 – 0.91), while immigrants born in USA and other areas were more than twice as likely to experience multimorbidity (OR: 2.51, 95% CI: 1.37 – 3.65). Compared to those within the youngest age group of 18 to 40 years, immigrants within all other age groups had greater odds of multimorbidity: (1) 41 to 59 years (OR: 1.68, 95% CI: 1.04 – 2.32), (2) 60 to 79 years (OR: 4.86, 95% CI: 3.06 – 6.65), and (3) 80 years or older (OR: 9.06, 95% CI: 5.27 – 12.84). Respondents who were married or in a common-law relationship were at lower odds of experiencing multimorbidity compared to respondents who reported being widowed, divorced or single (OR: 0.74, 95% CI: 0.57 – 0.92). Respondents reporting an income in the third quintile were less likely to have multimorbidity compared to respondents reporting an income in the lowest quintile (OR: 0.63, 95% CI: 0.44 – 0.83). Immigrants who reported being unemployed (OR: 0.20, 95% CI: 0.13 – 0.26) or employed (OR: 0.10, 95% CI: 0.07 – 0.14) were less likely to have multimorbidity compared to immigrants who were not in the labour force. Those who were former smokers (OR: 1.94, 95% CI: 1.49 – 2.40) or current smokers (OR: 1.45, 95% CI: 0.98 – 1.92) had greater odds of multimorbidity compared to those who had never smoked. Regular drinkers of alcohol were less likely to experience multimorbidity compared to non-drinkers (OR: 0.78, 95% CI: 0.59 – 0.97). Compared to respondents reporting infrequent physical activity, respondents reporting regular physical activity were less likely to have multimorbidity (OR: 0.69, 95% CI: 0.53 – 0.85).

Among males, respondents who immigrated over ten years ago had greater odds of experiencing multiple chronic conditions compared to respondents who immigrated five

years ago or less (OR: 3.13, 95% CI: 1.28 – 4.98). Compared to those born in Europe, immigrants born in East Asia, Oceania or other Asia were less likely to experience multimorbidity (OR: 0.62, 95% CI: 0.35 – 0.89). Men aged 60 to 79 years old (OR: 5.93, 95% CI: 2.45 – 9.41), and 80 years or older (OR: 10.66, 95% CI: 3.75 – 17.58) had a greater likelihood of experiencing multimorbidity compared to men within the youngest age group of 18 to 40 years old. Immigrants who were unemployed (OR: 0.21, 95% CI: 0.09 – 0.32) or employed (OR: 0.09, 95% CI: 0.04 – 0.14) had lower odds of multimorbidity compared to immigrants who were not in the labour force. Men who were former smokers were more likely to have multimorbidity compared to those who had never smoked (OR: 1.46, 95% CI: 0.98 – 1.94).

Among females, those arriving as a spouse or dependent of an economic immigrant were less likely than principal economic immigrants to have multimorbidity (OR: 0.55, 95% CI: 0.32 – 0.78). Compared to immigrants born in Europe, immigrants born in the USA and other regions had over three times the odds of multimorbidity (OR: 3.15, 95% CI: 1.28 – 5.01). Compared to respondents within the youngest age group of 18 to 40 years, respondents in all other age groups were more likely to experience multimorbidity: (1) 41 to 59 years (OR: 1.96 95% CI: 0.98 – 2.94), (2) 60 to 79 years (OR: 4.72, 95% CI: 2.35 – 7.10), and (3) 80 years or older (OR: 8.07, 95% CI: 3.40 – 12.74). Respondents who were married were less likely to have multiple chronic conditions compared to those who were widowed, divorced or single, (OR: 0.72, 95% CI: 0.49 – 0.95). Female immigrants who reported income within the two highest quintiles were less likely to have multimorbidity compared to other female immigrants reporting income in the lowest quintile: (1) quintile 4 (OR: 0.64, 95% CI: 0.37 – 0.91) and (2) quintile 5 (OR:0.51, 95% CI:0.19 – 0.84). Women who were unemployed (OR: 0.19, 95% CI: 0.10 – 0.27) or employed (OR: 0.11, 95% CI: 0.06 – 0.17) had lower odds of multimorbidity compared to immigrants who were not in the labour force. Former smokers (OR: 2.58, 95% CI: 1.67 – 3.50) and current smokers (OR: 2.09, 95% CI: 1.02 – 3.16) had a greater likelihood of multimorbidity compared to non-smokers. Respondents reporting regular physical activity were less likely to experience multimorbidity compared to respondents reporting infrequent physical activity (OR: 0.62, 95% CI: 0.42 – 0.82).

Table 4.6 Weighted odds ratios of multimorbidity associated with immigration factors, sociodemographic factors and health behaviours among immigrants 18 years or older in the 2007 to 2014 CCHS-IMDB in the total sample and by sex

	All (N=23024) OR (95% CI)	Males (N=10565) OR (95% CI)	Females (N=12459) OR (95% CI)
Immigration factors			
Immigration recency (years)			
Recent (pre-landing to 5)	REF	REF	REF
Mid-term (5 to 10)	1.19 (0.80, 1.77)	1.81 (0.91, 3.57)	0.92 (0.55, 1.56)
Non-recent (>10)	1.85 (1.34, 2.56)**	3.13 (1.73, 5.65)**	1.29 (0.86, 1.94)
Immigration category			
Economic class-principal applicant	REF	REF	REF
Economic class-spouse/dependent	0.71 (0.52, 0.97)*	1.11 (0.67, 1.85)	0.55 (0.35, 0.84)**
Family class	0.85 (0.65, 1.10)	0.93 (0.63, 1.36)	0.73 (0.50, 1.07)
Refugee/other	0.95 (0.71, 1.28)	1.29 (0.87, 1.91)	0.65 (0.41, 1.04)
Birth region			
Europe	REF	REF	REF
Africa or Middle East	0.75 (0.53, 1.05)	0.60 (0.37, 0.97)	1.05 (0.64, 1.74)
South Asia	1.38 (0.99, 1.93)	1.35 (0.86, 2.12)	1.53 (0.90, 2.61)
East Asia, Oceania or other Asia	0.69 (0.51, 0.94)*	0.62 (0.40, 0.96)*	0.84 (0.52, 1.35)
South or Central America	0.91 (0.65, 1.28)	0.71 (0.43, 1.17)	1.24 (0.77, 1.99)
USA or other miscellaneous	2.51 (1.60, 3.95)**	1.79 (0.85, 3.78)	3.15 (1.74, 5.70)**
Knowledge of official languages (at the time of CCHS interview)			
Neither	REF	REF	REF
English and/or French	0.88 (0.61, 1.27)	1.04 (0.58, 1.88)	0.72 (0.45, 1.17)

Table 4.6 (continued)

	All (N=23024)	Males (N=10565)	Females (N=12459)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sociodemographic factors (at the time of CCHS interview)			
Age (years)			
18 to 40	REF	REF	REF
41 to 59	1.68 (1.15, 2.45)**	1.55 (0.84, 2.88)	1.96 (1.19, 3.23)**
60 to 79	4.86 (3.35, 7.03)**	5.92 (3.29, 10.67)**	4.73 (2.86, 7.82)**
≥ 80	9.05 (5.96, 13.75)**	10.66 (5.58, 20.39)**	8.07 (4.53, 14.40)**
Marital status			
Single, widowed, divorced, or separated	REF	REF	REF
Married or common-law	0.74 (0.59, 0.94)*	0.85 (0.58, 1.24)	0.72 (0.52, 0.99)*
Education			
Secondary school diploma or less	REF	REF	REF
Post-secondary diploma/degree	1.18 (0.94, 1.49)	1.23 (0.88, 1.73)	1.12 (0.81, 1.54)
Income (quintiles)			
Q 1 (lowest)	REF	REF	REF
Q 2	0.90 (0.67, 1.22)	1.19 (0.76, 1.86)	0.74 (0.49, 1.11)
Q 3	0.63 (0.46, 0.86)**	0.67 (0.42, 1.07)	0.64 (0.42, 0.98)*
Q 4	0.77 (0.52, 1.16)	1.20 (0.69, 2.09)	0.51 (0.28, 0.96)*
Q 5 (highest)	0.90 (0.65, 1.24)	1.16 (0.73, 1.84)	0.72 (0.45, 1.14)
Employment status			
Not in labour force	REF	REF	REF
Unemployed	0.20 (0.14, 0.28)**	0.21 (0.12, 0.36)**	0.19 (0.12, 0.30)**
Employed	0.10 (0.07, 0.15)**	0.09 (0.05, 0.15)**	0.11 (0.07, 0.18)**

Table 4.6 (continued)

	All (N=23024)	Males (N=10565)	Females (N=12459)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Health behaviours (at the time of CCHS interview)			
Smoker type			
Never	REF	REF	REF
Former	1.94 (1.54, 2.45)**	1.46 (1.05, 2.03)*	2.58 (1.82, 3.68)**
Current	1.45 (1.05, 2.01)*	1.14 (0.73, 1.78)	2.09 (1.25, 3.48)**
Drinker type (past 12 months)			
Non-drinker	REF	REF	REF
Occasional	0.76 (0.56, 1.03)	0.85 (0.54, 1.34)	0.69 (0.45, 1.04)
Regular	0.78 (0.61, 0.99)*	0.71 (0.50, 1.00)	0.89 (0.61, 1.30)
Level of physical activity			
Infrequent	REF	REF	REF
Occasional	0.93 (0.68, 1.27)	1.06 (0.67, 1.66)	0.78 (0.49, 1.22)
Regular	0.69 (0.55, 0.87)**	0.75 (0.52, 1.07)	0.62 (0.45, 0.85)**
Fruits and vegetable consumption (times per day)			
< 5	REF	REF	REF
5 to 10	1.15 (0.93, 1.41)	1.23 (0.91, 1.66)	1.07 (0.80, 1.43)
>10	1.40 (0.84, 2.32)	1.86 (0.98, 3.53)	0.87 (0.37, 2.06)

*p<.05, **p<.01

Source: CCHS-IMDB

CCHS: Canadian Community Healthy Survey

CCHS-IMDB: Canadian Community Health Survey Linked to the Longitudinal Immigration Database

Table 4.7 Summary of weighted odds ratios of multimorbidity associated with immigration related factors among immigrants 18 years or older in the 2007 to 2014 CCHS-IMDB in the total sample and by sex

	All (N=23024) OR (95% CI)			Males (N=10565) OR (95% CI)			Females (N=12459) OR (95% CI)		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Immigration recency (years)									
Recent (pre-landing to 5)	REF	REF	REF	REF	REF	REF	REF	REF	REF
Mid-term (5 to 10)	1.43 (1.03, 2.00)**	1.31 (0.92, 1.85)	1.19 (0.80, 1.77)	2.68 (1.53, 4.70)**	1.80 (0.91, 3.56)	1.81 (0.91, 3.57)	0.97 (0.62, 1.50)	0.92 (0.56, 1.53)	0.92 (0.55, 1.56)
Non-recent (>10)	3.44 (2.66, 4.44)*	1.77 (1.33, 2.35)**	1.85 (1.34, 2.56)**	6.26 (3.88,10.12)**	3.48 (1.93, 6.26)**	3.13 (1.73, 5.65)**	2.37 (1.74, 3.24)**	1.34 (0.91, 1.98)	1.29 (0.86, 1.94)
Immigration category									
Economic class-principal applicant	REF	REF	REF	REF	REF	REF	REF	REF	REF
Economic class-spouse/dependent	0.42 (0.32, 0.56)**	0.70 (0.54, 0.92)*	0.71 (0.52, 0.97)*	0.40 (0.26, 0.61)**	1.04 (0.63, 1.72)	1.11 (0.67, 1.85)	0.42 (0.28, 0.61)**	0.57 (0.37, 0.86)**	0.55 (0.35, 0.84)**
Family class	0.92 (0.75, 1.14)	0.89 (0.71, 1.11)	0.85 (0.65, 1.10)	0.93 (0.69, 1.25)	0.83 (0.57, 1.21)	0.93 (0.63, 1.36)	0.88 (0.64, 1.20)	0.77 (0.53, 1.11)	0.73 (0.50, 1.07)
Refugee/other	0.98 (0.77, 1.25)	1.13 (0.88, 1.45)	0.95 (0.71, 1.28)	1.13 (0.82, 1.55)	1.26 (0.86, 1.84)	1.29 (0.87, 1.91)	0.79 (0.54, 1.16)	0.70 (0.45, 1.10)	0.65 (0.41, 1.04)
Birth region									
Europe	REF	REF	REF	REF	REF	REF	REF	REF	REF
Africa or Middle East	0.69 (0.52, 0.91)**	0.83 (0.63, 1.10)	0.75 (0.53, 1.05)	0.64 (0.43, 0.94)*	0.68 (0.44, 1.07)	0.60 (0.37, 0.97)	0.77 (0.54, 1.16)	0.95 (0.59, 1.52)	1.05 (0.64, 1.74)
South Asia	0.91 (0.70, 1.17)	1.22 (0.92, 1.62)	1.38 (0.99, 1.93)	0.96 (0.67, 1.36)	1.35 (0.89, 2.05)	1.35 (0.86, 2.12)	0.85 (0.58, 1.22)	1.20 (0.77, 1.88)	1.53 (0.90, 2.61)

Table 4.7 (continued)

	All (N=23024)			Males (N=10565)			Females (N=12459)		
	OR (95% CI)			OR (95% CI)			OR (95% CI)		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Birth region									
East Asia, Oceania or other Asia	0.53 (0.42, 0.68)**	0.57 (0.44, 0.74)**	0.69 (0.51, 0.94)*	0.54 (0.38, 0.76)**	0.64 (0.43, 0.97)*	0.62 (0.40, 0.96)*	0.52 (0.37, 0.73)**	0.65 (0.43, 0.98)*	0.84 (0.52, 1.35)
South or Central America	0.71 (0.54, 0.92)*	0.91 (0.69, 1.20)	0.91 (0.65, 1.28)	0.52 (0.34, 0.79)**	0.70 (0.43, 1.13)	0.71 (0.43, 1.17)	0.91 (0.63, 1.30)	0.94 (0.60, 1.47)	1.24 (0.77, 1.99)
USA or other miscellaneous	2.22 (1.52, 3.24)**	2.13 (1.57, 2.89)**	2.51 (1.60, 3.95)**	2.36 (1.33, 4.20)**	1.76 (0.84, 3.69)	1.79 (0.85, 3.78)	2.19 (1.33, 3.62)**	3.14 (1.76, 5.61)**	3.15 (1.74, 5.70)**
Knowledge of official languages (at the time of the CCHS interview)									
Neither	REF	REF	REF	REF	REF	REF	REF	REF	REF
English and/or French	0.33 (0.26, 0.42)**	0.86 (0.62, 1.18)	0.88 (0.61, 1.27)	0.39 (0.26, 0.59)**	1.16 (0.65, 2.05)	1.04 (0.58, 1.88)	0.29 (0.22, 0.40)**	0.70 (0.46, 1.07)	0.72 (0.45, 1.17)

*p<.05, **p<.01
Source: CCHS-IMDB
CCHS: Canadian Community Healthy Survey
CCHS-IMDB: Canadian Community Health Survey Linked to the Longitudinal Immigration Database

Multiplicative interactions between immigration recency and immigration category in the model explaining multimorbidity were found (p<0.05). Separate results by sex and economic class immigrant categories were not available due to confidentiality rules set by Statistics Canada, as such this model is not comparable to the previous models. The results of this analysis are presented in Table 4.8. Specifically, non-recent (landed more than ten years ago) economic immigrants were more than three times as likely to experience multimorbidity compared to recent (pre-landing) economic immigrants (OR: 3.95). In addition, mid-term (landed more than five or less than ten years ago) (OR: 1.05), and non-recent (landed more than ten years ago) (OR: 1.02) family class immigrants had greater odds of experiencing multimorbidity compared to recent economic class immigrants.

Table 4.8 Assessment of interaction of recency of immigration between immigration category among immigrants aged 18 years or older in the 2007 to 2014 CCHS-IMDB

	All (N=23024)
	OR (95% CI)
Sociodemographic factors (at the time of CCHS interview)	
Age (years)	
18 to 40	REF
41 to 59	1.74 (1.19, 2.54)**
60 to 79	5.08 (3.51, 7.35)**
≥ 80	9.18 (6.04, 13.96)**
Marital status	
Single, widowed, divorced, or separated	REF
Married or common-law	0.75 (0.60, 0.95)
Education	
Secondary school diploma or less	REF
Post-secondary diploma/degree	1.19 (0.94, 1.50)
Income (quintiles)	
Q 1 (lowest)	REF
Q 2	0.91 (0.68, 1.23)
Q 3	0.65 (0.47, 0.88)**
Q 4	0.77 (0.52, 1.16)
Q 5 (highest)	0.91 (0.66, 1.25)
Employment status	
Not in labour force	REF
Unemployed	0.20 (0.14, 0.28)**
Employed	0.10 (0.07, 0.15)**
Health behaviours (at the time of CCHS interview)	
Smoker type	
Never	REF
Former	1.94 (1.53, 2.45)**
Current	1.47 (1.06, 2.03)*
Drinker type (past 12 months)	
Non-drinker	REF
Occasional	0.77 (0.57, 1.04)
Regular	0.78 (0.61, 1.00)

Table 4.8 (continued)

	All (N=23024)
	OR (95% CI)
Health behaviours (at the time of CCHS interview)	
Level of physical activity	
Infrequent	REF
Occasional	0.93 (0.68, 1.27)
Regular	0.69 (0.55, 0.88)**
Fruits and vegetable consumption (times per day)	
> 5	REF
5 to 10	1.15 (0.94, 1.41)
>10	1.41 (0.85, 2.34)
Immigration factors	
Immigration recency (years)	
Recent (pre-landing to 5)	REF
Mid-term (5 to 10)	0.52 (0.25, 1.10)
Non-recent (>10)	1.20 (0.74, 1.96)
Immigration category	
Economic class	REF
Family class	0.36 (0.17, 0.75)**
Refugee/other	0.85 (0.40, 1.81)
Birth region	
Europe	REF
Africa or Middle East	0.74 (0.52, 1.04)
South Asia	1.37 (0.98, 1.92)
East Asia, Oceania or other Asia	0.70 (0.51, 0.95)
South or Central America	0.91 (0.65, 1.27)
USA or other miscellaneous	2.54 (1.61, 4.00)**
Knowledge of official languages (at the time of CCHS interview)	
Neither	REF
English and/or French	0.89 (0.62, 1.28)

Table 4.8 (continued)

	All (N=23024)
	OR (95% CI)
Immigration recency interaction terms	
Economic class immigrants × immigration recency (years)	
Recent (pre-landing to 5)	REF
Mid-term (5 to 10)	3.22 (0.74, 14.08)
Non-recent (>10)	3.29 (1.05, 10.30)*
Family class immigrants × immigration recency (years)	
Recent (pre-landing to 5)	REF
Mid-term (5 to 10)	5.61 (2.02, 15.61)**
Non-recent (>10)	2.35 (1.08, 5.11)*
Refugee/other immigrants × immigration recency (years)	
Recent (pre-landing to 5)	REF
Mid-term (5 to 10)	1.43 (0.44, 4.60)
Non-recent (>10)	1.13 (0.50, 2.55)

$*p<.05$, $**p<.01$

<div align="center">Chapter 5</div>

5   Discussion

This chapter provides a discussion of key findings of this study. Section 5.1 presents the key findings of this study. Section 5.2 discusses implications of these findings for health policy. Section 5.3 lists the limitations to this study. Section 5.4 provides a conclusion for the results of this study.

5.1   Key findings

5.1.1   Prevalence of multimorbidity

Among immigrants to Canada, 18 years of age or older, the prevalence of multimorbidity (i.e., two or more of the following chronic conditions: respiratory disease, cardiovascular disease, cancer or mental health) was estimated to be 3.5% among the total study population, 3.4% among males and 3.6% among females. Other Canadian studies which have reported on the prevalence of multiple chronic conditions among immigrants to Canada did not primarily investigate multimorbidity. However, these studies have reported on the prevalence of multiple chronic conditions of the foreign-born population in comparison to non-immigrants. For example, Davison et al. (2020) reported that 21.7% of foreign-born individuals had two health conditions and 26.3% had three health conditions among a sample aged 45 to 85 years of age (list of conditions not reported). These results differ from the ones obtained in this study likely due to the older study population (45 to 85 years old) in Davisons et al.'s (2020) study, whereas this current study had a relatively younger study population where all respondents 18 years and older were included. Results from a study conducted by Sun et al. (2009) are more aligned with this current study where 3.6% of Asian immigrants and 5.3% of non-Asian immigrants were reported to have more than five conditions from a list of 18 conditions. Although there are scarcely any Canadian studies primarily focused upon the investigation of multimorbidity among the foreign-born population, some other non-Canadian studies have explored this domain. For example, one American study found that 6% of foreign-born adults had multimorbidity (two or more of: hypertension, diabetes, obesity, arthritis,

stroke, cancer, chronic lung disease, and heart problems) in 2003, which later increased to 12% in 2008 (Jones et al., 2022). A Spanish study found that among documented immigrants, multimorbidity (two or more of 114 chronic expanded diagnostic clusters) was prevalent among 13.9% of males and 26.0% of females (Gimeno-Feliu et al., 2020). While an Italian study reported a multimorbidity (two or more conditions from a list of 26) prevalence of 9.3% among immigrants (Lenzi et al., 2016).

When investigating multimorbidity among categories of immigrants, this study found 2.6% of economic class immigrants (2.7% males, 2.5% females), 4.5% of family class immigrants (3.9% males, 4.8% females) and 4.7% of refugees (4.9% males, 4.4% females) had multimorbidity. The only other known study of multimorbidity among immigrants to Canada is an Ontario based study which utilized nine health conditions in defining multimorbidity (two or more of: arthritis, asthma, diabetes, COPD, cancer, congestive heart failure, Crohn's and colitis, hypertension, and myocardial infarction). This study reported that 5.4% of economic immigrants, 8.1% of family class immigrants and 8.4% of refugees had multimorbidity (Rouhani et al., 2021).

It is difficult to compare the results from our study to the previous literature since current multimorbidity research lacks a consistent definition of this term (Chua et al. 2021; Johnston et al., 2019). Such variations and heterogeneity in defining multimorbidity are likely to explain differences in the prevalence estimates produced in different studies. For example, Rouhani (2021) defined multimorbidity as two or more chronic diseases from a list of nine, whereas the current study used five major groups of chronic conditions rather than an extensive list of conditions. Research has shown that multimorbidity prevalence estimates generally increase with the inclusion of more health conditions (Agborsangaya et al., 2012; Johnston et al. 2019; Lenzi et al., 2016). Furthermore, Rouhani (2021) used clinical measurements to assess multimorbidity, whereas in this study, health conditions were self-reported which may underestimate chronic disease when compared to clinical measurement (Smith et al., 2008; Steinkichner et al., 2022). Lastly, lower estimates of multimorbidity in our study were also likely driven by the relatively young age of the study population. Although the values reported by Rouhani (2021) are greater than the ones observed in the current study, our study replicated the trend of economic immigrants

having a lower prevalence of multimorbidity compared to family and refugee class immigrants.

5.1.2 Correlates of multimorbidity

The second objective of this study was to investigate immigration factors, sociodemographic factors and health behaviours associated with multimorbidity.

5.1.2.1 Immigration related factors

The initial model controlling for immigration related factors found greater odds of multimorbidity among male non-recent immigrants (>10 years), male midterm immigrants (5 to 10 years) and among female non-recent immigrants compared to recent immigrants (≤ 5 years). However, in the second model, the relationship between multimorbidity and male midterm immigrants and female non-recent immigrants did not remain significant. This indicates that the disparity observed in the initial model can be attributed to the presence of a sociodemographic factor or factors that were accounted for in the second model. Despite attenuation of the relationship between male non-recent immigrants and multimorbidity upon controlling for sociodemographic factors and health behaviours, this group had over three times the odds of multimorbidity compared to recent immigrants. Furthermore, multimorbidity among economic and family class immigrants differed based on recency of immigration. There was a stronger association of multimorbidity among non-recent economic immigrants, and midterm and non-recent family class immigrants compared to their recently immigrated counterparts. This finding is in line with previous literature investigating migrants' length of residence in the host country, which have all found an increased likelihood of experiencing multiple chronic conditions as length of stay increased within the host country after controlling for age (Diaz et al., 2015; Gimeno-Feliu et al., 2017; Jatrana et al., 2014). It has been posited that this is likely a product of the healthy immigration effect, where foreign-born adults are often healthier than their native-born counterparts (Diaz et al., 2015; Gimeno-Feliu et al., 2017; Lenzi et al., 2016). However, with increasing length of stay in the host country, the migrants' health often converges to that of the native population due to adapting to the

lifestyle, social and environmental factors of the host country (O'Loughlin et al., 2007; Sanou et al., 2014). Another explanation may be that as migrants socially integrate into their new country, they are more likely to access health resources which in turn leads to the better detection of chronic health conditions (Ravichandiran et al., 2022).

In terms of region of birth, this study found that compared to immigrants born in Europe, males born in Africa or the Middle East, East Asia, Oceania, or other Asia and South or Central America and females born in East Asia, Oceania and other Asia had lower odds of multimorbidity. However, after controlling for sociodemographic factors and health behaviours only men who were born in East Asia, Oceania or other Asia had lower odds of multimorbidity compared to immigrants born in Europe. One Canadian study has reported on birth region and found immigrants from East Asia and the Pacific had one of the lowest risks of multimorbidity compared to long-term residents of Ontario (Rouhani, 2021). One Spanish study by Gimenou-Feliu et al., (2017) found lower odds of multimorbidity for Asian immigrants compared to the native-born population and another American study found lower odds of multimorbidity for Asian immigrants compared to Latin American and Caribbean immigrants. However, these studies grouped together all migrants from the Asian continent, whereas in this current study, South Asian immigrants were categorized separately from other Asian migrants. It was also found that among females, immigrants born in the USA or other miscellaneous areas had double the odds of multimorbidity compared to European immigrants, but upon controlling for sociodemographic factors and health behaviours, these females had triple the odds. This observation can be attributed to the presence of a covariate or covariates which were accounted for in the subsequent models. However, as this is a heterogeneous group of immigrants, further investigation is required to better understand the relationship between immigrants from the USA and multimorbidity. Currently, no known studies have investigated the relationship of immigrants from the USA and other miscellaneous areas and multimorbidity.

This current study found that spouse or dependents of economic class immigrants had lower odds of multimorbidity compared to principal applicants of the economic class. Although after the addition of sociodemographic factors and health behaviors into the

multivariate model, this relationship only remained significant for females. Rouhani (2021) is the only other author to undertake an investigation into the relationship between immigration categories and multimorbidity in Canada and found a lower risk of multimorbidity for economic immigrants compared to long-term residents of Ontario. However, unlike this current study, Rouhani (2021) did not separate economic principal applicants from spouse and dependents of economic applicants. Unfortunately, no other known studies have researched the relationship of spouse or dependents of economic class immigrants and multimorbidity. A possible explanation for the lower odds of multimorbidity, specifically among spouse and dependents of economic immigrants may be a result of the social support they have access to as they are immigrating with the principal applicant, however not all principal applicants are immigrating with their family and thus may not have this social advantage. Perceived social support for immigrants has been found to have a positive effect on health (Almeida et al., 2011; Morey et al., 2021).

5.1.2.2   Sociodemographic factors

In this study there was a constant increase in the odds of multimorbidity with increasing age for both men and women. This finding corroborates previous literature which has consistently reported age to be positively related with multimorbidity among both the general and foreign-born populations (Diaz et al., 2105; Gimeno-Feliu et al., 2017; Lenzi et al. 2016; Rouhani, 2021; Salive, 2013; Tasnim, 2019). This is likely due to increased duration of exposure to multimorbidity risk factors and increased vulnerability to developing chronic health conditions (Marengoni et al., 2011).

This study found that compared to those not in the labour force (i.e., permanently unable to work), immigrants who were unemployed had lower odds of multimorbidity, while those who were employed had even lower odds of multimorbidity. Investigations into the influence of employment status on multimorbidity among the general population have yielded similar results. Yildiz et al. (2020) found a greater likelihood of multimorbidity among those who were unemployed compared to those who were employed. Yildiz et al. (2021) reported that those with chronic disease were less likely to enter paid employment, with the lowest likelihood among those with three or more chronic conditions (Yildiz et

al., 2021). These findings may be explained by biological pathways between unemployment and increased likelihood of chronic disease. Compared to employed immigrants, unemployed immigrants have been found to have higher levels of glucose and glycated hemoglobin which indicates a greater risk of diabetes. (Sia et al., 2019). Additionally, workers burdened with multimorbidity are at a greater risk of becoming unemployed or leaving the labour force (Gurgel do Amaral et al., 2022; van Zon et al., 2018). Alternately, the positive influences of employment may be attributed to the social roles, networks and supports that employment may provide to its employees (Dooley et al. 1996; Paul & Batinic, 2010; Schuring et al, 2017; Warr & Jackson, 1985).

In this study, being married or in a common-law relationship was associated with a lower likelihood of multimorbidity compared to those who were single, widowed, divorced or separated. Previous literature regarding this relationship have been mixed. One study of the foreign-born population has indicated decreased odds of multimorbidity for married individuals compared to those who were separated, divorced or widowed, and an increased odds compared to those who were never married (Diaz et al., 2015), while another did not find a significant association between marital status and multimorbidity (Tasnim, 2019). The posited beneficial effects of partnership on multimorbidity are likely due to the social and emotional support that a marital relationship provides (Kiecolt-Glaser & Newton, 2001; Martire & Helgeson, 2017).

With regards to income, respondents with higher income had lower odds of multimorbidity compared to those with lower income. Likewise, a Norwegian study reported that among immigrants, lower income was associated with higher risk of multimorbidity (Diaz et al., 2015) The inverse relationship between income and multimorbidity is also a common observation in studies of the general population (Agborsangaya et al., 2012; Bayes-marin et al., 2020; Hudon et al., 2012, Hosseinpoor et al., 2012; Knies and Kumari, 2022; Mondor et al. 2018; Schäfer et al., 2012). A product of low income are health inequalities which stem from multiple interacting material, behavioural and psychosocial factors occurring throughout the life course. Such health inequalities contribute to poorer health outcomes among those of lower socioeconomic status (Geda et al., 2021; Olstad et al., 2019; Skalická et al., 2009). In particular among

immigrants, low-income status following migration has been attributed to food insecurity, inability to afford nutritional foods and higher levels of stress which may contribute to chronic health conditions (Berggreen-Clausen et al., 2022; Robert, 2012).

5.1.2.3   Health behaviours

This study found a significant correlation between smoking status and multimorbidity. Female former and current smokers had greater odds of multimorbidity, although this finding was only observed among male former smokers. Findings from the previous literature regarding smoking status have been remarkably varied. Being a current or past smoker was associated with an increased likelihood of multimorbidity among men, but not among women in one Canadian study (Fortin et al., 2014). Interestingly, another Canadian study found smoking to be more strongly associated with multimorbidity among females rather than males (Geda et al., 2021). Smoking was found to be associated with multimorbidity among women in an Indian study (Mishra et al., 2021), and among those aged 40 years or older in an Australian study (Taylor et al., 2010). Opposingly another Canadian study did not report any significant associations in men or women (Sakib et al., 2019), while one South African study reported a decreased likelihood of multimorbidity among smokers (Alaba & Chola, 2013). Although the literature regarding the relationship between smoking and multimorbidity is varied, multiple studies have reported an increased susceptibility to smoking related chronic diseases in women compared to men (Freedman et al., 2008; Haghani et al. 2020; Huxley et al., 20071; Langhammer et al., 2000), which may explain the findings of this study.

This study found that women who exercised regularly were less likely to have multimorbidity compared to women who do not exercise regularly. Interestingly, this finding was not replicated among males. Although physical activity has been extensively supported as a strategy to improve the health of people with chronic health conditions (Chakravarthy et al., 2002; Luan et al., 2019; Singh, 2002, Morres et al., 2019), there have been mixed findings in the literature in regards to the relationship between physical activity and multimorbidity. Dhalwani et al. (2016) found physical inactivity was associated with a greater risk of multimorbidity, similarly de Souza et al. (2012) and

Geda et al. (2021) found an increased odds of multimorbidity with physical inactivity. However, other studies have reported no association between physical activity and multimorbidity among men or women (Sakib et al., 2019; Fortin et al., 2014; Hudon et al., 2008), while one study suggests exercise may be more beneficial for older adults than younger adults (Taylor et al., 2010). Although the findings regarding multimorbidity and physical activity are mixed, there is a general consensus among the literature that physical inactivity is an important cause of chronic conditions and engaging in physical activity can delay and prevent chronic health conditions (Booth et al., 2012; Pedersen & Saltin, 2006; Swainson et al., 2019).

5.2   Implications of key findings

The findings of this study indicate that multimorbidity among immigrants is associated with immigration related factors such as immigration recency, birth region and immigration category. This observation is of considerable importance as investigation of such factors in the context of multimorbidity is scarce. In Canada there is a notable lack of multimorbidity research among immigrants, especially regarding differences in immigrant sub-groups. This is surprising since over 20% of the Canadian population are immigrants, with this number expected to increase (Statistics Canada, 2022). Moving forward, multimorbidity research should consider immigration related characteristics which will provide a better understanding of the role these factors may play in having multimorbidity.

As the immigrant population in Canada continues to grow at an increasing rate, it is crucial to consider the diverse makeup and heterogeneity of this population in terms of immigration related characteristics as well as sociodemographic and health behaviours which may assist in tailoring intervention and prevention efforts for multimorbidity. For example, these programs can target non-recent immigrants, family class immigrants and refugees. Additional efforts can aim to improve immigrant employment opportunities and reduce income disparities. In addition, being a former smoker, or female current smoker, older age and not being married were found to be associated with multimorbidity. As such, multimorbidity prevention efforts and policies can be expanded to include such populations.

Future research should aim to conduct longitudinal studies on the health of immigrants by measuring health status upon arrival and throughout the life course in order to establish temporality between change in sociodemographic and health behaviours and the development of multimorbidity. Additional immigration related factors can be studied such as education level upon arrival, intended occupation, province of nomination, and year of immigration. Additionally, future research can assess differences in multimorbidity among immigrants across countries, as well as if specific clusters of diseases differ by immigration category. Investigations into the effectiveness of interventions and supports in place for immigrants with multimorbidity, with importance being placed on the cultural competency of such interventions in effectively meeting the health needs of the targeted population should also be considered. Currently the literature utilizes diverse approaches in defining multimorbidity (Chua et al. 2021; Johnston et al., 2019), as such there is a need to move towards a standardized definition of this condition which can facilitate comparison of estimates between studies. Overall, more multimorbidity research needs to be conducted among immigrants as this field is understudied.

5.3   Study limitations

This is the first study to provide an analysis of the relationship between multimorbidity and immigration related factors among immigrants in Canada using the invaluable CCHS-IMDB dataset. It explores the role of immigrant related factors such as immigration category, immigration recency and birth region which have not yet been investigated to assess multimorbidity among immigrants across Canada. Despite these advantages, this study presents some limitations.

The Immigrant Landing File used to link the IMDB to the CCHS only includes records for immigrants who landed after 1980. Respondents to the CCHS who landed before 1980, did not have their landing information included in the dataset and thus were not included in the study.

Although the CCHS is an invaluable source of data on the health of the Canadian population, it does present with some shortcomings. The CCHS survey data is cross-

sectional, which prevents the establishment of temporality and direction of the association between various sociodemographic and health behaviours and the main study outcome. Although the institutionalized population, homeless, residents of remote areas and reserves and those who are full-time members of the Canadian forces can be included in the IMDB, the CCHS does not include this population in their survey sample. Thus, some immigrants may have been excluded from the CCHS, and as a result, also from this study. The self-reported nature of the CCHS makes it prone to a number of biases. Respondents may not be able to accurately recall information such as their daily fruit and vegetable intake or may alter their responses to those which are more socially desirable. Miller et al. (2008) have reported that 24 dietary hour recalls are susceptible to substantial social approval bias, where respondents are likely to overstate their fruit and vegetable intake. It is possible similar biases may have affected accurate reporting by respondents in the CCHS. It is also important to consider that language barriers and differences in cultural background, especially among recent immigrants may pose challenges in understanding various health related concepts (Johnson et al., 2006; Warneke et al., 1997).

Additionally, sociocultural factors such as stigma could have contributed to underreporting of mental health related illnesses. Stigma and inability to recognize mental health issues has been reported as a barrier to seeking help for mental health related services among Canadian immigrants (Kirmayer et al., 2011; Li and Ru 2022; Mental Health Commission of Canada, 2016), so it is likely that mental illness is underdiagnosed and thus underreported by many immigrants in the CCHS. Underreporting of physical illnesses is also common among recent Canadian immigrants due to inadequate access to health services leading to underdiagnosis of chronic conditions (Perez, 2002; Shommu et al., 2016). Underdiagnosis in this population can lead to underreporting of chronic conditions in the CCHS.

This study was conducted to improve our understanding of multimorbidity among the immigrant population in Canada as having multiple chronic health conditions is associated with negative health consequences such as poor quality of care, adverse health outcomes and premature death. Investigating multimorbidity among this population can

assist in identifying disparities in health, which have implications for preventative care and health services. However, this study was aimed at investigating the co-occurrence of two or more health conditions within an individual, and as such these results should not be applied to specific chronic diseases.

5.4   Conclusions

The aim of this study was to assess the prevalence of multimorbidity and examine the relationship between multimorbidity and immigration factors, sociodemographic factors and health behaviours among the adult immigrant population in Canada using the 2007-2014 CCHS-IMDB. It was found that 3.5% of the total study population, 3.4% of males and 3.6% of females had multimorbidity. When examining the relationship between multimorbidity and various immigration factors, sociodemographic factors and health behaviours, the sex-specific adjusted analyses found that region of birth, age, employment status and smoking status were significantly associated with multimorbidity for both men and women. In addition, among men, being a non-recent immigrant (>10 years) was associated with multimorbidity whereas among women, arriving as a spouse or dependent of an economic immigrant, marital status, household income and regular physical activity were associated with multimorbidity. Landing duration was more important in explaining multimorbidity among non-recent economic immigrants and their spouse or dependents and mid-term and non-recent family class immigrants, compared to recent economic or family class immigrants.

In addition to sociodemographic factors and health behaviours, immigration factors should be considered in multimorbidity public health initiatives in the immigrant population.

Further research should investigate additional immigration related characteristics such as year of immigration, province of nomination, intended occupation and education level upon arrival. Longitudinal assessments would also be beneficial in gaining an insight to the direction of the relationships between the variables of interest and multimorbidity . Such studies can also assist in the assessment and support of immigrant health and well-being during their residency in their new country.

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stats/immigrant-survey.pdf

Appendices

Appendix A: Search strategy

1. Medline (Ovid)	
Date of Search: 2021-10-13 Number of hits: 855 Comments:	Field labels: .ti,ab,tw.= title, abstract, text word exp/= MeSH, exploded

1. exp comorbidity/
2. exp multimorbidity/
3. exp chronic disease/
4. exp multiple chronic conditions
5. (multimorbid* or "multi-morbid*" or "multi morbid*" or comorbid* or "co-morbid*" or "co morbid*" or "multiple chronic conditions" or "multiple chronic illnesses*" or "multiple chronic diseases" or "multiple conditions" or "multiple illnesses" or "multiple diseases" or "multiple diagnoses" or "morbidity pattern*" or polymorbid* or "poly-morbid*" or "poly morbid*" or polypatholog* or "poly-patholog*" or "poly pathology*" or pluripatholog* or "pluri-patholog*" or "pluri pathology*" or multipatholog* or "multi-patholog*" or "multi patholog*" or "disease cluster*" or "chronic disease*" or "chronic illness*" or "noncommunicable disease*" or "non-communicable disease*" or "non communicable disease*" or "noncommunicable illness*" or "non-communicable illness*" or "non communicable illness*").ti,ab,tw.
6. or/1-5
7. exp "Emigrants and Immigrants"/
8. exp "Emigration and Immigration"/
9. exp "Transients and Migrants"/
10. exp refugees/
11. exp population groups/
12. exp human migration/
13. (immigra* or emmigra* or migration or migrate* or migrant* or alien* or foreign* or newcomer* or refugee* or asylum* or transient*).ti,ab,tw.
14. or/7-13

15. Exp Canada/
16. (Canad* or "British Columbia" or Alberta or Saskatchewan or Manitoba or Ontario or Quebec or "New Brunswick" or "Nova Scotia" or "Prince Edward Island" or PEI or Newfoundland or Yukon or "North West Territories" or Nunavut).ti,ab,tw.
17. or/15-16
18. 6 and 14 and 17
19. Remove duplicates from 18

2. EMBASE (Ovid)	
Date of Search: 2021-10-25 Number of hits: 1933 Comments:	Field labels: .ti,ab,tw.= title, abstract, text word exp/= MeSH, exploded

1. exp comorbidity/
2. exp multiple chronic conditions/
3. exp chronic disease/
4. exp non communicable disease/
5. (multimorbid* or "multi-morbid*" or "multi morbid*" or comorbid* or "co-morbid*" or "co morbid*" or "multiple chronic conditions" or "multiple chronic illnesses*" or "multiple chronic diseases" or "multiple conditions" or "multiple illnesses" or "multiple diseases" or "multiple diagnoses" or "morbidity pattern*" or polymorbid* or "poly-morbid*" or "poly morbid*" or polypatholog* or "poly-patholog*" or "poly pathology*" or pluripatholog* or "pluri-patholog*" or "pluri pathology*" or multipatholog* or "multi-patholog*" or "multi patholog*" or "disease cluster*" or "chronic disease*" or "chronic illness*" or "noncommunicable disease*" or "non-communicable disease*" or "non communicable disease*" or "noncommunicable illness*" or "non-communicable illness*" or "non communicable illness*").ti,ab,tw.
6. or/1-5
7. exp migrant/
8. exp migration/
9. exp refugee/
10. exp population group/
11. (immigra* or emmigra* or migration or migrate* or migrant* or alien* or foreign* or newcomer* or refugee* or asylum* or transient*).ti,ab,tw.
12. or/7-11
13. exp Canada/
14. (Canad* or "British Columbia" or Alberta or Saskatchewan or Manitoba or Ontario or Quebec or "New Brunswick" or "Nova Scotia" or "Prince Edward Island" or PEI or Newfoundland or Yukon or "North West Territories" or Nunavut).ti,ab,tw.
15. or/13-14
16. 6 and 12 and 15
17. Remove duplicates from 16

3. Scopus	
Date of Search: 2021-10-25 Number of hits: 257 Comments:	Field labels: TITLE-ABS-KEY= title, abstract, keyword
1. TITLE-ABS-KEY (multimorbid* or "multi-morbid*" or "multi morbid*" or comorbid* or "co-morbid*" or "co morbid*" or "multiple chronic conditions" or "multiple chronic illnesses*" or "multiple chronic diseases" or "multiple conditions" or "multiple illnesses" or "multiple diseases" or "multiple diagnoses" or "morbidity pattern*" or polymorbid* or "poly-morbid*" or "poly morbid*" or polypatholog* or "poly-patholog*" or "poly pathology*" or pluripatholog* or "pluri-patholog*" or "pluri pathology*" or multipatholog* or "multi-patholog*" or "multi patholog*" or "disease cluster*" or "chronic disease*" or "chronic illness*" or "noncommunicable disease*" or "non-communicable disease*" or "non communicable disease*" or "noncommunicable illness*" or "non-communicable illness*" or "non communicable illness*") 2. TITLE-ABS-KEY (immigra* or emmigra* or migration or migrate* or migrant* or alien* or foreign* or newcomer* or refugee* or asylum* or transient*) 3. TITLE-ABS-KEY (Canad* or "British Columbia" or Alberta or Saskatchewan or Manitoba or Ontario or Quebec or "New Brunswick" or "Nova Scotia" or "Prince Edward Island" or PEI or Newfoundland or Yukon or "North West Territories" or Nunavut) 4. #1 and #2 and #3	

4. PsychInfo (Ovid)	
Date of Search: 2021-10-25 Number of hits: 69 Comments:	Field labels: .ti,ab,tw.= title, abstract, text word exp/= MeSH, exploded

1. exp morbidity/
2. exp comorbidity/
3. exp chronic illness/
4. (multimorbid* or "multi-morbid*" or "multi morbid*" or comorbid* or "co-morbid*" or "co morbid*" or "multiple chronic conditions" or "multiple chronic illnesses*" or "multiple chronic diseases" or "multiple conditions" or "multiple illnesses" or "multiple diseases" or "multiple diagnoses" or "morbidity pattern*" or polymorbid* or "poly-morbid*" or "poly morbid*" or polypatholog* or "poly-patholog*" or "poly pathology*" or pluripatholog* or "pluri-patholog*" or "pluri pathology*" or multipatholog* or "multi-patholog*" or "multi patholog*" or "disease cluster*" or "chronic disease*" or "chronic illness*" or "noncommunicable disease*" or "non-communicable disease*" or "non communicable disease*" or "noncommunicable illness*" or "non-communicable illness*" or "non communicable illness*").ti,ab,tw.
5. or/1-4
6. exp Immigration/
7. exp Human Migration/
8. exp Immigration/
9. exp Refugees/
10. (immigra* or emmigra* or migration or migrate* or migrant* or alien* or foreign* or newcomer* or refugee* or asylum* or transient*).ti,ab,tw.
11. or/6-10
12. (Canad* or "British Columbia" or Alberta or Saskatchewan or Manitoba or Ontario or Quebec or "New Brunswick" or "Nova Scotia" or "Prince Edward Island" or PEI or Newfoundland or Yukon or "North West Territories" or Nunavut).ti,ab,tw.
13. 5 and 11 and 12

5. Web of Science	
Date of Search: 2021-10-25 Number of hits: 785 Comments:	Field labels: TOPIC= title, abstract, keyword

#1 TOPIC: (multimorbid* or "multi-morbid*" or "multi morbid*" or comorbid* or "co-morbid*" or "co morbid*" or "multiple chronic conditions" or "multiple chronic illnesses*" or "multiple chronic diseases" or "multiple conditions" or "multiple illnesses" or "multiple diseases" or "multiple diagnoses" or "morbidity pattern*" or polymorbid* or "poly-morbid*" or "poly morbid*" or polypatholog* or "poly-patholog*" or "poly pathology*" or pluripatholog* or "pluri-patholog*" or "pluri pathology*" or multipatholog* or "multi-patholog*" or "multi patholog*" or "disease cluster*" or "chronic disease*" or "chronic illness*" or "noncommunicable disease*" or "non-communicable disease*" or "non communicable disease*" or "noncommunicable illness*" or "non-communicable illness*" or "non communicable illness*")

#2 TOPIC: (immigra* or emmigra* or migration or migrate* or migrant* or alien* or foreign* or newcomer* or refugee* or asylum* or transient*)

#3 TOPIC: (Canad* or "British Columbia" or Alberta or Saskatchewan or Manitoba or Ontario or Quebec or "New Brunswick" or "Nova Scotia" or "Prince Edward Island" or PEI or Newfoundland or Yukon or "North West Territories" or Nunavut)

#1 AND #2 AND #3

6. ProQuest Dissertation & Theses Global

Date of Search: 2021-10-25 Number of hits: 45 Comments:	Field labels: noft= anywhere except full text

1. noft (multimorbid* or "multi-morbid*" or "multi morbid*" or comorbid* or "co-morbid*" or "co morbid*" or "multiple chronic conditions" or "multiple chronic illnesses*" or "multiple chronic diseases" or "multiple conditions" or "multiple illnesses" or "multiple diseases" or "multiple diagnoses" or "morbidity pattern*" or polymorbid* or "poly-morbid*" or "poly morbid*" or polypatholog* or "poly-patholog*" or "poly pathology*" or pluripatholog* or "pluri-patholog*" or "pluri pathology*" or multipatholog* or "multi-patholog*" or "multi patholog*" or "disease cluster*" or "chronic disease*" or "chronic illness*" or "noncommunicable disease*" or "non-communicable disease*" or "non communicable disease*" or "noncommunicable illness*" or "non-communicable illness*" or "non communicable illness*")

   AND

2. noft (immigra* or emmigra* or migration or migrate* or migrant* or alien* or foreign* or newcomer* or refugee* or asylum* or transient*)

   AND

3. noft (Canad* or "British Columbia" or Alberta or Saskatchewan or Manitoba or Ontario or Quebec or "New Brunswick" or "Nova Scotia" or "Prince Edward Island" or PEI or Newfoundland or Yukon or "North West Territories" or Nunavut)

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