

Effect of socio-demographic factors on the association between multimorbidity and acute care service use: a population-based retrospective cohort study

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Abstract

Background: This study explores how a broad-range of socio-demographic factors shape the relationship between multimorbidity and one-year acute care service use (i.e., hospital, emergency department visits) among older adults in Ontario, Canada. **Methods:** We linked multiple cycles (2005-2006, 2007-2008, 2009-2010, 2011-2012) of the Canadian Community Health Survey (CCHS) to health administrative data to create a cohort of adults aged 65 and older in Ontario. Twelve chronic conditions identified from the administrative data were used to estimate multimorbidity (number of chronic conditions). We identified acute care service use over one year from the administrative data. We examined the relationship between multimorbidity and service use stratified by a comprehensive range of socio-demographic variables available from the CCHS. Logistic and Poisson multivariable regressions were used to explore the association between multimorbidity and service use and the role of socio-demographic factors in shaping this relationship. **Results:** Of the 28,361 members of the study sample, 60% were between the ages of 65 and 74 years, 57% were female, 72% were non-immigrant, and over 75% lived in an urban area. Emergency department visits and hospitalizations consistently increased with the level of multimorbidity. Stratified analyses revealed further patterns, with many being similar for both services – e.g., the odds ratios for both services were higher at all levels of multimorbidity for men, older age groups, and those with lower annual household income. Rurality and immigrant status appeared to impact emergency department use (higher in rural residents and non-immigrants) but not hospitalizations. Multimorbidity and most socio-demographic variables remained significant predictors of acute care service use in the multivariable regressions. **Conclusions:** Strong evidence links multimorbidity with increased acute care service use. This study showed that socio-demographic factors did not modify the relationship between multimorbidity and acute care service use, they were independently associated with acute care service use. Acute care service use was associated with perceived physical and mental health status as well as psychosocial factors, suggesting that optimizing service use requires attention to self-reported health status and social determinants, with programs that are multifaceted and integrated across the health and social service sectors.

Background

Multimorbidity – the coexistence of two or more chronic conditions in the same person – is highly prevalent in older adults. Studies from a range of settings and populations show an increasing prevalence of multimorbidity, with estimates ranging from 65 to 98% in those > 65 years of age (1–6). Studies from around the world also report that the prevalence of multimorbidity is on the rise due to global aging, including increases in Canada, from 17.4–24.3% (27% increase) (7), the Netherlands, from 12.75–16.2% (12% increase) (8), the U.S. from 22–30% (36% increase) (9). Multimorbidity has been associated with decreased physical functioning (10, 11), lower quality of life (11), higher mortality (12), and increased healthcare service use and cost (13, 14). It is now regarded as one of the largest global healthcare challenges of the 21st century (6, 7, 15).

This paper is concerned with the impact of multimorbidity on healthcare utilization, a topic for which detailed knowledge is incomplete (16). Lehnert et al.'s systematic review (13) found that the majority of the 35 included (observational) studies showed a positive association between multimorbidity and service use/cost in older adults. This review and studies published after it note that while multimorbidity and healthcare service use are strongly related, the evidence has been inconsistent on how other socio-demographic factors known to be independently related to multimorbidity and healthcare service use impact the relationship between the two (13, 17).

Studies, most published since the Lehnert et al. review, have identified a range of factors affecting healthcare service use in older adults with multimorbidity, including age and sex (17–21), socio-economic status (17), eligibility for free medical care (18), living alone (22), and impaired activities of daily living (19). However, the results for these factors have been inconsistent. Van den Bussche et al. (19) found that service use was related to multimorbidity, but no differences in this relationship were seen across sex or age groups. Fortin et al. (23) found sex differences where multimorbidity was higher in women than men yet men had higher healthcare use. Results similar to Fortin et al.'s have been reported by others (17, 19). Inconsistent age/sex interactions have been seen, with one study showing that increasing age was associated with increasing physician consultations in men and decreasing consultations in women (17), and another showing a larger age effect on consultations in women versus men (18). Some studies have found lower socio-economic status was associated with lower healthcare service use (17), and others have found no association (24). This heterogeneity of study findings can reflect different levels of multimorbidity (25), inaccurate or incomplete correlates data (17), and geographical differences in healthcare systems and care delivery models (15, 26). It also highlights the importance of region-specific studies and the use of large population-based databases to overcome limitations (3).

Many studies to date have treated socio-demographic factors as covariates that are adjusted for in regression analyses examining the relationship between multimorbidity and healthcare service use, or examined only a few socio-demographic factors. Adjusting for confounders in regression models does not explore potential effect modification, i.e., whether the relationship between multimorbidity and healthcare service use is consistent across levels of the socio-demographic factors. More stratified analyses and examination of interactions between socio-demographic factors and multimorbidity can help to shed light on important moderator effects. Examining only a few socio-demographic factors can mean that key confounders have been missed. Therefore, it is important to consider a broad range of factors to identify the key factors shaping the relationship between multimorbidity and healthcare service use, and to assess the consistency of the relationship across population subgroups. Only then will we have the information needed to design patient-centred interventions that capitalize on widely applicable core elements yet allow interventions to be tailored to address the modifiable risk factors unique to population subgroups.

The purpose of this study was to examine the relationship between multimorbidity and acute care service use (i.e., hospital and emergency department visits) in older adults in Ontario, Canada, and how socio-demographic factors impact this relationship. We used a large-scale population-based survey linked to

administrative data to explore the associations among multimorbidity, acute care service use, and a comprehensive range of socio-demographic factors. The findings can inform future explanatory theories that deepen our understanding of multimorbidity and its impacts.

Methods

Study design and setting

This is a retrospective cohort study in which we used data from four cycles of the Canadian Community Health Survey (CCHS) linked with health administrative data from Ontario, Canada's largest province. Ontario has a population of approximately 14 million residents with the vast majority receiving provincial health insurance coverage for acute care services.

Data Sources

The CCHS is a national cross-sectional survey that collects information related to health status, health care utilization, and health determinants for the Canadian population. CCHS cycles 2005–2006 (27), 2007–2008 (28), 2009–2010 (29), and 2011–2012 (30) were chosen to maximize sample size and ensure consistency in the framing of questions relating to CCHS items used in this study. The four CCHS cycles were administered in participants' homes using computer-assisted personal interviewing and participants in Ontario were asked if they would consent to have their CCHS data linked to provincial administrative data holdings. The index date for linkage was the participant's CCHS interview date. Administrative databases used in the study were the: Registered Persons Database (demographics); Ontario Health Insurance Plan (OHIP) (physician visits); Discharge Abstract Database (inpatient hospitalizations); National Ambulatory Care Reporting System (emergency department other ambulatory contacts); Same Day Surgery (same-day surgeries, procedures); and Ontario Drug Benefit (outpatient prescription claims). Two additional data sources were accessed for specific diagnostic information on chronic conditions: the Ontario Mental Health Reporting System and the Ontario Cancer Registry. More information on these databases is provided in Additional File 1. All data are held at ICES, where they were linked using encoded identifiers and analyzed. ICES is an independent, non-profit research institute funded by an annual grant from the Ontario Ministry of Health and Long-Term Care. As a prescribed entity under Ontario's privacy legislation, ICES is authorized to collect and use health care data for the purposes of health system analysis, evaluation and decision support. Secure access to these data is governed by policies and procedures that are approved by the Information and Privacy Commissioner of Ontario. The study received approval from the Hamilton Integrated Research Ethics Board at McMaster University (certificate #13–590) and renewed yearly as required.

Study sample

We included Ontario CCHS participants who responded to any of the included CCHS cycles and who agreed to have their data linked to the health administrative data. We excluded those who were under 65 or over 85 years of age ($n = 103,377$) as we expected those under 65 to have health service use

substantially different from older adults and there was only a small number of CCHS participants over age 85. We excluded people who could not be identified as Ontario residents (n = 94), who did not have health system contact within the 5 years prior to their survey date (n = 161), who resided in long-term care (n = 158) or received hospice or palliative care services (n = 322), who participated in more than one CCHS cycle (we chose only the first cycle, n = 580), who did not report their chronic disease status (n = 1,016) and who were ineligible for OHIP coverage at index (n = 71). The final sample included 28,361 individuals (see Fig. 1).

Chronic conditions and multimorbidity

We identified 12 chronic conditions: Alzheimer's diseases/dementia, anxiety/depression, arthritis, cancer, asthma, chronic obstructive pulmonary disease (COPD), diabetes, heart disease, hypertension, inflammatory bowel disease, stomach or intestinal ulcers, and stroke. These conditions were chosen because they could be identified in the administrative data, are prevalent in older adults, and are frequently reported in the literature on multiple chronic conditions (7, 31, 32). Chronic conditions were identified as either entry into a disease-specific database created at ICES or using an algorithm that searched for specific diagnostic codes and/or outpatient prescription claims within the 5 years prior to baseline. More details about each diagnostic definition can be found in Additional File 2.

Multimorbidity was operationalized as a count of individual chronic conditions (0, 1, 2, 3, 4, or 5 or more).

Acute Care Service Use

The outcome in this study was acute care service use, which included emergency department visits and hospital admissions. The analyses included two measures for each service: a dichotomous variable (any visit/admission) and a count variable (number of visits/admissions).

Socio-demographic & Health Status Variables

The socio-demographic and health status variables selected for the study were determined by those available from the CCHS, guided by Anderson and Newman's Behavioural Model of Health Care Utilization which identifies the following 3 determinants of health service use: need, enabling, and predisposing factors (33, 34). Need is determined by a person's perceived need for health services, which in turn is a function of self-perceived health, activities of daily living (ADLs/IADLs) or restricted activity, self-reported symptoms, quality of life, etc. Enabling factors include a person's income, health insurance status, and access to regular care. Predisposing factors include demographic variables, attitudes, and beliefs. Anderson and Newman's model has been primarily used for explaining health care utilization in the general population, with strong evidence of a socio-economic gradient in both developed and developing countries (35–39). Our goal in using the Anderson and Newman model was to ensure that we were as comprehensive as possible in capturing the different types of determinants. Predisposing variables in our study included sex, age, marital status and living arrangement; enabling factors included education, household income, and rurality; and needs-based variables were captured by the need for any assistance with daily activities, and two health-status variables (self-perceived physical and mental

health). Additional File 3 provides further details on how these variables were defined and operationalized in the study.

Multiple imputation using a discriminant function method (40) was employed to address missing data, which only occurred for certain CCHS variables. All CCHS data and chronic conditions and a flag indicating death during a five-year prospective observation period from administrative data were used to impute missing data. Supplemental Table B1 shows the amount of missing data for each variable, with household income have the highest level of missing data (7.56%), followed by education (3.22%) and self-reported mental health (2.25%).

Statistical Analysis

Our main interest was the role of socio-demographic and health status factors in moderating the association between multimorbidity and acute care service use. We began by conducting bivariate analyses exploring the association between multimorbidity and acute care service use stratified by each socio-demographic and health status variable. Logistic regression was employed in the bivariate analysis, modelling any vs. no acute care service over one year. Analyses showing differences in the multimorbidity/service use relationship across strata, were followed up with more detailed stratified analyses to determine whether the patterns were similar across demographic subgroups. For example, a difference in the relationship between multimorbidity and service use between males and females was followed with further stratified analyses (e.g., age and sex) to determine if the sex difference was similar across age groups. We also performed multivariable regressions, which included multimorbidity and all the socio-demographic and health status variables, to adjust for these factors in exploring the association between multimorbidity and acute care service use. Logistic regression was used for the dichotomous dependent variable (any versus no health service use) and Poisson regression was used to analyze the number of health service encounters. Interactions between multimorbidity and the covariates were explored in the regressions. We were selective in exploring interactions due to the large number of covariates, and guided this analysis based on signals from the stratified analyses and inclusion of variables fundamental in epidemiological studies (e.g., age, sex).

SAS version 9.4 was used for all statistical analyses, and the level of significance used throughout the study was $\alpha = 0.05$.

Results

Socio-demographic, Health Status and Acute Care Service Use

Of the 28,361 members of the study sample, 60% were between the ages of 65 and 74 years, 57% were female, 72% were non-immigrant, and over 75% lived in an urban area and had annual household incomes below \$80,000. While 72% perceived their mental health to be very good or excellent, fewer (46%) perceived their physical health to be so with 44% having 3 + chronic conditions. The majority (80%) did

not need help with basic daily tasks, such as meal preparation, routine household errands, personal care etc. During the previous year, 7% had at least one emergency department visit and 12% had at least one acute care episode (see Table 1).

Stratified Analyses: Relationship Between Acute Care Service Use and Multimorbidity

Figures 2a-2j show the odds ratios (ORs) for each acute care service (emergency department, hospitalization) for any use within 1 year of CCHS index date by level of multimorbidity (number of chronic conditions), stratified by *selected* socio-demographic variables. Given the large number of stratification variables, we selected for the main body of the paper those where significant or key relationships were seen, with the remaining figures provided in Supplemental File C. All odds ratios use a reference of 0 chronic conditions for one of the subgroups, e.g., in Fig. 2a the OR of 1.2 and 1.4 for females and males (respectively) with 1 chronic condition represent the odds of any emergency department use during the past year in those with 1 chronic condition compared to females with no chronic conditions.

Emergency department visits and hospitalizations consistently increased with the level of multimorbidity. Stratified analyses revealed further patterns independent of the level of multimorbidity, with many being similar for both emergency department visits and hospitalizations. For example, the ORs for both services were higher at all levels of multimorbidity for: men (vs women) (Figs. 2a, 2b), older age groups (age 75–84 vs 65–74) (Figs. 2c, 2d), and those with lower annual household income (below \$30,000 vs above) (Figs. 2e, 2f). Different OR patterns for the two services were seen for rurality and immigrant status, which appeared to impact emergency department use (higher in rural vs urban residents and non-immigrants vs immigrants) but not hospitalizations (Figs. 2g-2j).

Additional File 4 shows that the ORs for both services were higher at all levels of multimorbidity for those: with less education (Figs. 4a, 4b), lower perceived physical and mental health (Figs. 4g-4j), and that needed help with daily tasks (Figs. 4k, 4l). The ORs for both services did not differ substantially by living arrangement (Figs. 4c, 4d) or marital status (Figs. 4e, 4f).

Multivariable Regression Results

Table 2 shows the results of the multiple regression for any ED visit and the number of ED visits, with the independent variables including multimorbidity and all other correlates (simultaneously included in the model). The results were similar for both outcomes (any ED visit, number of ED visits). Multimorbidity was among the most significant predictors of ER visits according to the OR (for 4+ chronic conditions: OR was 1.75, 95% CI was 1.51–2.02). Most correlates were also associated with an ED visit independent of multimorbidity, with higher odds of an ED visit seen in older respondents, those with lower education and lower household income, and in males, non-immigrants, rural residents, those needing help with basic tasks, and those with lower perceived physical health. Living arrangement and perceived mental health were not associated with either ED outcome.

Table 3 shows the results for the multiple regression for any hospitalization and the number of hospitalizations, with the same independent variables used in the ED regressions. The results were similar for both outcomes, with higher odds of hospitalization seen in older respondents, those with higher levels of multimorbidity, lower household income, lower perceived physical health, and in those that were male, non-immigrant, needed help with basic tasks or lived alone. Odds of hospitalization were *lower* in those with lower perceived mental health. Education and residency (urban/rural) were not associated with either hospitalization outcome.

We do not report the results of exploring the interactions between multimorbidity and the covariates, as the few significant interactions seen were highly inconsistent across subgroups.

Age and Sex Differences in Service Use

We explored service use differences by age and sex, since some studies report age/sex influences on health care use and/or cost. Figures 3a and 3b compare males and females respectively on the average annual ED visits and hospitalization (among those with at least one ED visit or hospitalization) across age/multimorbidity strata. These figures do not suggest there are significant differences between males and females across most of the age/multimorbidity strata. The largest difference between males and females occurs in the highest multimorbidity/age category (4+, 75–84) for ED visits, where females remain the same but males decline in use from an average of 2.0 to 1.5 visits compared to the lower multimorbidity category (2–3, 75–84).

Discussion

Summary of main findings

This study is one of the few to examine the influence of a comprehensive range of socio-demographic factors and health status factors (perceived mental and physical health) on the relationship between multimorbidity and acute care service use. We found that multimorbidity was a strong predictor of both ED visits and hospital admissions, even after controlling for a range of socio-demographic factors. While most of the factors considered in this study influenced acute care service use independent of multimorbidity, they did not change its fundamental relationship with service use - i.e., increased multimorbidity was consistently associated with increased service use and the impact was similar across many subgroups.

Comparison with existing literature

We found that sex influenced service use in the adjusted model, with higher odds of ED visits and hospital admissions among males. The effects of sex on healthcare service use and cost have been demonstrated in a number of studies from Canada and other high- and middle-income countries (24, 41–45), with the results generally showing the opposite to our findings – i.e., greater use/cost in women. Reproductive and sex-related morbidity and mortality have been found to account for sex differences in health care costs in one Canadian study (45), but studies on other populations have found these factors

explain some but not all service use/cost differences (41, 44). Sex differences may also reflect use of different types of services. Friberg et al. (44) found that women were more likely to receive primary care while men were more likely to receive inpatient (hospital) care, and Bertakis et al. (41) found women had higher healthcare service use including ED visits but not hospitalizations after adjusting for health and socio-economic status. Canadian studies focused on ED use show little evidence of sex differences, particularly among older adults aged 65+ years of age (46, 47). Our findings are nevertheless consistent with a number of studies showing that older men in particular dominate resource-intensive health care (12, 44, 45, 48). This may reflect the kinds of conditions men are most likely to have or their higher mortality risk (due to a shorter life expectancy) thus leading to the need for more demanding (acute care) services (44). It may also reflect a reluctance by men to seek health care except in cases of acute/serious illness (49).

Our study found independent age effects as well, with higher odds of ED visits and hospital admissions in older adults (age 75–84 vs 65–74). Ample evidence demonstrates the importance of age as a determinant of healthcare service use (44), although many studies do not control for multimorbidity in examining the impact of age on service use (or vice versa), resulting in uncertainty regarding the independent influence of these factors. The age effect observed in our study may reflect differences in access to or preferences for services, or the severity of underlying conditions. It may also reflect the presence of other conditions or symptoms common in older adults that require receipt of healthcare services but are not captured by measures of chronic illness (e.g., frailty, incontinence, falls, pain). Age effects on hospital use independent of multimorbidity were also reported by Payne et al. (50) in their retrospective study of a large (n = 180,815) Scottish general population cohort, and have been seen in studies of specific disease cohorts, such as those with diabetes (51, 52).

Overall, we did not find a significant age/sex interaction influencing acute care service use, consistent with other studies reporting few or no significant age/sex influences, including the study by van den Bussche et al. (19) looking at ambulatory care services and Hessel et al. (24) who studied general practitioner and specialist services. The drop we observed in ED visits for males in the highest multimorbidity/age category (4+, 75–84) compared to the lower multimorbidity/age category (2–3, 75–84) is unusual, and we are aware of only one other study with a similar finding – i.e., Librero et al. (53) found that patients in the highest morbidity group (5+ conditions) were significantly less likely to have an ED visit (OR = 0.51) compared to those without chronic conditions, whereas patients with moderate morbidity burden (1–2) had significantly higher chances (OR = 1.24). The Lehnert et al. (13) review noted that the Librero et al. (53) study was unusual, with all others showing a positive association (ranging from weak to strong) between number of chronic conditions and ED visits. Our finding of a drop in ED visits in males in the highest multimorbidity/age category suggests that further research may be helpful – e.g., men in the highest multimorbidity category may spend more time in the hospital thus have less time to visit the ED, and women may show this same pattern in an older age cohort due to their longer life expectancy (e.g., 85+, excluded from our study).

Socioeconomic status shaped acute care service use in our adjusted analysis. Lower household income and education were each associated with higher odds of ED visits, and lower household income was associated with higher odds of hospital admissions. This finding is consistent with another Canadian study that found that the association between the level of multimorbidity and healthcare costs was greater at higher levels of neighbourhood marginalisation (7). It is also consistent with other studies which use a range of measures of socioeconomic status at the individual and/or regional level, including deprivation quintiles, education, and free medical care (17, 18, 54). It is important to note that the socioeconomic gradient seen in this study exists despite Canadian residents having access to near-universal health insurance coverage, suggesting that despite the fact that Canada has a national system of health and social services, older adults with lower socioeconomic status are less likely to use acute care services. Also important is that the socioeconomic gradient found in our study is independent of multimorbidity, which itself is typically more prevalent in socioeconomically-deprived populations (55). It may be that individuals living in marginalized areas face barriers to accessing healthcare services (56), with cascading effects in terms of developing poorer health outcomes and requiring more expensive healthcare expenses (7). Further research is needed to better understand the socioeconomic gradient relating to acute care service use within the context of the Canadian healthcare system.

Immigrant status was independently associated with acute care service use in our adjusted analysis. Non-immigrants had higher use of both acute care services compared to immigrants, with larger differences for ED use compared to hospitalizations. Roberge et al's study on ED use (57) found lower service use in immigrants compared to non-immigrants in their study of Canadian residents from Quebec. The longitudinal nature of their study was helpful in understanding the possible reasons for this difference - e.g., it showed that recent immigrants were healthier and younger than the general population, and over time ED use in immigrants became similar to non-immigrants such that after 10 years service use was identical in the two groups (57). Other research suggests that lower service use by immigrants could be a reflection of access barriers due to language or lack of knowledge (58), which is further supported by reports of unmet healthcare needs among immigrants (59). This literature collectively highlights the complexity of this phenomenon and the need for further study.

Geographic location influenced ED use but not hospitalizations in our adjusted analysis, with higher ED use among rural versus urban residents. Other Canadian studies have observed greater use of ED services in rural areas (57, 60). This has been attributed in part to the way services are organized in rural areas, with rural physicians tending to practice in emergency departments and hospitals and thus encourage patients to use these services to preserve continuity of care (61, 62). The vast majority (88%) of people in the study by Roberge et al. (57) reported having consulted a health professional before going to the ED and were advised by them to go there, perhaps reflecting the organization of primary care and/or urgency of the healthcare need. This study also found that fewer people with a regular source of primary health care went to EDs, and suggested that this may be due to the increased likelihood of rapid service access for immediate needs and benefits linked to continuity of care (63, 64). However, another Canadian study found that those with a regular doctor were as likely to report ED use as those without one, and that heavy users of primary care services were equally heavy users of ED services (60, 65).

Similarly, a large US study found that those who lacked a regular doctor were *less* likely to be a frequent ED user (66). Therefore, having a usual source of care does not guarantee reduced ED use and lack of access to usual care does not necessarily increase ED use, highlighting the importance of other drivers such as the patient's health status, perceptions of need, and the organization/accessibility of primary care services. The finding that users of EDs in rural areas of Canada are less sick compared to those in urban areas (57) suggests that factors linked to nonurgent use reported in other studies may be relevant, notably perceived need for specialized services and access barriers (67, 68). Clearly, EDs and hospitals operate differently in urban and rural settings, thus it is important to understand this context in order to correctly interpret acute care use and design interventions to optimize it.

Self-perceived physical health and daily functioning (IADLs in our study) were each associated with acute care service use in the adjusted analysis, with low/poor self-perceived health and functionality linked to higher ED use and hospitalizations. Previous research is consistent with our finding (69–72), and also shows that adding functional status to health status measures derived from administrative data improves the ability to identify high risk/high-cost system users (69, 73). Studies also show that, compared to users of primary care services and medical clinics, more people will seek ED services for health problems causing pain, limitations in their daily functioning, and risk of complications (57, 62, 74). Collectively, this evidence suggests that chronic illness alone is insufficient in explaining healthcare service use. Capturing a broader range of health status measures may in fact hold the key to designing future interventions that are effective in addressing service needs/use.

Self-perceived mental health was associated with hospitalization but not ED use in our adjusted analysis, with lower perceived mental health associated with fewer hospitalizations. Evidence exists linking lower self-perceived mental health to higher use of mental health services, complementary services (e.g., chiropractic, acupuncture), and general practice (75); however, the evidence is weaker in relation to use of hospitalizations. Remes et al. (76) found that anxiety was not associated with hospital admissions unless it was comorbid with depression, and other studies show that self-reported mental health was not as strong in predicting hospitalizations as various physical health measures (e.g., self-reported physical health, physical comorbidity) (69, 77). Regarding ED use, U.S. studies suggest that mental health disorders are a key driver of ED use, regardless of insurance coverage. Capp et al.'s (78) large U.S. study with over 66 million annual visits found that ED visits increased by 8.6% from 2006 to 2011, yet ED visits by adults primarily for mental health disorders increased by 20.5%. Mental health disorders have also been found to be a significant factor accounting for non-urgent ED use (79). While our study did not find that self-perceived mental health was associated with ED use, this may be due to differences across studies in the mental health measure used – e.g., self-reported mental health (our measure) is dimensionally different than objective measures of mental illness (80) and is not recommended as a substitute/proxy for mental diagnoses (75, 81).

Living alone influenced hospitalizations but not ED use, with living alone associated with higher hospitalizations in our study. Results are conflicting in studies that have examined this issue – e.g., Shaw et al. (82) and Cafferata (83) found that living alone was associated with higher use of hospital services,

Manski et al. (84) found no difference in hospital use among those living alone versus with someone, and a systematic review of 126 studies found that weaker social relationships were associated with increased hospital re-admissions and longer hospital stays (85). Inconsistent findings may reflect differences in measuring and/or equating constructs – e.g., social isolation and loneliness are not the same entity (86) and living alone does not necessarily indicate social isolation (87). However, it is plausible that social relationships impact acute care service use given reported links between social isolation/loneliness and poor health (88, 89) and studies showing that social isolation/loneliness predicts ED use (79, 90–94).

Strengths and Limitations

A major strength of this study was the use of a large sample of Canadian older adults and administrative data with robust and well-reported measures of chronic conditions and accurate capture of health service use. By linking to the CCHS, we were able to incorporate a comprehensive range of sociodemographic variables that are typically not available when using administrative data alone. Other strengths include minimal missing data, and modelling acute care service outcomes two different ways (any service and number of services) showing that this methodological choice did not significantly impact the findings.

We also acknowledge the key limitations of our study. Our measure of multimorbidity included 12 chronic conditions. These conditions represent the most prevalent chronic conditions in Canadian older adults (95) and those often used in multimorbidity research (96). However, there are conditions other than those captured in this study that may influence healthcare service use. Also, our measure of multimorbidity - the number of chronic conditions - does not capture differences in the types/clusters/severity of the conditions, which can also impact healthcare service use. Essentially, we still lack a consistent definition or framework for thinking about multimorbidity, which impacts research and the comparability of studies. Our study focused on acute care (hospital, emergency department) services; it would be useful to examine primary care and other service use for a more comprehensive understanding of impacts. Finally, we explored a number of interactions between multimorbidity and the covariates, which was necessarily selective due to the large number of covariates in the study. Although no interaction terms were significant in the regressions, it is possible that some relevant interactions were missed.

Conclusion

Strong evidence exists linking multimorbidity with increased use of a range of healthcare services, including the acute care services examined in this study. Our study showed that although a number of socio-demographic and health status factors were also independently associated with greater acute care use, none modified the relationship between multimorbidity and acute care service use and were independently associated with it. Some of these factors such as age and sex are not modifiable, but they can be taken into account in allocating resources and identifying groups for targeted interventions and programs. Other factors like socio-economic status and social isolation play a role in both multimorbidity and healthcare service use and would likely benefit from cross-sectoral approaches to effectively address the underlying issue.

This study also highlighted areas for future research. We found lower service use among immigrants, but it was not clear whether this reflected a healthier and younger population or one facing access barriers. Rural residents had higher service use, but was this because of the organization of primary care or higher illness rates? More sophisticated approaches to measuring multimorbidity may also be useful, such as using cluster analysis to identify disease portfolios associated with costly service use. Our results linking low/poor self-reported physical health and functionality to higher service use suggest the need to take a broad view of physical health that includes “conditions” such as pain, incontinence, and functional limitations. Including self-reported measures in standard clinical assessments can be done, and may be the source of potent predictors of service needs/use. Ultimately, the study’s results suggest that optimizing acute care service use will require attention to social determinants, with programs that are multifactorial and integrated across the health and social service sectors.

Abbreviations

Acronym (Abbreviation)	Explanation
ADL	Activities of Daily Living
CCHS	Canadian Community Health Survey
COPD	Chronic Obstructive Pulmonary Disease
ED	Emergency Department
IADL	Independent Activities of Daily Living
ICES	Institute for Clinical Evaluative Sciences
LCL	Lower 95% Confidence Limit
OHIP	Ontario Health Insurance Plan
OR	Odds Ratio
UCL	Upper 95% Confidence Limit

Declarations

Ethics approval and consent to participate

The study received approval from the Hamilton Integrated Research Ethics Board at McMaster University (certificate #13-590) and renewed yearly as required.

Administrative data were obtained from the Institute for Clinical Evaluative Sciences (ICES), an independent, non-profit research institute funded by an annual grant from the Ontario Ministry of Health and Long-Term Care. As a prescribed entity under Ontario’s privacy legislation, ICES is authorized to collect and use health care data for the purposes of health system analysis, evaluation and decision

support. Secure access to these data is governed by policies and procedures that are approved by the Information and Privacy Commissioner of Ontario.

Consent for publication

Not applicable.

Availability of data and materials

The data that support the findings of this study are available from the Institute for Clinical Evaluative Sciences (ICES), an independent, non-profit research institute funded by an annual grant from the Ontario Ministry of Health and Long-Term Care. However, restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Those interested in acquiring these data must submit an application to ICES.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

LG, AG, KF, JP and MMR developed the study design. RP, LF and FN conducted the analysis under the direction of LG, AG and KF. LG, AG, KF, RP, LF and FN participated in the interpretation of the analyses. KF prepared the initial draft of the manuscript. All authors reviewed and commented on the manuscript draft, and approved the final version of the manuscript submitted for publication.

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Tables

Table 1

Prevalence of selected socio-demographic and health status characteristics, multimorbidity and acute care service use

Characteristic	Category	Frequency (n)	Percentage (%)
Age	65–74	16979	59.87
	75–84	11382	40.13
Sex	Male	12093	42.64
	Female	16268	57.36
Immigrant Status	Immigrant	7736	27.28
	Non-Immigrant	20625	72.72
Education	Post Secondary Degree	12661	44.64
	Secondary School Degree	6139	21.65
	No Diploma	9561	33.71
Household Income	Under \$30,000	10382	36.61
	\$30,000 to \$79,999	13723	48.39
	\$80,000 or more	4256	15.01
Living Arrangement	Living with others	16583	58.47
	Living Alone	11778	41.53
Geography	Urban	21402	75.46
	Rural	6959	24.54
IADLs ^a	Does not need help with basic tasks	22732	80.15
	Needs help with basic tasks	5629	19.85
Self perceived physical health	Excellent/Very Good	12937	45.62
	Good	9027	31.83
	Fair or Poor	6397	22.56
Self perceived Mental Health	Excellent/Very Good	20369	71.82
	Good	6490	22.88
	Fair or Poor	1502	5.3

^a Independent Activities of Daily Living

Characteristic	Category	Frequency (n)	Percentage (%)
Chronic Conditions	0	2457	8.7
	1	5786	20.4
	2	7694	27.1
	3+	12424	43.80
Emergency Department Visits	Any visit (past year)	1895	6.7
	Mean (standard deviation)	1.74 (1.76)	
Acute Care Episode (Hospital or Emergency Department Visit)	Any episode (past year)	3515	12.4
	Mean (standard deviation)	1.34 (0.73)	
^a Independent Activities of Daily Living			

Table 2
Odds and Incidence Rates of Hospitalization, Multiple Imputation Results

Variable	Odds of Hospitalization			Incidence Rate of Hospitalization		
	OR	OR LCL ^a	OR UCL ^a	OR	OR LCL ^a	OR UCL ^a
Chronic Conditions						
0-1	-	-	-	-	-	-
2-3	1.31	1.20	1.44	1.35	1.24	1.47
4+	1.84	1.64	2.06	1.80	1.61	2.00
Age						
65-74	-	-	-	-	-	-
75-84	1.32	1.22	1.42	1.29	1.20	1.39
Sex						
Female	-	-	-	-	-	-
Male	1.45	1.34	1.57	1.43	1.32	1.54
Immigrant Status						
Immigrant	-	-	-	-	-	-
Non-Immigrant	1.16	1.06	1.26	1.14	1.05	1.24
Education						
Post-secondary degree	-	-	-	-	-	-
Secondary school degree	.95	.86	1.05	.98	.89	1.08
No diploma	1.08	.99	1.18	1.11	1.02	1.21
Household Income						
Over \$80,000	-	-	-	-	-	-
\$30,000 to \$79,999	1.22	1.07	1.38	1.30	1.15	1.47
Under \$30,000	1.22	1.06	1.40	1.28	1.12	1.47
Living Arrangement						

^a LCL = Lower 95% Confidence Limit, UCL = Upper 95% Confidence Limit

^b Independent Activities of Daily Living

Variable	Odds of Hospitalization			Incidence Rate of Hospitalization		
	OR	OR LCL ^a	OR UCL ^a	OR	OR LCL ^a	OR UCL ^a
Living with others	-	-	-	-	-	-
Living alone	1.15	1.06	1.25	1.12	1.04	1.22
Geography						
Urban	-	-	-	-	-	-
Rural	1.04	.96	1.14	1.05	.96	1.13
IADLs^b						
Does not need help with basic tasks	-	-	-	-	-	-
Needs help with basic tasks	1.68	1.54	1.84	1.58	1.45	1.72
Self-Perceived Physical Health						
Excellent/Very Good	-	-	-	-	-	-
Good	1.50	1.36	1.65	2.30	2.08	2.55
Fair or Poor	2.29	2.05	2.54	1.51	1.37	1.65
Self-Perceived Mental Health						
Excellent	-	-	-	-	-	-
Good	.88	.81	.97	.90	.83	.98
Fair or Poor	.79	.68	.93	.84	.73	.97
^a LCL = Lower 95% Confidence Limit, UCL = Upper 95% Confidence Limit						
^b Independent Activities of Daily Living						

Table 3
Odds and Incidence Rates of Emergency Department Visits, Multiple Imputation Results

Variable	Odds of an Emergency Department Visit			Incidence Rates of Emergency Department Visits		
	OR	OR LCL ^a	OR UCL ^a	OR	OR LCL ^a	OR UCL ^a
Chronic Conditions						
0-1	-	-	-	-	-	-
2-3	1.21	1.08	1.36	1.30	1.14	1.48
4+	1.75	1.51	2.02	1.73	1.45	2.06
Age						
65-74	-	-	-	-	-	-
75-84	1.43	1.30	1.58	1.38	1.23	1.54
Sex						
Female	-	-	-	-	-	-
Male	1.16	1.05	1.29	1.24	1.11	1.40
Immigrant Status						
Immigrant	-	-	-	-	-	-
Non-Immigrant	1.35	1.20	1.51	1.41	1.24	1.60
Education						
Post-secondary degree	-	-	-	-	-	-
Secondary school degree	.91	.80	1.04	1.00	.86	1.16
No diploma	1.12	1.00	1.26	1.14	1.00	1.30
Household Income						
Over \$80,000	-	-	-	-	-	-
\$30,000 to \$79,999	1.12	.95	1.32	1.16	.96	1.39
Under \$30,000	1.29	1.07	1.55	1.36	1.11	1.67
Living Arrangement						
Living with others	-	-	-	-	-	-
^a LCL = Lower 95% Confidence Limit, UCL = Upper 95% Confidence Limit						
^b Independent Activities of Daily Living						

Variable	Odds of an Emergency Department Visit			Incidence Rates of Emergency Department Visits		
	OR	OR LCL ^a	OR UCL ^a	OR	OR LCL ^a	OR UCL ^a
Living alone	.98	.88	1.09	.97	.86	1.10
Geography						
Urban	-	-	-	-	-	-
Rural	1.26	1.13	1.40	1.33	1.18	1.51
IADLs^b						
Does not need help with basic tasks	-	-	-	-	-	-
Needs help with basic tasks	1.26	1.12	1.41	1.23	1.07	1.42
Self-Perceived Physical Health						
Excellent/Very Good	-	-	-	-	-	-
Good	1.33	1.17	1.51	1.45	1.26	1.66
Fair or Poor	1.91	1.66	2.19	2.03	1.73	2.38
Self-Perceived Mental Health						
Excellent	-	-	-	-	-	-
Good	.93	.83	1.04	.93	.81	1.06
Fair or Poor	1.02	.84	1.23	.97	.76	1.23
^a LCL = Lower 95% Confidence Limit, UCL = Upper 95% Confidence Limit						
^b Independent Activities of Daily Living						

Figures

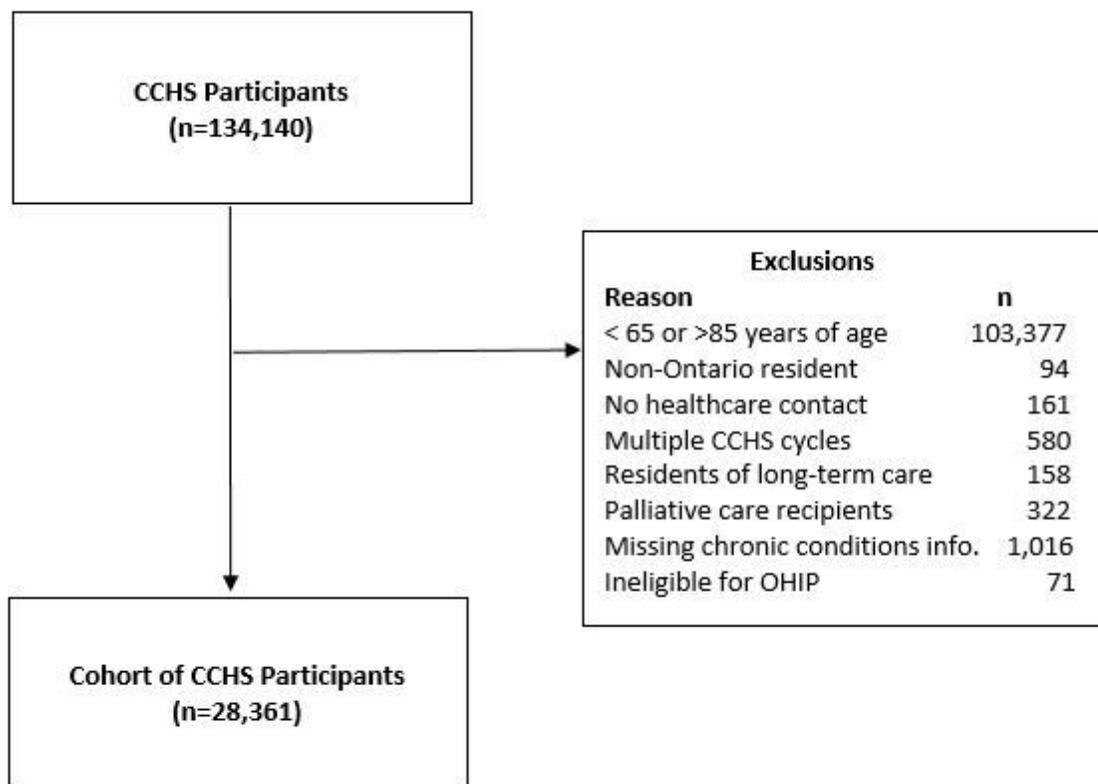


Figure 1

Title: Study cohort of Canadian Community Health Survey participants (Ontario) who consented to administrative data linkage
 Legend: CCHS - Canadian Community Health Survey, OHIP – Ontario Health Insurance Plan

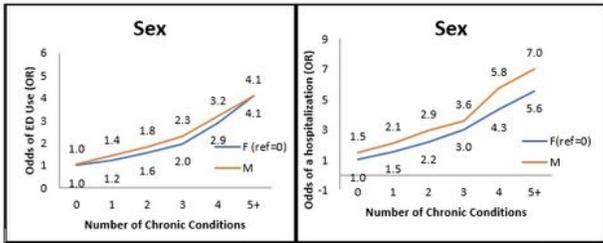


Figure 2a

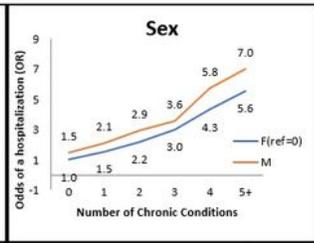


Figure 2b

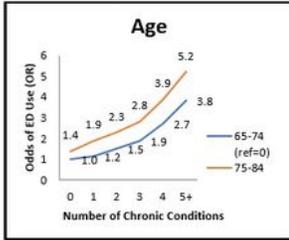


Figure 2c

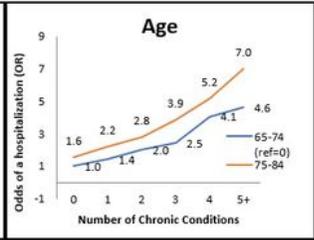


Figure 2d

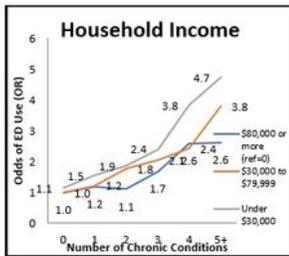


Figure 2e

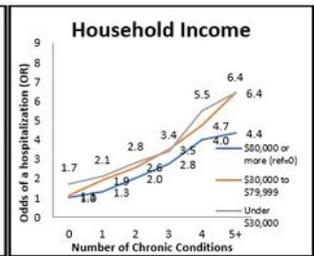


Figure 2f

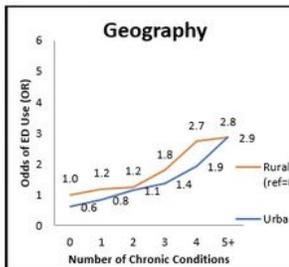


Figure 2g

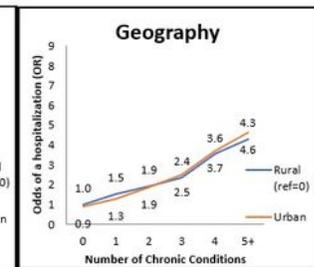


Figure 2h

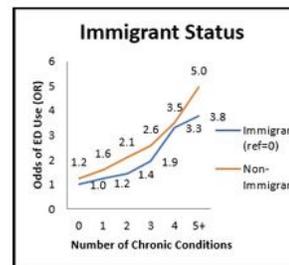


Figure 2i

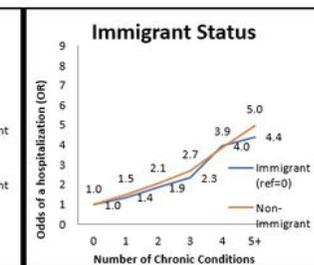


Figure 2j

Figure 2

Title : Odds of Any 1-Year Emergency Department (ED) and Hospital Use by Number of Chronic Conditions
 2a: Odds of ED Use (Sex) 2b: Odds of Hospital Use (Sex) 2c: Odds of ED Use (Age) 2d: Odds of Hospital Use (Age) 2e: Odds of ED Use (Income) 2f: Odds of Hospital Use (Income) 2g: Odds of ED Use (Geography) 2h: Odds of Hospital Use (Geography) 2i: Odds of ED Use (Immigrant) 2j: Odds of Hospital Use (Immigrant)

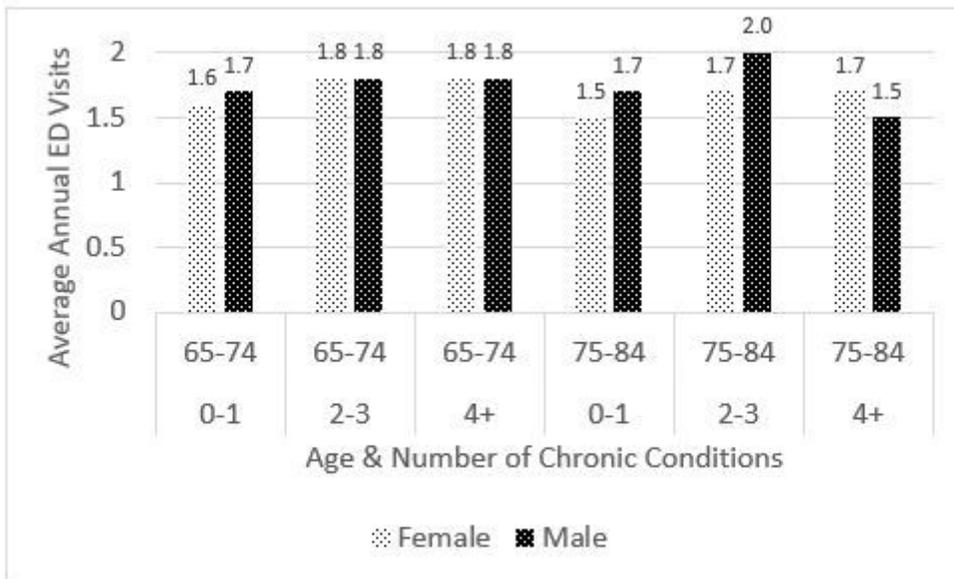


Figure 3a

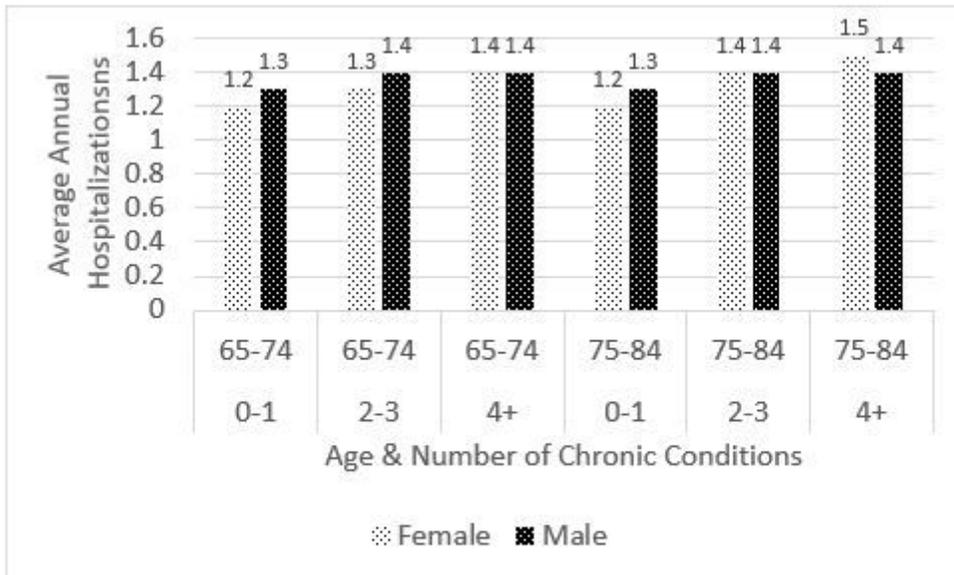


Figure 3b

Figure 3

Title : Average 1-Year Emergency Department (ED) and Hospital Use by Sex, Age, Number of Chronic Conditions
 3a: Average 1-Year Emergency Department (ED) Visits by Sex, Age and Number of Chronic Conditions
 3b: Average 1-Year Hospital Use by Sex, Age and Number of Chronic Conditions

Supplementary Files

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