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Original quantitative research

Stepping up to the Canadian opioid crisis: a longitudinal analysis of the correlation between socioeconomic status and population rates of opioid-related mortality, hospitalization and emergency department visits (2000–2017)

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Abstract

Introduction: High levels of income inequality and increased opioid-related harm across Canada bring into question the role of socioeconomic status (SES) in the opioid epidemic. Only a few studies have examined this association, and most of those have analyzed this issue on a provincial level. This study examined the association between opioid-related health outcomes and SES, and investigated rate ratios over time.

Methods: Administrative databases were used to identify opioid-related mortality, hospitalization and emergency department visits between 2000 and 2017. Patient's postal code was linked to the quintile of median household income at the forward sortation area level. Crude rates and age- and sex-adjusted rates in each quintile were calculated, as well as the adjusted rate ratio of average annual rates between the lowest and highest quintiles. The significance of the time trend of rate ratios for all outcomes was examined using linear regression.

Results: A stepped gradient of opioid-related outcomes across all income quintiles emerged from these data. For mortality, hospitalization and emergency department visits, the average annual rate ratio between lowest quintile and highest quintile was 3.8, 4.3 and 4.9, respectively. These ratios were generally stable and consistent over the study period, albeit the opioid-related mortality SES gap decreased gradually ($p < 0.01$).

Conclusion: Area income quintile was found to be highly associated with opioid outcomes. Psychosocial factors (stress, unemployment, housing insecurity) that are typically concentrated in low SES areas may play a significant role in the opioid epidemic. Health policies should address these factors in order to provide effective solutions.

Keywords: analgesics, opioid, mortality, hospitalization, emergency service, hospital, social class, opiate addiction, income, time

Introduction

Canada has seen a significant increase in opioid-related mortality and morbidity,¹ rendering the opioid epidemic a challenging public health priority.^{2,3} The incidence

of opioid-related harms continues to grow;^{4,5} for example, the rate of opioid-poisoning hospitalizations in Canada increased by more than 50% over a 10-year period (2007–2017),⁶ while the rate of opioid-related emergency department

Highlights

- Socioeconomic status (SES) may be an important factor in determining opioid outcomes.
- Only a few research studies to date have investigated this relationship.
- We used administrative databases to examine the associations between SES (measured by area's income quintile) and opioid mortality, hospitalization and emergency department (ED) visits.
- We found evidence of a socioeconomic gradient in all opioid-related outcomes. The rate ratio between lowest income and highest income quintiles was approximately 4 for mortality and hospitalizations and approximately 5 for ED visits.
- The rate ratio between lowest income and highest income quintiles was generally stable and consistent over time. However, the mortality rate ratio showed a decreasing trend.

(ED) visits increased by more than 100% in Alberta and Ontario from 2012 to 2017.⁶ Many factors influence adverse outcomes of opioid use and can affect patients in a multitude of ways.⁷

A potentially important issue in understanding opioid-related harms is socioeconomic

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position. Whether conceptualized as socioeconomic status (SES), social class or simply as income or wealth, one's location in social hierarchies might play a major role in opioid-related harms.^{8,9} Since the mid-1990s, health sciences have shifted from a predominantly biomedical and clinical focus to a growing emphasis on population health (i.e. "health as a social science").¹⁰ Using this lens, adverse opioid outcomes should be considered in light of the relationship between social position and individual behaviours.^{1,7,11}

SES is a complex construct, signifying one's position within a social hierarchy, and often measured by income, education and occupational status.^{12,13} SES typically captures both material and social conditions and reflects both current social and economic resources and past conditions.¹⁴ In this regard, lifestyle "choices" such as substance use can be seen as not simply the result of an individual's decisions and agency. Rather, they are structured by aspects of past experience (including families, neighbourhoods, education and other earlier life events) in addition to current access to material and social resources that might help in coping with challenges. SES is often spatially concentrated, with individuals and families with lower SES tending to live in areas with poorer access to resources.^{15,16}

Research linking SES and opioid-related harms is emerging.⁷ Several studies have examined this association in the US,¹⁷⁻¹⁹ though there have been few studies in Canada at the national level. Carrière et al. examined opioid-poisoning hospitalizations in Canada (excluding Quebec) between 2011 and 2016, using the 2011 National Household Survey (NHS) linked to hospitalizations.²⁰ Lower income, lower education, unemployment and Indigenous identity were found to be associated with higher rates of opioid-related hospitalizations (rate ratio = 3.9 between the highest and lowest income quintiles; 95% confidence interval [CI]: 3.4–4.6.²⁰). Regardless of questions of the validity of NHS income data due to the changes in census methodology in 2011,²¹ this study was restricted to opioid-poisoning hospitalizations at one point in time. Importantly, it did not assess opioid use disorder (OUD), defined by the American Psychiatric Association as "a problematic pattern of opioid use (both prescribed and illicit) leading to problems or distress"^{22,p.541} with several criteria pertaining to dose, craving,

effects on work or school, use in dangerous situations and withdrawal in the 12-month period.^{23,24}

Canadian studies have examined the association between SES and opioid outcomes using provincial databases.²⁵ Researchers found in British Columbia that low SES (measured by the highest deprivation quintile) is associated with a greater reduction in life expectancy at birth due to overdose-related causes.^{26,27} A study in Ontario found that the prevalence ratios of opioid morbidity were two to three times higher in the lowest quintile areas compared to the highest,²⁸ probably due to higher opioid prescribing rates and lower levels of care-seeking behaviour.

Although such studies can enlighten us about provincial patterns, they are of limited use in painting a national picture. All Canadian provinces are facing the opioid epidemic,²⁹ and understanding its relationship to SES will be essential to develop policies for prevention, harm reduction and treatment at a national level. It is also important to understand how these relationships might have changed over time, as the epidemic has progressed.³⁰

The objective of this study was therefore to examine how rates of opioid-related outcomes are related to area SES, and how these trends have unfolded over time at the national level.

Methods

This retrospective observational study analyzed data from Canada from 2000 to 2017. The methodology of this study has been described previously.²⁹ National administrative databases were employed to provide a complete depiction of all vital statistics and all encounters with the universal health care system in Canada.³¹ We accessed the most comprehensive data available in Canadian jurisdictions including mortality (from all of Canada, 2000–2012 and Canada except Quebec, 2013–2017), hospitalization (Canada except Quebec, 2000–2012) and ED visits (Ontario, 2002–2008 and Ontario/Alberta combined, 2009–2012) ([Appendix 1](#)).

Data sources

Opioid mortality

We used the Canadian Vital Statistics Death (CVSD) database from 1 January 2000 until 31 December 2017 to identify

opioid-related mortality. CVSD is an administrative database capturing all death cases in Canada, with demographic attributes (age, sex and postal code of the deceased's residence) as well as medical attributes. The main and additional causes of death are coded using the International Classification of Disease Tenth Revision (ICD-10). Due to a technical limitation, opioid mortality data from Quebec were not available after 2012 and were not included in the average or in the annual rate calculation.²⁹ However, we included Quebec data in additional analysis of the annual rate from 2000 to 2012.

Opioid hospitalization

The Discharge Abstract Database (DAD) contains specific information about each hospitalization episode in Canada, outside of Quebec. It contains patient demographics (age, sex and first three characters of the postal code of area of residence) as well as clinical information. Diagnoses are coded according to the ICD Ninth Revision (ICD-9) and ICD-10, with up to 25 diagnoses listed. The first is the "main" diagnosis, and others are comorbidities.³² Hospitalizations are recorded by fiscal year, from 1 April to 31 March. For this study, data were available from 2000/01 until 2012/13.

Opioid ED visits

The National Ambulatory Care Reporting System (NACRS) contains specific information about each ED visit in all facilities in Ontario (from 2002/03) and Alberta (starting from 2010/11); it also contains demographic and clinical information. Although some facilities in other provinces contribute to NACRS data, only Ontario and Alberta contribute from 100% of facilities.³³ For this study, data were available from 2002/03 to 2012/13. We included all cases from Ontario in annual rates as well as annual average rates. We also combined Ontario and Alberta in the annual rates starting from 2010/11.

Population and SES estimates

Estimates of population and SES were generated using census data. Each year of the study period was linked to population estimates of the individual's area of residence at the forward sortation area (FSA) level ([Appendix 2](#)). FSAs are relatively small geographic units identified by the first three characters of the postal code. In urban areas, FSAs typically cover roughly 200 city blocks of major metropolitan areas, or entire medium-sized cities. In

rural areas, FSAs usually include larger regions.³⁴

SES was estimated by FSA median annual total gross household income. Aggregate-level indicators are the most-used measures of SES in health research³⁵ and the use of FSAs enabled identification of local differences in opioid-related mortality with a high level of granularity while protecting individual confidentiality. FSAs were arranged into median household income quintiles within provinces. Because of changes to the 2011 census,²¹ income data for this year might not be reliable for small areas. We therefore used income from the 2006 census (Appendix 2). To calculate average annual mortality rates over the whole study period, we used population and income estimates from the 2016 census. For average annual hospitalization and ED visit rates, we used population estimates from 2016 and income estimates from 2006.

Measurements

Opioid mortality

To identify opioid death cases, we utilized the modified algorithm of the Centers for Disease Control and Prevention, and added heroin to captured entities.²⁹ In this algorithm, underlying cause of death should be drug poisoning, while an opioid or opioid-related entity should be listed in the multiple cause of death codes.³⁶ Appendix 3 contains the ICD codes for identifying opioid-related mortality. A sensitivity of 75% and a positive predictive value of 90% were estimated for this algorithm.³⁶

Opioid hospitalization and ED visits

A Canadian Institute for Health Information (CIHI) algorithm was used to identify opioid-related hospitalizations and ED visits—including both opioid poisonings and opioid use disorders.³⁷ To capture hospitalizations before the full implementation of ICD-10 in Canada, we also used ICD-9 codes (Appendix 4).¹⁷ A sensitivity of 75% and positive predictive value of about 80% were reported for this algorithm.³⁸ We considered all fields of diagnosis if they contributed significantly to the duration of hospitalization or ED visit.³⁷

Data analysis

For deaths, hospitalizations and ED visits, we linked cases to the FSA population estimate and income quintile of the respective year of the census. We excluded

cases missing postal codes, as well as cases in FSAs that could not be assigned income quintiles or for which median income was suppressed by Statistics Canada for confidentiality reasons. We calculated crude annual rates of opioid mortality, hospitalization and ED visits within each income quintile by summing all cases per annum and dividing them by the estimated population. For average annual rates, the numerator was all cases over the study period, while the denominator (population estimate from 2016 census year) was multiplied by the number of follow-up years. We adjusted all rates for age and sex differences between income quintiles using direct standardization.³⁹ Consistent with the CIHI method,³⁷ the Canadian population from the 2011 census was used as the standard population,⁴⁰ with age in 5-year intervals.

Rate ratios of the average annual age- and sex-standardized mortality, hospitalization and ED visits rates were computed by dividing the rate in each income quintile by that of the highest quintile. The 95% CIs for rate ratios were computed using the method suggested by Newman.⁴¹ We used the lowest and highest income quintiles for the annual rate ratio calculation. We plotted the rate ratios of the mortality, hospitalization and ED visits over the study years. The significance of the slope was examined by estimating a linear regression between the year and rate ratio. A significance level of 5% was used for all statistical tests.

Ethics approval was obtained from the University of Waterloo Office of Research

Ethics (ORE#41558). Data were accessed through the South-Western Ontario Research Data Centre (SWORDC), and analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA). The numbers of cases and crude rates were rounded, according to Statistics Canada's confidentiality rules, while adjusted rates and rate ratios were produced using unrounded numbers.

Results

Average annual rates were based on the realized 19 560 death cases, 82 125 hospitalizations and 71 055 ED visits. Of these, 96.4%, 94.5% and 100% were linked to an FSA with an estimated income quintile, respectively. Linkage success was higher for the annual crude rates, with 99.4%, 98.9% and 100% for death cases, hospitalizations and ED visits, respectively.

The crude average annual opioid-related mortality rate ranged from 17.9 cases per million in the highest income quintile to 69.0 cases per million in the lowest income quintile. Adjusted rates ranged from 18.6 to 72.1 cases per million between the highest and lowest income quintiles, respectively (Table 1). Therefore, the rate ratio between the lowest and highest income quintiles was 3.8 (95% CI: 3.6–4.0).

Crude average annual rates of opioid-related hospitalization ranged from 91.2 hospitalizations per million in the highest quintile to 402.8 hospitalizations per million in the lowest quintile (Table 2). The adjusted rates also ranged from 96.5 to 413.2 cases per million between the

TABLE 1
Average annual opioid-related mortality^a rate per million in Canada (excluding Quebec) by forward sortation area income quintile between 2000 and 2017

FSA income quintile	Death cases	Population ^b	Average annual crude rate	Average age- and sex-adjusted rate	Adjusted rate ratio ^c	95% CI
1 (highest)	1585	4 923 280	17.9	18.9	1.0 (reference)	
2	2325	5 115 515	25.3	26.4	1.4	1.3–1.5
3	4035	6 070 270	36.9	38.5	2.0	1.9–2.2
4	4960	6 086 520	45.3	48.2	2.6	2.4–2.7
5 (lowest)	5955	4 792 290	69.0	72.1	3.8	3.6–4.0

Abbreviations: CI, confidence interval; FSA, forward sortation area.

^a Data from the Canadian Vital Statistics Death (CVSD) database.

^b Population estimates are based on census data.

^c Rate ratios are based on rates by areas' household income quintile.

TABLE 2
Average annual opioid-related hospitalization^a rate per million in Canada (excluding Quebec) by forward sortation area income quintile between 2000/01^b and 2012/13^b

FSA income quintile	Hospitalization cases	Population ^c	Average annual crude rate	Average age- and sex-adjusted rate	Adjusted rate ratio ^d	95% CI
1 (highest)	4 520	4 923 280	91.2	96.5	1.0 (reference)	
2	5 835	5 115 515	135.6	138.9	1.4	1.4–1.5
3	9 020	6 070 270	200.0	203.8	2.1	2.1–2.2
4	15 785	6 086 520	276.2	284.7	3.0	2.9–3.0
5 (lowest)	21 855	4 792 290	402.8	413.2	4.3	4.2–4.4

Abbreviations: CI, confidence interval; FSA, forward sortation area.

^a Data from the Canadian Vital Statistics Death (CVSD) database.

^b Fiscal years.

^c Population estimates are based on census data.

^d Rate ratios are based on rates by areas' household income quintile.

highest and lowest income quintiles, and the rate ratio between the lowest and highest income quintiles was 4.3 (4.2–4.4). The crude and adjusted average annual rate of ED visits ranged from 165.8 and 175.4 in the highest quintile to 842.1 and 861.6 per million, respectively (Table 3). Thus, a more pronounced rate ratio of 4.9 (4.8–5.1) for the average annual rate of ED visits was seen over the study period.

The time trend of the rate ratio between the lowest and highest income quintiles showed that the lowest quintile consistently had higher rates of opioid-related mortality, hospitalizations and ED visits (Appendices 5–9). Income-related inequality in opioid-related mortality rates decreased from 2000 to 2017 (Figure 1A). We estimated the slope of the linear time trend to be -0.13 ($p < 0.01$). When we restricted

the analysis to 2000 to 2012 from all of Canada (Figure 1B), the slope was less pronounced (-0.10) but was still significant ($p = 0.01$).

Conversely, income-related inequality in opioid-related hospitalizations from 2000/01 to 2012/13 did not change significantly, with an estimated slope of 0.01 ($p = 0.08$) (Figure 2). The inequality in opioid-related ED visits also did not show a significant change from 2002/03 to 2012/13; the slope of this trend was 0.03 ($p = 0.50$) (Figure 3).

Discussion

This study explored the relationships between SES, as represented by the income quintile of the area of residence, and adverse outcomes from opioid use in Canada from 2000 to 2017 for mortality,

from 2000/01 to 2012/13 for hospitalizations and from 2002/03 to 2012/13 for ED visits. Results indicate a stepped gradient in all opioid-related outcomes from the highest income quintile to the lowest quintile. The rate ratios of the average annual rate between the lowest quintile and highest quintile were 3.8, 4.3 and 4.9 for mortality, hospitalization and ED visits, respectively. This gradient was generally stable and consistent over the study period. However, mortality inequity seemed to be gradually reducing from 2000 to 2017.

These results are similar to those of a previous study of opioid-related hospitalizations (rate ratio of 3.9).⁴² However, our study found that the same SES inequities found in hospitalization risk extended to opioid-related mortality and ED visits. This is also similar to patterns found in mortality due to other causes associated with high-risk behaviours, such as HIV infections and alcohol-related diseases.⁴³ In terms of the time trend, this inequity was, for the most part, stable over time in Canada. However, inequity in mortality is decreasing.

Population health research examining inequalities in health spans several decades. While Canadians have played a leading role in developing the population health perspective,⁴⁴ there is no question that a catalyst for this thinking arose from the classic *Black Report* published in 1980.⁴⁵ The report demonstrated that, even after 40 years of universal health care, not much had changed in terms of income inequality and health. Another key message was that the patterns of health seen in the population—regardless of the specific health outcome—had a stepped gradient relationship with income. Similar patterns have also been found in Canada^{43,46} and in the United States.⁴⁷ Our results are consistent with this gradient phenomenon. That is, there was no apparent threshold above or below which everyone shared the same, or even similar, risk. Rather, at each level in the income gradient there was lower opioid mortality, hospitalization and ED visits than in the quintile below it.

To this day, there is no definitive explanation for the existence of income gradients in so many health outcomes. Despite the unequal distribution we observed, the harms of the opioid epidemic are clearly

TABLE 3
Average annual opioid-related emergency department visits^a rate per million in Ontario by forward sortation area income quintile between 2002/03^b and 2012/13^b

FSA income quintile	ED visit cases	Population ^c	Average annual crude rate	Average age- and sex-adjusted rate	Adjusted rate ratio ^d	95% CI
1 (highest)	5 015	2 749 745	165.8	175.4	1.0 (reference)	
2	8 205	2 601 525	286.7	301.6	1.7	1.7–1.8
3	15 190	2 912 585	474.1	499.0	2.8	2.8–2.9
4	20 625	2 808 070	667.7	710.1	4.1	3.9–4.2
5 (lowest)	22 020	2 377 180	842.1	861.6	4.9	4.8–5.1

Abbreviations: CI, confidence interval; ED, emergency department; FSA, forward sortation area.

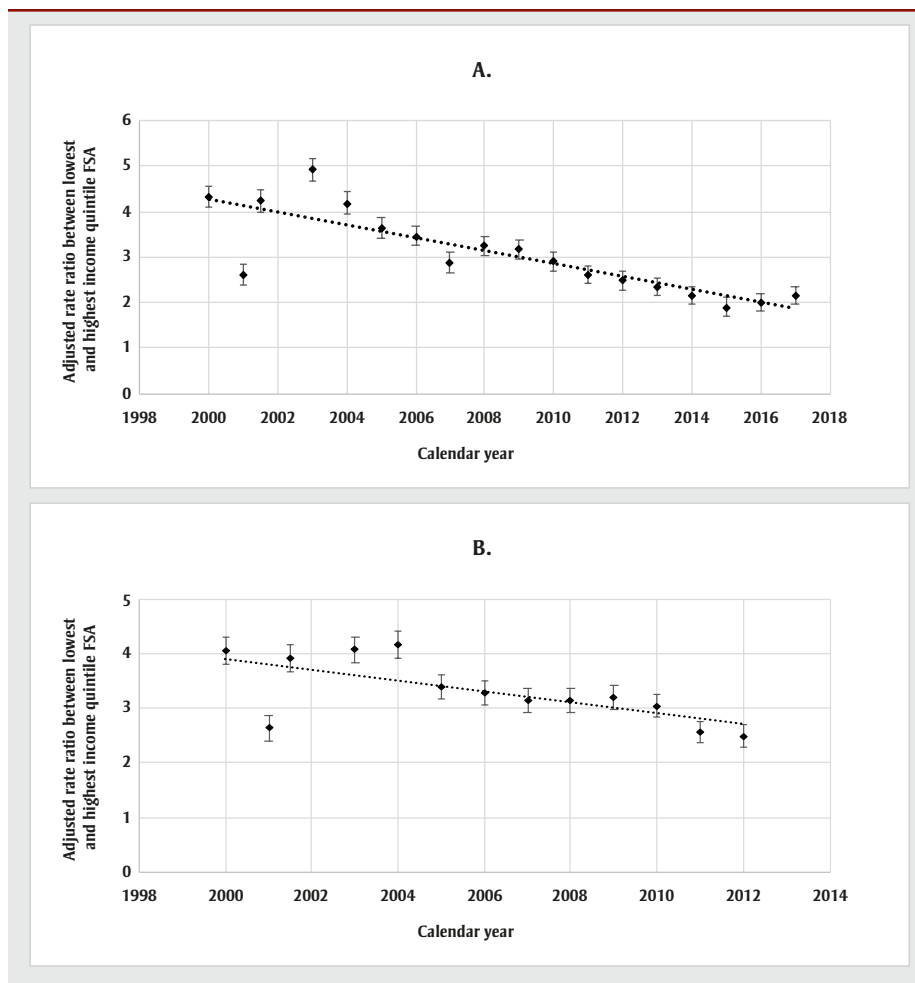
^a Data from National Ambulatory Care Reporting System metadata (NACRS).

^b Fiscal years.

^c Population estimates are based on census data.

^d Rate ratios are based on rates by areas' household income quintile.

FIGURE 1
Time trend of rate ratio of the annual opioid-related mortality^a rate per million between the lowest and highest income quintile of forward sortation areas in Canada (excluding Quebec) between 2000 and 2017 (A) and in Canada between 2000 and 2012 (B)



Abbreviation: FSA, forward sortation area.

^a Data from the Canadian Vital Statistics Death (CVSD) database.

not restricted to people with low income. This observation is somewhat different from the conventional wisdom that asserts poverty and homelessness as the main culprits in the opioid epidemic.⁴⁸ The higher risk in quintile 2 compared to quintile 1 (i.e. the highest income quintile) is not likely due to higher risk of poverty or homelessness. Moreover, the clear and consistent gradient suggests that it is not material conditions (access to goods, services, neighbourhood quality) that matter the most. People living in areas in the second-highest income quintile in Canada are not likely experiencing poverty, nor are they tremendously different from those in the highest quintile in terms of their material well-being. Instead, it suggests that psychosocial factors play a key role in this gradient.

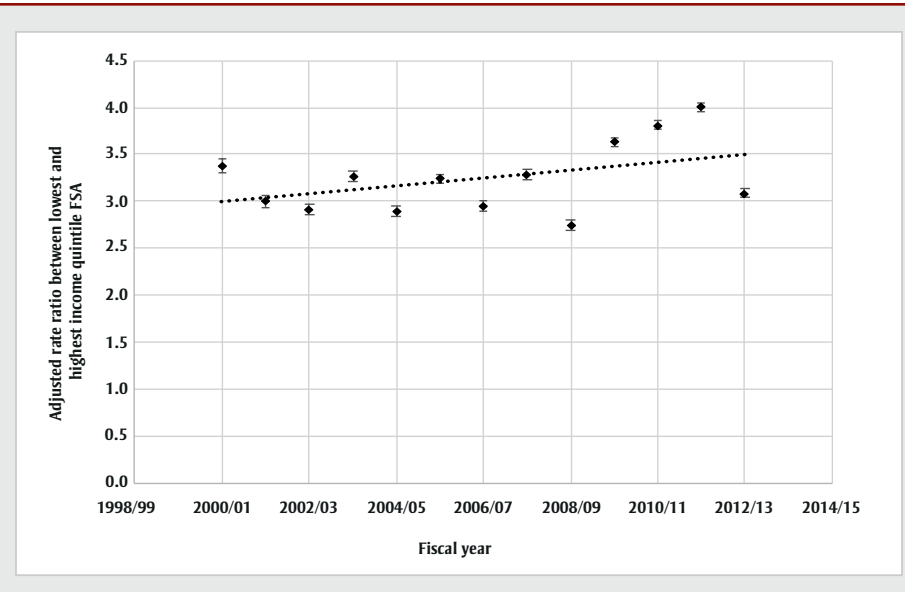
In addition to a clear gradient, these data allow us to see the progression of the epidemic over time, with its effects moving from less to more privileged areas. Those living in low-income areas were the most impacted by various factors that tend to be most intense in areas where marginalized people are clustered, and therefore felt the effects early. Social marginalization has likely intensified psychosocial factors that make certain strata of our society more vulnerable to this epidemic.⁴⁹ However, opioid mortality rates seen in the lowest-income areas in 2005 were reached by the highest-income areas 8 to 10 years later. Hence, the closing gap in mortality might indicate that the opioid epidemic will eventually be felt throughout Canadian society, and that high SES merely delays its effects and cannot prevent it.

There is no one psychosocial factor that can be singled out as the main reason people use substances such as opioids. We may speculate that feeling marginalized, suffering from discrimination, experiencing trauma, living in social isolation or having limited social support drives opioid use among people in deprived areas. Social capital, which can be conceptualized as an individual or as an area-level attribute, broadly refers to relationships that allow people or communities to access various resources, including material, social and psychological supports.^{50,51} Socially disadvantaged people or communities might be less able to mobilize resources from others, including family or other networks, that could buffer psychosocial stress.⁵¹ Residents of lower-SES areas might have higher risk of the sorts of both social stressors and adverse events that can lead to opioid misuse and poorer access to alternative supports.

Beyond social capital, psychosocial factors pertaining to culture and support within the community (or the social contagion)⁵² play a major role in individual behaviours.⁵³ According to social learning theory, people will adapt to and model behaviours observed in their social circles through attention, memory and motivation.⁵⁴ This network effect has been found to be a major determinant in many health behaviours. For example, having a friend who had successfully completed smoking cessation was found to decrease the likelihood of smoking by almost one-third.⁵⁵ Having a friend with depression was highly correlated with the likelihood of being diagnosed with depression oneself.⁵⁶ Similar results have been reported for sleep loss⁵⁷ and obesity.⁵⁸ Therefore, opioid social contagion (within families, social circles or neighbourhoods) could be a major factor driving the opioid gradient.^{59,60} This effect might be augmented when the intersectionality of several socio-economic factors is accounted for.⁶¹

Providing meaningful economic opportunities, delivering high-quality and equitable health care and education and reviving social capital in marginalized areas may be among our highest public health priorities in Canada, if we want to get the opioid epidemic under control. Although it may not be clear which specific policies and programs are required, it is clear that ignoring equity issues will dilute the efficacy of interventions.⁶²

FIGURE 2
Time trend of rate ratio of the annual opioid-related hospitalization^a per million in Canada (excluding Quebec) between the lowest and highest income quintiles of forward sortation areas between 2000/01^b and 2012/13^b



Abbreviation: FSA, forward sortation area.

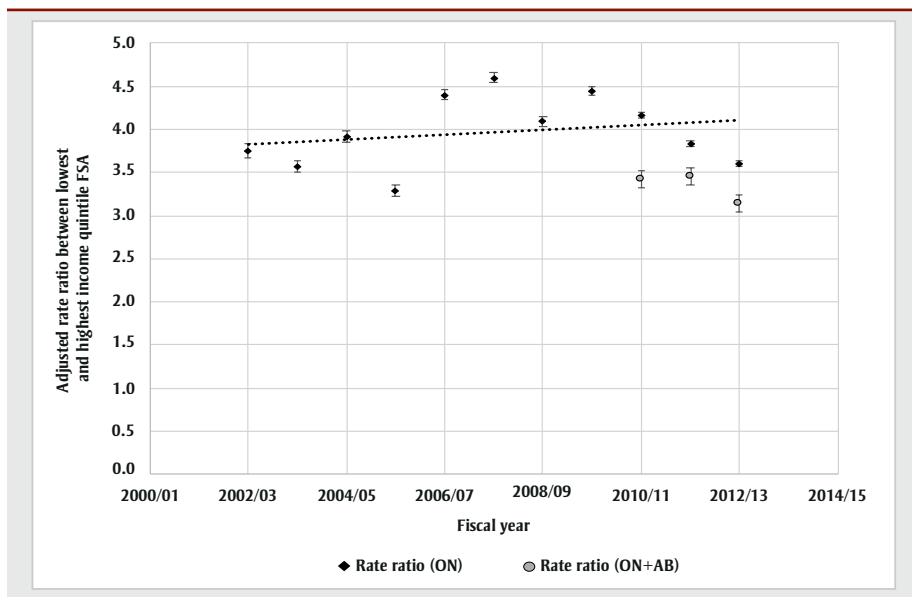
^a Data from the Discharge Abstract Database (DAD).

^b Fiscal years.

Distributing an opioid overdose medication (naloxone) in areas with high need is an effective intervention that will save lives, but it may not treat the root cause. Naloxone programs might partially explain the slight decrease in opioid mortality

inequity we found in recent years. Nevertheless, they do not prevent hospitalization and emergency department visits; hence, inequity in these outcomes remained constant—in fact it increased, albeit insignificantly. Our results point to

FIGURE 3
Time trend^a of annual opioid-related emergency department visits^b rate ratio in Ontario (between 2002/03 and 2009/10) and in Ontario and Alberta (between 2010/11 and 2012/13) in the highest and lowest income quintiles of forward sortation areas



Abbreviations: AB, Alberta; FSA, forward sortation area; ON, Ontario.

^a Fiscal years.

^b Data from National Ambulatory Care Reporting System metadata (NACRS).

the need to consider the psychosocial conditions that underly the continuing epidemic, as well as to provide equitable health care services and reduce the various stigmas associated with opioid use and treatment.⁶³

Strengths and limitations

This study showed the association between SES and opioid-related mortality, hospitalization and emergency department visits using comprehensive databases over an extended period. However, several limitations must be noted. First, some cases could have been missed using administrative databases.⁶⁴ With a sensitivity of 75%,^{36,38} for example, it is possible that we may have missed some opioid-related mortality. However, such misclassification is probably not differential. It is not plausible that the coding of opioid outcome would be different for individuals living in different income quintile areas. Even with this potential misclassification that may have caused us to underestimate individual opioid outcomes rates, the rate ratio would still be unchanged. In addition, although the identified outcomes included both prescribed and illicit opioids, this distinction would not have changed the rate ratio. Second, we used the 2006 income quintiles for about 10 years of assessment, which could have resulted in misclassification of areas into quintiles. However, areas are not expected to make major shifts in relative position over five years, for example, from quintile 5 to quintile 1. Since we focussed our analysis for the rate ratio on the highest and lowest quintiles, this misclassification's effect should be negligible. Third, not all databases captured all opioid outcomes nationally. For example, the ED visits database was only available for Ontario and Alberta. However, these are currently the most comprehensive databases available for research.

Conclusion

While adverse opioid-related mortality, hospitalization and emergency department visits affect every stratum of SES in Canada, they are associated with SES in a stepped gradient fashion, and this pattern has persisted over the past two decades. Material factors cannot be the only explanation; psychosocial factors pertaining to support within the family and community may make individuals significantly prone to adverse opioid outcomes. The results of this study illustrate that targeted policy

frameworks that take into consideration psychosocial aspects of SES should be adopted. Psychosocial factors should be considered in service design and the delivery of health care interventions, such as opioid stewardship, as well as public policies that address the opioid epidemic from an equity perspective.

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Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions and statement

WA: conceptualization, methodology, data acquisition, data analysis, writing—original draft, writing—review and editing. MC: conceptualization, methodology, writing—review and editing. SE: conceptualization, methodology, writing—review and editing. FC: conceptualization, methodology, funding acquisition, writing—review and editing. HS: data analysis, writing—review and editing. MG: data analysis, writing—review and editing.

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Original quantitative research

Encouraging older adults with pre-frailty and frailty to “MoveStrong”: an analysis of secondary outcomes for a pilot randomized controlled trial

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Abstract

Background: This 8-week pilot stepped-wedge randomized controlled trial evaluated the MoveStrong program for teaching adults who have frailty/pre-frailty about balance and functional strength training and sufficient protein intake to prevent falls and improve mobility.

Methods: We recruited individuals aged 60 years and over, with a FRAIL scale score of 1 or higher and at least one chronic condition, who were not currently strength training. The program included 16 exercise physiologist-led hour-long group sessions and two dietitian-led hour-long nutrition sessions. We analyzed secondary outcomes—weight, gait speed, grip strength, physical capacity (fatigue levels), sit-to-stand functioning, dynamic balance, health-related quality of life (HRQoL), physical activity levels and protein intake—using a paired *t* test and a generalized estimating equation (GEE).

Results: Of 44 participants (mean [SD] age 79 [9.82] years), 35 were pre-frail and 9 were frail. At follow-up, participants had significantly improved grip strength (1.63 kg, 95% CI: 0.62 to 2.63); sit-to-stand functioning (2 sit-to-stands, 95% CI: 1 to 3); and dynamic balance (1.68 s, 95% CI: 0.47 to 2.89). There were no significant improvements in gait speed, HRQoL index scores, self-rated health, physical activity levels (aerobic activity and strength training) or protein intake. GEE analysis revealed an interaction between exposure to MoveStrong and gait speed, sit-to-stand functioning, dynamic balance and HRQoL index scores. The total cost to administer the program and purchase equipment was CAD 14 700, equivalent to CAD 377 per participant.

Conclusion: Exploratory analyses suggest MoveStrong exercises may improve gait speed, sit-to-stand functioning, dynamic balance and HRQoL index scores in older individuals who are frail and pre-frail.

Highlights

- The MoveStrong program teaches older adults who are pre-frail and frail about balance and functional strength training and sufficient protein intake.
- The program may improve grip strength, sit-to-stand functioning and dynamic balance.
- The program may be associated with improvements in other outcomes, such as health-related quality of life and gait speed.

Keywords: *FRAIL score, exercise, nutrition, complex intervention, RCT, protein intake, balance, functional strength*

Introduction

The Canadian 24-Hour Movement Guidelines for adults aged 65 years and older recommend muscle-strengthening and

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balance-challenging activities at least twice a week.^{1,2} There is moderate- to high-certainty evidence that functional strength and balance training are crucial for promoting functional independence and mobility and reducing the risk of falls in older adults.³⁻⁶

As many as 88% of Canadian adults 65 years and older are not meeting these exercise guidelines.⁷ Furthermore, inadequate nutrition and low protein intake is common among older adults. Initiating exercise when protein intake is insufficient may cause weight loss and limit gains in muscle strength.⁸ The PROT-AGE group recommends individuals 65 years and older consume at least 1.0 to 1.2 grams of protein per kilogram of body weight per day to maintain or regain lean body mass and muscle function.⁹ However, Wijnhoven et al.¹⁰ found that almost 50% of adults aged 55 years and older consumed less than 1.0 g/kg/d. Lower protein intake is associated with a higher prevalence of frailty.¹¹

A major knowledge gap exists in promoting and sustaining programs to increase the uptake of balance and functional strength training as well as protein intake among older adults, particularly individuals who are pre-frail or frail.

Previous complex interventions¹² evaluating the implementation of specific types of exercises under real-world conditions for older adults include home-based exercise programs such as the Otago Exercise Program^{13,14} and the Lifestyle-integrated Functional Exercise (LiFE) program¹⁵, or facility-based exercise programs such as Mi-LiFE, which is a group-based version of the LiFE program¹⁶. The goal of these three programs is to promote the uptake of balance and functional strength training to prevent falls and manage chronic diseases in older adults.

A meta-analysis found the Otago Exercise Program reduced the number of falls and fall-related injuries (incidence rate ratio [IRR] = 0.65, 95% confidence interval [CI]: 0.57 to 0.75; and IRR = 0.65, 95% CI: 0.53 to 0.81, respectively) compared with the control group.¹⁷ Similarly, Clemson and colleagues¹⁵ found that teaching older adults how to integrate functional strength and balance exercises into daily life activities (the LiFE program) was associated with a reduced fall rate (IRR = 0.69, 95%

CI: 0.48 to 0.99) and improvements in static and dynamic balance and sit-to-stand functioning, compared with controls. Yet, there is less evidence on how to effectively implement strength and balance training programs into community-based programs, especially for older adults who are pre-frail or frail.¹⁶ In addition, it is still unclear which type of program or combination of programs promotes long-term participation in physical activity and encourages older adults to exercise at a frequency and intensity to confer gains.

The aim of this pilot study was to evaluate the feasibility of implementing a balance and functional strength training program, with attention to protein intake, under real-world settings. Our research team collaborated with several stakeholders to create MoveStrong, a program to teach balance and functional strength training with attention to protein intake to older adults who are pre-frail or frail. In a previous manuscript, we describe the feasibility of implementation, the adverse events, program fidelity and the participants' and providers' experience with the MoveStrong program.¹⁸

The aim of this paper is to report on the effects of the MoveStrong program on secondary outcomes such as frailty indicators (i.e. body weight, physical capacity, sit-to-stand functioning, dynamic balance, grip strength and gait speed), health-related quality of life (HRQoL), physical activity levels and protein intake at baseline and follow-up. We also report health care resource utilization and costs at 6 months prior to starting the intervention and at follow-up.

Methods

We conducted this study in accordance with the extension of the CONSORT 2010 reporting guidelines for stepped-wedge cluster randomized trials¹⁹ and pilot and feasibility trials.²⁰ We also used the TIDieR (Template for Intervention Description and Replication) checklist to promote full and accurate description of the intervention.^{18,21}

Trial design

The study design was an 8-week pilot, assessor-blinded, multisite, closed cohort stepped-wedge randomized controlled trial (RCT). Each site was exposed to the

intervention but not at the same time. Before the program began, all sites were randomized to start at different time points, each 3 weeks apart. At regular 3-week intervals (the “steps”), one site crosses from the control group to the intervention group (Figure 1).²² This process continues until all sites have been exposed to the MoveStrong program.

We selected the stepped-wedge design because all participants eventually receive the intervention—and hence the benefits of progressive resistance training.²² In addition, in a parallel design, participants allocated to the no-exercise control group are more likely to drop out and participant blinding is not possible in exercise trials. The stepped-wedge RCT is also preferred over the traditional parallel RCT when sites are substantially heterogeneous (e.g. rural vs. urban populations, community dwelling vs. residential) and the intra-cluster correlation may be high.¹⁹ Lastly, this design allowed us to determine the feasibility of using a stepped-wedge design for a larger pragmatic trial.

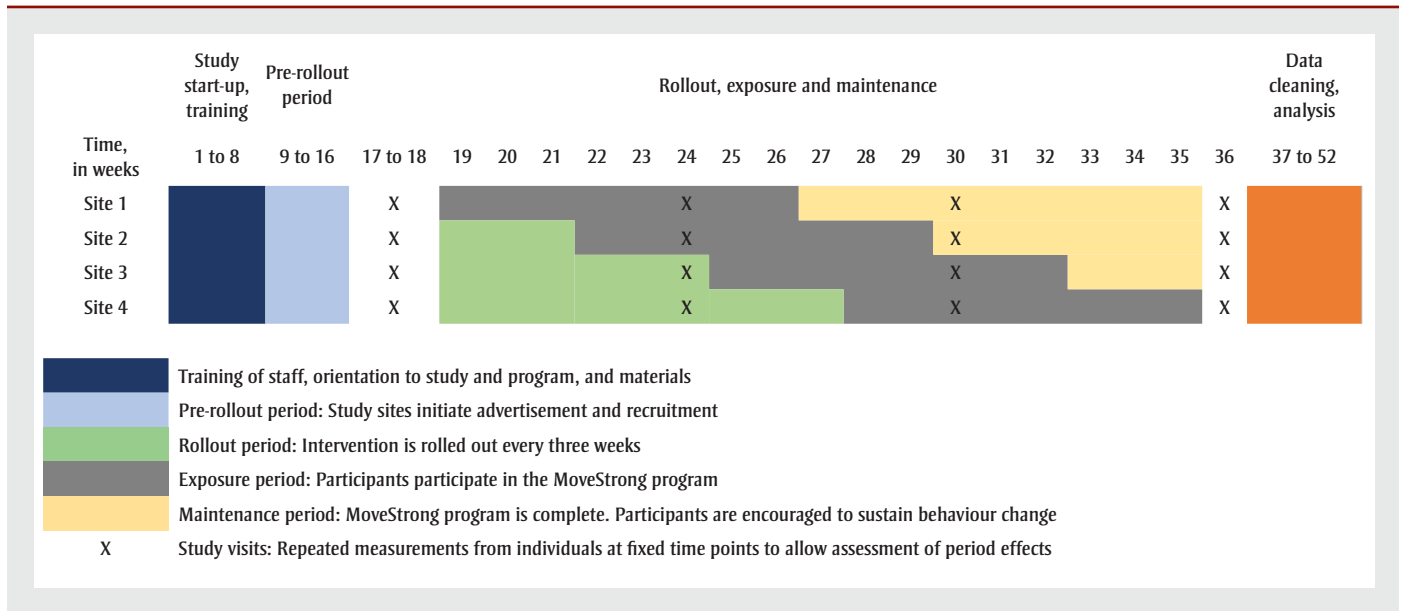
Study setting

We evaluated the program in areas that typically represent real-world practice, and we selected three distinct settings in Ontario: retirement homes/assisted living facilities, community centres and a family health team. We chose one rural site (Sudbury) and three urban sites (Cambridge, Guelph, Kitchener–Waterloo) to ensure diversity in city population, structure and health service. There are differences between urban and rural populations in terms of health-seeking behaviours, health status and health service use, cost and outcomes. In general, rural residents have access to fewer health services and providers than urban residents.²³

The MoveStrong program was implemented and delivered at a kinesiologist-led clinic partnered with Arbour Trails (retirement home/assisted living and independent living facility, Guelph, site 1); Kinnect to Wellness (physical fitness centre, Sudbury, site 2); the Village of Winston Park (retirement home/assisted living and independent living facility, Kitchener, site 3); and a YMCA that operated at two locations (Cambridge and Kitchener–Waterloo; site 4).

To deliver the exercise program, we contracted exercise physiologists already

FIGURE 1
Timeline for the MoveStrong program pilot RCT



Abbreviation: RCT, randomized controlled trial.

working at the sites or teaching exercise in the community who had at least one year of experience delivering exercise to older adults. This allowed us to assess the feasibility of real-world implementation rather than have it delivered in a research setting. We also contracted two registered dietitians to deliver education sessions at the northern and southern Ontario sites.

Participants

We included participants if they (1) spoke English or attended with a translator; (2) were aged 60 years or older; (3) had a FRAIL (Fatigue, Resistance, Ambulation, Illnesses, and Loss of weight) scale score of 1 or higher (i.e. a score of 0 indicates robustness, of 1 or 2 indicates pre-frailty and of 3 to 5 indicates frailty)²⁴; and (4) had at least one of the following chronic conditions diagnosed by a physician: diabetes, obesity, cancer (other than minor skin cancer), chronic lung disease, cardiovascular disease, congestive heart failure, hypertension, osteoporosis, arthritis, stroke or kidney disease.

We encouraged participants to attend with a caregiver/friend for social or physical support; the caregiver/friend could also complete the screening and assessment process to determine if they were eligible to enrol in the study.

We excluded individuals who (1) were currently doing a similar resistance exercise

two or more times per week; (2) were receiving palliative care; (3) could not perform basic activities of daily living; (4) had severe cognitive impairment (e.g. were unable to follow two-step commands or could not explain the research study to the research assistant); (5) planned to be away for more than 1 week during the trial; or (6) had absolute exercise contraindications. We determined absolute exercise contraindications using the American College of Sports Medicine guidelines.²⁵ We did not exclude individuals who were participating in regular aerobic physical activity.

Recruitment and randomization

We recruited participants from local primary care practices, retirement homes/assisted living facilities and via advertisement in the local community (e.g. physiotherapy clinics, libraries and churches) using face-to-face techniques, traditional and social media (Facebook and Twitter), posters, flyers and brochures. We set up recruitment booths at the two retirement home/assisted living facility sites. Because of the delay between recruitment and randomization, we decided a priori that participants who dropped out prior to randomization could be replaced up until the start of the intervention.

A biostatistician, independent of the study, created a computer-generated randomization sequence to randomize sites to start

the program at one of four start times, each 3 weeks apart. A co-investigator (MCA) kept the randomization sequence concealed, communicating it to all sites after randomization. Each site was assigned to receive the intervention at calendar weeks 19, 22, 25 or 28 (see Figure 1); participants who received the intervention during later weeks were asked to continue their usual activities until the start of the program.

Intervention

Exercise program

The MoveStrong exercise program includes functional strength training movements for older adults of varying abilities, using minimal equipment. Each exercise was informed by the GLA:D program for arthritis²⁶, BoneFit²⁷ and meta-analyses on resistance exercise and fall prevention for older adults^{6,28-31}. We sought input from representatives from the YMCAs of Cambridge and Kitchener-Waterloo, Community Support Connections, and Osteoporosis Canada, as well as patient advocates. To promote personal relevance, the exercises are aligned with functional movements such as lunging/stepping, reaching, squatting, pulling, lifting and carrying, and pushing.

Participants were prescribed one exercise from each category: stepping (e.g. foot stomps, heel drops); step-up or leg extension (e.g. stationary lunge, seated leg

extension, step-up); reach (e.g. resisted thoracic extension, back to wall shoulder flexion, shoulder press); squat (e.g. squat, sit-to-stand); pull (e.g. elastic band row, pull apart, bent-over dumbbell row); hinge with or without carry (e.g. seated back extension, glute bridge, wall tap hip hinge, weighted hinge, hinge plus weighted carry); and push (e.g. resisted chest press, wall push-up, counter/table push-up).

Each site received a standardized toolkit with materials for participant workbooks and a trainer manual. The trainer manual provided guidance on how to deliver the workshop, select and progress exercises, adapt exercises for common impairments, cueing tips and discussion topics. The research team met with the exercise physiologists at each site for one to two hours to demonstrate how to deliver the MoveStrong program and to review the manual. Each exercise physiologist was advised to use informal assessments of multiple repetitions maximum and a repetition in reserve strategy to guide exercise selection and progression. We instructed the exercise physiologist to increase the difficulty of the movement if participants could perform more than eight repetitions.

Exercise physiologists could decide how to deliver the program in their setting—as an exercise class or by allowing participants to work through the program on their own or in stations.

Each participant received a one-to-one session with an exercise physiologist (not blinded to site allocation) who selected a starting level and variations for each functional movement, intensity, and number of repetitions and sets. The participant workbooks included pictures and instructions for each exercise so that the participants could practise and exercise at home or elsewhere; each participant received their workbooks during the one-on-one session with the exercise physiologist. Participants attended physiologist-led group exercise sessions (1 exercise physiologist to ≤6 participants) twice a week for 8 weeks. Program components included a warm-up (5 minutes), the exercise program (50 minutes) and cool-down (5 minutes), during which the exercise physiologist led a group discussion on when and where participants could practise the exercise(s), at home or in a setting of choice.

During the first 2 weeks, the focus was on form rather than on intensity. Exercise difficulty, resistance or volume (up to 3 sets, up to 8 repetitions) was increased over time, with a target intensity of a maximum of eight repetitions. We did not formally assess one-repetition maximum.

Nutrition education

The nutrition program included two components: a nutrition education booklet; and two dietitian-led hour-long group seminars to answer questions and discuss topics related to protein intake. The dietitians were not blinded to allocation. The booklet and seminars reviewed the cost of preparing high-protein foods; how and why to spread protein intake throughout the day; how much protein was in the participant's usual diet and how much was recommended; low-cost options to add protein to meals; easy-to-consume protein-rich snacks with minimal preparation; high quality protein supplements (e.g. rapidly digested, high leucine-content foods, such as whey); and how to prioritize high-protein choices in retirement home/assisted living facility restaurants. During each seminar, the dietitian provided samples of protein-rich snacks. Seminars were held during weeks 2 and 5 to allow time to review material, revisit topics and address questions.

We recommended 1.2 grams of protein per kilogram of body weight per day and 20 to 30 grams of protein per meal.^{8,32} As protein intake may be influenced by living conditions (e.g. living in a retirement home/assisted living facility vs. independent living), the dietitian reviewed methods on how to select high-protein options from the retirement home restaurant menu. For example, residents learned how to estimate the amount of protein in common foods listed on the menu (e.g. 85 grams salmon has 19 grams of protein, or 1 cup of 2% milk has 8 grams of protein).

Outcomes

Frailty indicators

The Fried Frailty Index guided the selection of frailty indicators. The indicators included change in body weight, gait speed, physical capacity, physical activity (fatigue) levels and handgrip strength.³³ We measured body weight using a calibrated scale at baseline (study visit 1) and follow-up (study visit 4).

We assessed gait speed using the 10-metre walk test³⁴; physical capacity (i.e. fatigue levels) using two questions from the Center for Epidemiologic Studies Depression Scale (“I felt that everything I did was an effort” and “I could not get going”)³⁵; and physical activity levels with the physical activity screen³⁶. The physical activity screen assesses moderate- to vigorous-intensity aerobic physical activity in minutes per week and strength training in days per week. We did not include the MoveStrong exercise program sessions in our calculation for strength training.

Grip strength of the non-dominant hand was measured in kilograms using a digital Jamar Hand Dynamometer.^{37,38} Other predictor variables of frailty³⁹ included sit-to-stand functioning, assessed with the 30-second chair-stand test⁴⁰, and dynamic balance, assessed with the four-square step test⁴¹. All frailty indicators, except body weight, were measured at baseline (study visit 1), study visit 2, study visit 3 and follow-up (study visit 4).

Health-related quality of life

We assessed HRQoL using the EuroQol Group 5 Dimension 5 Level (EQ-5D-5L) questionnaire.⁴² The first part of the questionnaire comprises five dimensions (mobility, self-care, usual activities, pain/discomfort, anxiety/depression) and each dimension has five levels (no problems, slight problems, moderate problems, severe problems, extreme problems). Scores range from 0.9489 (highest reported quality of life) to 0.2041 (lowest reported quality of life).⁴³ The second part of the questionnaire records the participant's self-rated health on a vertical visual analog scale, where the endpoints are labelled “The best health you can imagine” (score of 100) to “The worst health you can imagine” (score of 0).

Protein intake

We used the 2018 Automated Self-Administered 24-Hour (ASA24) Dietary Assessment Tool (epi.grants.cancer.gov/asa24/) to conduct interviewer-administered diet recalls. We collected three-day food records (two weekdays and one weekend) to capture an accurate description of each participant's typical daily diet. The ASA24 Dietary Assessment Tool is a free web-based instrument that enables highly standardized multipass recall to obtain detailed information about dietary intake using multiple probes and reminders to enhance recall.⁴⁴ The tool generates

a “total calorie consumption” across all meals and snacks consumed in a single day and automatically codes carbohydrate, fat, protein and alcohol intake.⁴⁴

Health care resource utilization and costs

We used a health care resource utilization and costs questionnaire to assess direct and indirect costs of health service utilization developed in consultation with two health economists (WI and DL). We collected data on intervention costs and resource use to assess the feasibility of data collection methods for a larger trial. The health care resource utilization and costs questionnaire consists of six direct health care service categories: (1) primary care visits; (2) emergency department or specialist visits; (3) hospital days; (4) other health care provider visits (e.g. nurse, physiotherapist, occupational therapist); (5) adverse events such as falls and fractures; and (6) lab services.

The questionnaire also asks about participants’ out-of-pocket costs, such as over-the-counter medications, supplements or devices, the use of homecare, complementary therapy (e.g. massage therapist, naturopath) and transportation costs. The total cost per person was calculated by multiplying the number of units of service (quantity) by the unit cost (price). We reported costs using the 2020 Canadian dollar (CAD).

We obtained costs for implementing the program from financial records. Because the costs associated with developing the program were incurred before the trial, these are not included. We also did not include the costs of evaluating the program or of recruiting the exercise physiologist, because in many instances, the relevant organization had existing staff that could deliver the program. We also did not put a value on the time participants spent exercising or attending the nutrition sessions as we assumed these activities were done in their leisure time.

Sample size

We selected a recruitment rate of 10 participants at each site because of the proposed class ratio of one instructor to five participants. Having 10 participants allowed us to determine the feasibility of delivering two nutrition sessions and two groups of exercise sessions at each site.¹⁸ We allowed sites to over-recruit by one or two people.

Data safety monitoring committee

A physiotherapist, a physician and a biostatistician, not involved in the trial, reviewed potential adverse events after three sites completed the program and provided guidance for a future trial. There were no interim analyses and there were no guidelines on stopping the pilot trial.

Statistical analyses

Demographic, health care resource utilization and cost data were reported using means and standard deviations or as 95% confidence intervals for continuous data, and as a count and percentage for categorical outcomes. We conducted a paired *t* test ($\alpha = 0.05$) on secondary outcomes at baseline and follow-up using imputed data. We used multiple imputation procedures to impute the missing data values (fully conditional specification method, number of imputations = 5, maximum iterations = 25). We used baseline data for sites 1 and 2 at weeks 17 to 18 and for sites 3 and 4 at week 24. Follow-up data for sites 1 and 2 were at week 30 and for sites 3 and 4 at week 36 (see Figure 1). To model the interaction between exposure to the MoveStrong program and site on secondary outcomes we applied a generalized estimating equation (GEE). In our protocol, we originally planned to do linear regression, but revised our analysis plan to better account for clustering by site.⁴⁵ We had planned to do a subgroup analysis with and without caregiver or friend participation but not enough caregivers/friends participated.

For protein intake at baseline, we only collected baseline measures for 40 individuals.

We calculated health care resource utilization by multiplying unit costs from the 2015 Common Billing Codes for family physicians and the 2020 Ministry of Health Ontario Health Insurance Plan Laboratories and Genetics Branch to each resource to calculate direct medical costs. We estimated specialist visits at CAD 300.00 and allied health professional visits at CAD 61.25⁴⁶; if data were missing, we assumed the value to have no associated costs and did not include it.

Some participants did not consent to measuring their body weight; we used the average body weight for their sex to estimate their protein and energy (kcal/kg/day) intakes.

Significance (*p* values) was reported to three decimal places, with statistical significance defined as $p < 0.05$. No correction (e.g. Bonferroni correction) for multiple testing was made because of the exploratory nature of the analyses.

All analyses were performed using SPSS Statistics for Windows version 27 (IBM Corp., Armonk, NY, US).

Ethics

We obtained ethics approval from University of Waterloo Ethics committee (#31752).

Results

We screened 75 individuals for eligibility and enrolled 44 participants prior to randomization (Table 1, Figure 2); only 39 individuals started the intervention. One participant attended with a caregiver, but the caregiver did not enrol in the program.

Mean (SD) age was 79 (9.82) years; 35 participants were pre-frail, and 9, frail.

Frailty indicators

Intention-to-treat analyses revealed a significant difference from baseline to follow-up for grip strength, sit-to-stand functioning and dynamic balance (Table 2). There were no significant differences in body weight, gait speed, physical capacity (fatigue) or physical activity levels at baseline to follow-up.

The GEE analysis (linear response, factor = exposure to MoveStrong by site, covariates = site, within-subject variable = study visit, maximum likelihood estimate, Wald chi-square) suggests a significant interaction for exposure to MoveStrong on the following variables: gait speed (10-metre walk test), sit-to-stand functioning (30-second chair-stand test), dynamic balance (four-square step test) and HRQoL according to the EQ-5D-5L index score (Table 3).

GEE analysis indicated there were no interactions for body weight, grip strength, physical activity levels or protein intake. We conducted a similar GEE analysis for physical capacity using an ordinal response and found no interaction for exposure to the MoveStrong program and physical capacity (fatigue levels).

Health-related quality of life

Intention-to-treat analysis revealed no significant difference from baseline to follow-up

TABLE 1
Demographic and health status of MoveStrong pilot randomized control trial participants at baseline, according to site (n = 44)

Characteristics	Site 1: Arbour Trails ^a (n = 9)	Site 2: Kinnect to Wellness ^b (n = 15)	Site 3: Village of Winston Park ^c (n = 9)	Site 4: YMCA ^d (n = 11)
Mean age (SD), years	78 (11.50)	81 (5.39)	84 (8.80)	72 (7.71)
Mean height (SD), cm	161 (10.89); n = 7	156 (26.18)	160 (7.63); n = 7	161 (7.71)
Mean weight (SD), kg	72 (19.17); n = 7	73 (12.44)	65 (7.64); n = 8	67 (12.80)
Body mass index (SD)	24.96 (3.52); n = 7	29.17 (4.27)	24.99 (4.12); n = 7	25.65 (4.56)
Female sex, n (%)	7 (78)	10 (67)	7 (78)	10 (91)
Ethnicity, n (%)				
White	8 (89)	15 (100)	8 (89)	9 (82)
South Asian	0 (0)	0 (0)	1 (11)	2 (18)
Middle Eastern	1 (11)	0 (0)	0 (0)	0 (0)
Marital status, n (%)				
Married	2 (22)	7 (47)	4 (44)	7 (64)
Widowed	4 (44)	6 (40)	5 (56)	2 (18)
Single/separated/divorced	3 (33)	2 (13)	0 (0)	2 (18)
Highest level of education, n (%)				
Middle school	0 (0)	5 (33)	0 (0)	1 (9)
High school	0 (0)	8 (53)	4 (44)	3 (27)
Higher education (college or university)	9 (100)	2 (13)	5 (56)	7 (64)
Employment, n (%)				
Retired (not working)	6 (67)	15 (100)	9 (100)	11 (100)
Medical leave	2 (22)	0 (0)	0 (0)	0 (0)
Part-time (<40 h/wk)	1 (11)	0 (0)	0 (0)	0 (0)
Annual income, CAD				
<40 000	3 (33)	7 (47)	3 (33)	4 (36)
40 000–60 000	1 (11)	5 (33)	0 (0)	3 (27)
>60 000	3 (33)	0 (0)	2 (22)	0 (0)
Prefer not to say	2 (22)	3 (20)	4 (44)	4 (36)
Place of residence, n (%)				
Retirement home, alone	5 (56)	1 (7)	5 (56)	0 (0)
Retirement home, with someone	0 (0)	0 (0)	2 (22)	0 (0)
In the community, alone	2 (22)	4 (27)	1 (11)	4 (36)
In the community, with someone	2 (22)	10 (67)	1 (11)	7 (64)
Visits from friends and family, n (%)				
Daily	3 (33)	9 (60)	2 (22)	1 (9)
Weekly	3 (33)	5 (33)	7 (78)	9 (82)
Monthly	2 (22)	1 (7)	0 (0)	1 (9)
Yearly	1 (11)	0 (0)	0 (0)	0 (0)
Use of homecare in the last 6 months, n (%)	1 (11)	1 (7)	1 (11)	1 (11)
Mean FRAIL scale score (SD)	2.00 (0.50)	2.07 (0.96)	2.11 (0.60)	1.36 (0.67)
FRAIL scale, n (%)				
Time feeling tired during the past 4 weeks	5 (56)	6 (40)	5 (56)	7 (64)
Difficulty walking up 10 steps without resting	4 (44)	7 (47)	4 (44)	2 (18)
Difficulty walking several hundred yards	5 (56)	12 (80)	8 (89)	2 (18)
≥5 physician-diagnosed chronic diseases	3 (33)	2 (13)	1 (11)	0 (0)
Weight change >5% in the last 6 months	3 (33)	4 (27)	1 (11)	4 (36)
≥2 components on the FRAIL scale	8 (89)	10 (67)	8 (89)	3 (27)
≥3 components on the FRAIL scale	1 (11)	5 (33)	2 (22)	1 (9)

Continued on the following page

TABLE 1 (continued)
Demographic and health status of MoveStrong pilot randomized control trial participants at baseline, according to site (n = 44)

Characteristics	Site 1: Arbour Trails ^a (n = 9)	Site 2: Kinnect to Wellness ^b (n = 15)	Site 3: Village of Winston Park ^c (n = 9)	Site 4: YMCA ^d (n = 11)
Comorbidities, n (%)				
Cardiovascular diseases	4 (44)	6 (40)	5 (56)	2 (18)
Hypertension	8 (89)	11 (73)	6 (67)	4 (36)
Respiratory illnesses	3 (33)	5 (33)	2 (22)	1 (9)
Bone disease (osteoporosis)	4 (44)	8 (53)	5 (56)	6 (55)
Joint disease	5 (56)	15 (100)	6 (67)	5 (45)
Type 2 diabetes	3 (33)	6 (40)	2 (22)	4 (36)
Low back pain	5 (56)	13 (87)	4 (44)	5 (45)
Falls and fractures in the last 6 months, n (%)				
Individuals who fell	1 (11)	4 (27)	1 (11)	0 (0)
Individuals who sustained a fragility fracture	0 (0)	0 (0)	0 (0)	0 (0)
Use of assistive devices, n (%)				
Walker	2 (22)	0 (0)	1 (11)	1 (9)
Wheelchair	1 (11)	0 (0)	0 (0)	0 (0)
Physical activity screen, n (%)				
Achieved ≥ 75 min/wk of vigorous-intensity aerobic physical activity or ≥ 150 min/wk of moderate-intensity aerobic physical activity	2 (22)	1 (7)	0 (0)	7 (64)

Abbreviations: CAD, Canadian dollar; FRAIL, Fatigue, Resistance, Ambulation, Illnesses, and Loss of weight; h, hours; min, minute; SD, standard deviation; wk, week.

^a Arbour Trails retirement home/assisted living and independent living facility, Guelph, Ontario.

^b Kinnect to Wellness physical fitness centre, Sudbury, Ontario.

^c Village of Winston Park retirement home/assisted living and independent living facility, Kitchener, Ontario.

^d YMCA operating in two locations, Cambridge, Ontario, and Kitchener–Waterloo, Ontario.

on the EQ-5D-5L index score and on the self-rated health score using the visual analog scale of the EQ-5D-5L (Table 2); however, GEE analysis indicates there may be an interaction for exposure to the MoveStrong program on EQ-5D-5L index scores (Table 3).

Protein intake

Intention-to-treat analyses of average protein (g/d and g/kg/d) and energy (kcal/kg/d) intake revealed no significant differences from baseline to follow-up (Table 2). The GEE analysis revealed no significant interaction between exposure to the MoveStrong program on energy intake in kcal/kg/d or protein intake in g/d (Table 3).

We found that participants do not consume an equal amount of protein at each meal; the highest amount of protein was consumed at dinner (baseline: 32.60 [13.07] g, n = 33; follow-up: 30.71 [8.55] g, n = 33), and it was also the only meal where the average protein intake was within the recommended range of 20 to 30 g/meal.

After attending the nutrition sessions, participants reported consuming new protein-rich foods (i.e. foods they did not report eating at baseline) including meat (fish, chicken, turkey, pork, beef); dairy (milk, yogurt, cheese); plant-based (whole wheat, rice, quinoa); and others (eggs, seeds, nuts, protein powder). The average protein intake at baseline was 69.46 g/d (95% CI: 69.46 to 22.29; n = 39) or 1.01 g/kg/d (95% CI: 0.91 to 1.11; n = 33) and was above the recommended dietary allowance (RDA; 0.8 g/kg/d). However, 14 participants (35%) had a protein intake below the RDA, while 27 participants (67%) consumed less than our target of 1.2 g/kg/d.

At baseline, the average percentage of energy from protein was within the Acceptable Macronutrient Distribution Range (AMDR) of 10% to 35%.

The average energy intake at baseline was 23.81 kcal/kg/d (95% CI: 21.40 to 26.30; n = 39), which was less than the RDA (30 kcal/kg/d). Of the 40 participants, 28 (70%) had an average energy intake less

than the RDA and 20 (50%) consumed less than 21 kcal/kg/d.

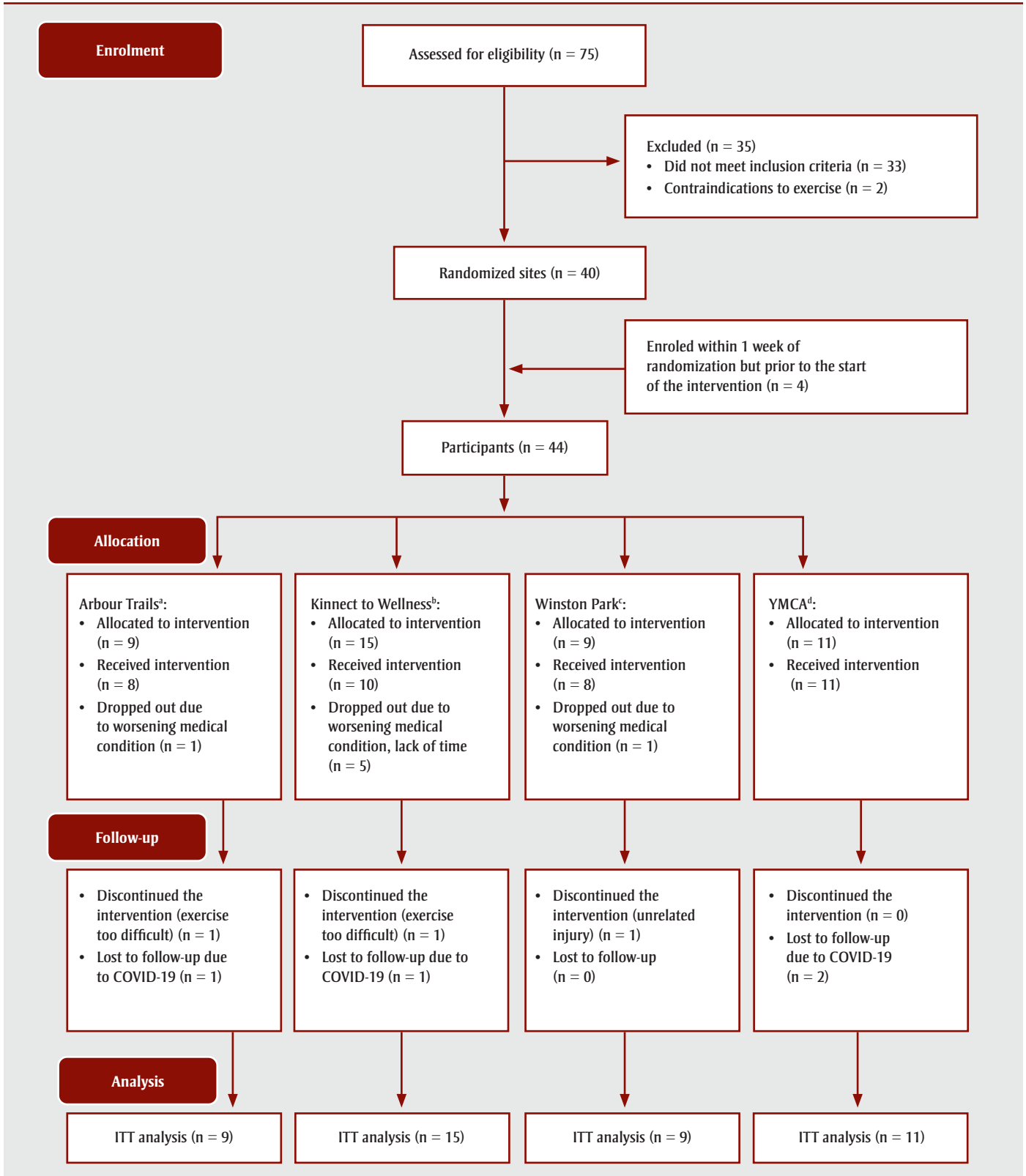
Resource use

The total cost to administer the program and purchase equipment at all four sites was CAD 14 700, or CAD 377 per participant. The total direct medical cost during the study was CAD 22 430, while the total indirect medical cost was CAD 21 610. Six weeks prior to starting the intervention, participants reported a direct medical cost of CAD 6148 over six weeks, and of CAD 7389 over six weeks at follow-up. Six weeks prior to starting the intervention, participants reported an indirect medical cost of CAD 6464 over six weeks; after the intervention, this was CAD 5916 over six weeks. The main cost drivers were identified to be physician visits, test procedures and transportation.

Discussion

The main challenge in evaluating complex interventions is in the number of components that act both independently and interdependently.^{12,47} For this reason,

FIGURE 2
CONSORT flow diagram reporting participant enrolment, allocation, follow-up and analysis in the MoveStrong pilot RCT²⁰



Abbreviations: ITT, intention-to-treat; RCT, randomized controlled trial.

^a Arbour Trails retirement home/assisted living and independent living facility, Guelph, Ontario.

^b Kinnect to Wellness physical fitness centre, Sudbury, Ontario.

^c Village of Winston Park retirement home/assisted living and independent living facility, Kitchener, Ontario.

^d YMCA operating in two locations, Cambridge, Ontario, and Kitchener–Waterloo, Ontario.

TABLE 2
Secondary outcomes and pair sample statistics, MoveStrong pilot randomized control trial (n = 44 participants)

Secondary outcomes	Mean values (95% CI)			Mean change score (95% CI)
	Baseline	During the MoveStrong program	Follow-up	Paired <i>t</i> test (baseline vs. follow-up)
Frailty indicators				
Body weight, kg	69.79 (65.92 to 73.66)	69.80 (65.93 to 73.65)	69.62 (65.73 to 73.52)	0.17 (-0.34 to 0.68)
Gait speed (10-m walk test), m/s	1.06 (0.95 to 1.18)	1.06 (0.95 to 1.16)	1.12 (1.00 to 1.24)	0.60 (0.00 to 0.12)
Physical capacity ("I felt that everything I did was an effort" on the CES-D)	0.70 (0.45 to 0.96)	0.86 (0.53 to 1.20)	1.00 (0.67 to 1.33)	-0.30 (-0.65 to 0.06)
Physical capacity ("I could not get going" on CES-D)	0.73 (0.48 to 0.98)	0.82 (0.49 to 1.15)	1.00 (0.65 to 1.35)	-0.27 (-0.63 to 0.08)
Grip strength (non-dominant hand), kg	20.45 (17.95 to 22.95)	21.82 (18.96 to 24.69)	22.07 (19.44 to 24.71)	1.63 (0.62 to 2.63)*
Physical activity screen – aerobic activity, min/wk	100.00 (49.59 to 150.41)	150.20 (111.37 to 189.04)	118.64 (84.22 to 153.05)	31.25 (-8.50 to 71.00)
Physical activity screen – strength training, d/wk	0.41 (0.03 to 0.79)	2.18 (1.57 to 2.79)	1.70 (1.09 to 2.32)	-1.30 (-2.03 to 0.06)
Sit-to-stand functioning (30-s chair–stand test), n	9.18 (7.73 to 10.63)	9.70 (8.23 to 11.18)	11.32 (9.60 to 13.04)	2.14 (1.07 to 3.20)*
Dynamic balance (FSST), s	14.86 (13.09 to 16.62)	14.10 (12.06 to 16.15)	13.17 (11.49 to 14.87)	1.68 (0.47 to 2.89)*
HRQoL				
EQ-5D-5L index score	0.79 (0.75 to 0.83)	0.83 (0.80 to 0.85)	0.82 (0.78 to 0.85)	-0.02 (-0.06 to 0.01)
Self-rated health on the visual analog scale	71.01 (65.16 to 76.87)	75.42 (71.30 to 79.54)	77.10 (72.35 to 81.85)	-6.09 (-12.43 to 0.26)
Protein intake – ASA24 Dietary Assessment Tool				
Protein, g/d	69.46 (69.46 to 22.29)	–	70.88 (54.80 to 77.00)	1.65 (-4.44 to 7.73)
Protein, g/kg/d	1.01 (0.91 to 1.11)	–	1.00 (0.91 to 1.09)	0.01 (-0.07 to 0.10)
% Energy from protein	16.76 (15.80 to 17.70)	–	17.83 (16.60 to 19.00)	0.92 (-0.37 to 2.20)
Energy, kcal/kg/d	23.81 (21.40 to 26.30)	–	22.52 (20.20 to 24.80)	-0.64 (-1.69 to 0.40)

Abbreviations: ASA24, Automated Self-Administered 24-Hour [dietary assessment tool]; CES-D, Center for Epidemiologic Studies Depression Scale; CI, confidence interval; d, days; EQ-5D-5L, EuroQol Group 5 Dimension 5 Level; FSST, four-square step test; HRQoL, health-related quality of life; kcal, kilocalories; min, minute; wk, week.

* $p < 0.05$.

Campbell and colleagues¹² suggest evaluating complex interventions in several phases. This pilot study is considered part of phase II¹² and involves testing the feasibility of delivering the intervention and piloting outcomes for a larger trial.

We piloted several secondary outcomes and found an interaction between participating in the MoveStrong program and gait speed (10-metre walk test), sit-to-stand functioning (30-second chair–stand test), dynamic balance (four-square step test) and HRQoL (EQ-5D-5L index score). We found no interaction between participating

in the MoveStrong program and body weight, grip strength, physical capacity (i.e. fatigue levels), self-rated health on the visual analog scale of the EQ-5D-5L and protein intake. Future trials on balance and functional strength training among older adults with frailty or pre-frailty should consider the responsiveness of frailty indicators when selecting study outcomes, such as those reported in our pilot study.

The MoveStrong exercises aim to mimic activities performed in real-life situations. Maintaining adequate strength and

balance using functional movements intuitively makes sense for improving physical function and preventing falls because specificity is important in exercise prescription. The efficacy of balance in combination with functional training as types of exercise that can mediate fall risk and mobility impairments has been highlighted in several systematic reviews.^{3,6,29,48} We found that participating in the MoveStrong program may improve activities that involve grip strength, sit-to-stand functioning and dynamic balance.

We also saw improvements in outcomes that were directly related to movements in

TABLE 3
Generalized estimating equation analysis of secondary outcomes of MoveStrong pilot randomized control trial, modelled for exposure and site (n = 44 participants)

Secondary outcomes	Estimate of difference-adjusted clustering within a site	95% CI	p value
Frailty indicators			
Body weight	-2.94	-6.77 to 0.90	0.13
Gait speed (10-m walk test)	0.15	0.06 to 0.24	<0.05
Physical capacity ("I felt that everything I did was an effort" on the CES-D)	-0.19	-0.66 to 0.28	0.43
Physical capacity ("I could not get going" on CES-D)	-0.277	-0.71 to 0.15	0.21
Grip strength (non-dominant hand)	1.59	-0.69 to 3.88	0.17
Physical activity screen – aerobic activity	-0.11	-23.16 to 22.94	0.99
Physical activity screen – strength training	-0.11	-0.42 to 0.21	0.51
Sit-to-stand functioning (30-s chair-stand test)	2.78	1.56 to 3.97	<0.05
Dynamic balance (FSST)	-1.61	-3.14 to -0.08	<0.05
HRQoL			
EQ-5D-5L index score	0.03	0.01 to 0.06	<0.05
Self-rated health on the visual analog scale of the EQ-5D-5L	2.29	-1.18 to 5.76	0.19
Protein intake (ASA24 Dietary Assessment Tool)			
Protein (g/kg/d)	1.05	0.89 to 1.22	0.06
Protein (g/d)	77.90	72.78 to 83.03	0.08
Energy	26.24	20.65 to 31.83	0.13

Abbreviations: ASA24, Automated Self-Administered 24-Hour [dietary assessment tool]; CES-D, Center for Epidemiologic Studies Depression Scale; d, day; EQ-5D-5L, EuroQol Group 5 Dimension 5 Level; FSST, four-square step test; HRQoL, health-related quality of life; RCT, randomized controlled trial.

our exercise program. For example, the 30-second sit-to-stand is a feasible outcome to measure sit-to-stand functioning in the lower limbs, and daily activities that use these muscles include getting up from a chair. Program participants completed two additional sit-to-stands by the end of the study; an increase of two or more repetitions for the 30-second sit-to-stand represents the minimum clinically important difference.⁴⁹

Foot clearance is an important function in everyday life, and the ability to do this in different directions is essential when reacting to stimuli in the real world (i.e. navigating a busy street or walking on an uneven pavement).⁵⁰ The four-square step test incorporates rapid stepping while changing direction; however, we found this test was difficult for older adults categorized as frail, with six participants (≥3 on the FRAIL scale) unable to complete the test. Future studies should consider adding another test of dynamic balance and a static balance test feasible for older adults who are frail. If a research study

includes older adults with either pre-frailty or frailty, at least two tests to measure balance should be considered, such as the Berg Balance Scale as well as the four-square step test.

Lastly, we did not see an improvement in gait speed using the 10-metre walk test; however, the average gait speed at baseline was average for adults over 75 years old (mean gait speed 1.06 m/s, 95% CI: 0.95 to 1.18); high functioning gait speed is greater than 1.1 m/s.⁵¹ In addition, three of the four sites did not have the 14-metre cleared pathway required to conduct this test, so we performed several 10-metre walk tests in the hallway where other residents were walking, which could have interfered with our results. Future trials should consider specificity and target population in program design and outcome selection and ensure that they select outcomes that are feasible and responsive in the target population.

The interactions between the MoveStrong program and HRQoL were significant, but

the interactions between the program and physical capacity levels (i.e. fatigue levels) were not. Several systematic reviews suggest that exercise may make little difference to HRQoL in older adults.^{2,3,5,52} However, many exercise studies in older adults may be exhibiting healthy responder bias and ceiling effect. Most participants who enrol in exercise trials may already have high HRQoL scores at baseline so there would be little room for improvement; however, the individuals in our study had multiple chronic conditions and were pre-frail or frail. Although, the mean change EQ-5D-5L score was not significant in our study (-0.02 points, 95% CI: -0.06 to 0.01), the minimum clinically important difference for this scale is 0.18 (95% CI: 0.03 to 0.54; 18 studies).⁵³ It is possible that a longer study may show a more meaningful change.

We also found no significant interaction between exercise exposure and site on protein intake. Protein intake is significantly associated with eating occasion among older Canadians in long-term care, with the greatest intake at dinner.⁵⁴ In the current study, dinner was the only meal where the average amount of protein consumed was 20 to 30 g. There is evidence that higher protein intake and a more even distribution of daily protein intake across meals are associated with greater muscle mass and strength.^{55,56}

In terms of energy, the average intake was less than the RDA (i.e. 30 kcal/kg/d), but above 21 kcal/kg/d; a daily energy intake of less than 21 kcal/kg/d is associated with frailty.⁵⁷ Our current intervention mainly focussed on increasing protein intake while maintaining energy intake; however, it may be important for future interventions to also emphasize maintaining or increasing energy intake to meet the RDA and to avoid a level that may be associated with frailty.

In Canada, the total health care costs of physical inactivity have been estimated at CAD 6.8 billion.⁵⁸ The total cost of implementing and delivering our program was CAD 14 700, or CAD 377 per participant, which is similar to that of other strength and balance training interventions.⁵⁹⁻⁶¹ A 2016 study found the cost of implementing a community-based version of the Otago Exercise Program to be USD 585 per client, inclusive of administrative costs.⁶² Assuming an average exchange rate of

CAD 1 to USD 0.7553 in 2016, with an inflation of 1.74% per year, USD 585 would be equivalent to CAD 830 per client in 2020, which is substantially more than our cost of CAD 377 per participant. Our program was designed to use as little equipment as possible to help reduce costs. A larger multisite trial is now needed to determine the cost-effectiveness of implementing the MoveStrong program at a larger scale.

We could not perform a subgroup analysis by sex/gender, living arrangement or frailty level because of the sample size, the small number of male participants or of frail individuals at each site, and the potential of conflating differences between sites with differences in living arrangement. If subgroup analyses are not performed under the correct circumstances or if several subgroup analyses are performed, the likelihood of false negative and false positive significance tests increases rapidly.^{63,64} A subgroup analysis by sex/gender, living arrangements (i.e. retirement/assisted living vs. community dwelling) and frailty level should be considered in future larger trials.

Strengths and limitations

Our study had several strengths. Our research team is represented by a collaborative group including implementation scientists, health care providers, health economists and patient partners. Involving knowledge users and individuals who can use the research evidence to inform policy and practice decisions is an important shift from solely scientist-driven research to collaborative problem-based research. We also recruited a diverse group of participants from across Ontario, which increases the generalizability through relevance, applicability and impact of the research results. Lastly, our program operationalized specific models and frameworks in the Knowledge to Action cycle⁶⁵ to pilot the feasibility of the MoveStrong program in practice.

We acknowledge some limitations in our study. Some individuals had trouble completing the balance assessment. To impute the missing data we used multiple imputation, which could have led to a Type II error. In addition, data collection during the last assessment was abruptly stopped due to the COVID-19 pandemic, and we were not able to collect the performance-based outcomes for eight participants.

Protein intake was based on three days. Although three days is a commonly used timeframe to assess changes in food intake, it may not have been sufficient to demonstrate significant clinical and statistical change. Furthermore, the capacity of participants to recall food consumption may be affected by their not preparing their own meals. To mitigate the challenge of recalling dietary intake, we asked for the menus from the retirement homes to ensure some reliability in data collection.

Lastly, statistical analysis of stepped-wedged trials is complex, and we opted to use a GEE analysis. One of the limitations of using GEE with few clusters is the risk of Type I error.

Conclusion

Participating in the MoveStrong program may improve grip strength, sit-to-stand functioning and dynamic balance. We did not see improvements in gait speed, physical capacity, HRQoL or protein intake. There may be an interaction between exposure to the MoveStrong program and gait speed, sit-to-stand functioning, dynamic balance and HRQoL index scores. Future trials on balance and functional strength training in older adults with pre-frailty and frailty should consider specificity of the exercises and the potential for ceiling or floor effects of certain outcomes.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Authors' contributions and statement

LMG, LT, HK, MA, SB, AC, LF, RJ, DL, WI, JM, MM, AP, SES, ZW: Conceptualization, methodology, writing – review and editing

IBR: Project administration, writing-original draft

IBR, JW: Data curation, formal analysis

LT, HK, LMG: Resources, software, validation of formal analysis

LGM: Supervision, funding acquisition

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

Registration

This trial was registered in ClinicalTrials.gov under identifier NCT04037436.

Protocol

The original protocol was published online in ClinicalTrials.gov: https://clinicaltrials.gov/ProvidedDocs/36/NCT04037436/Prot_SAP_ICF_000.pdf

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Original qualitative research

The mental health experience of treatment-seeking military members and public safety personnel: a qualitative investigation of trauma and non-trauma-related concerns

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Abstract

Introduction: Paramedics, firefighters, police officers and other public safety personnel (PSP) as well as Canadian Armed Forces (CAF) members are frequently exposed to stressors and demanding work environments. Although their specific work-related tasks may vary, a commonality between these occupations is the significant likelihood of repeated exposure to potentially psychologically traumatic events (PPTE) over the course of their careers. Due in part to these repeated exposures, CAF members and PSP are at an elevated risk of mental health concerns including posttraumatic stress disorder. The purpose of this study was to obtain a more in-depth understanding of the trauma- and non-trauma-related experiences of active or retired PSP and CAF members that may be implicated in mental health issues and resultant treatment and recovery.

Methods: Study participants were recruited during inpatient treatment at a private mental health and addictions inpatient hospital in Canada. We conducted and audiotaped semistructured focus groups and transcribed the discussions. Interpretive phenomenological analysis and thematic coding generated a coding scheme from which to identify concepts and linkages in the data.

Results: Analysis generated four primary themes: interpersonal relationships, personal identity, mental health toll and potential moral injury. A variety of subthemes were identified, including family dynamics, inability to trust, feelings of professional/personal betrayal, stigma within the CAF/PSP culture, increased negative emotions about self/others, and a reliance on comradery within the service.

Conclusion: The information gathered is critical to understanding the perspectives of PSP and military members as the career stressors and related exposure to PPTE of these occupations are unique.

Keywords: *posttraumatic stress disorder, military, first responders, potentially psychologically traumatic events*

Highlights

- Police, paramedics, other public safety personnel (PSP) and members of the Canadian Armed Forces witness more potentially psychologically traumatic events and report higher rates of mental health disorders than the general population.
- While seeking treatment at an inpatient facility, study participants described the impact of their military/PSP experiences on their relationships and mental health through semistructured focus group discussions.
- Relationships with family and friends, personal identity, mental health impact and potential moral injury are areas that influence self-perception, role evaluation and feelings of connectedness with society.
- Specific mental health programming may be beneficial for active and retired military members and PSP because of their unique career stressors.

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Introduction

Public safety personnel (PSP), including but not limited to police officers, firefighters, correctional officers, dispatchers and paramedics¹ as well as members of the armed forces, have higher exposure to potentially psychologically traumatic events (PPTe) and report higher rates of mental health disorders than the general population. The 2018 Canadian Armed Forces members and Veterans Mental Health Follow-up Survey found that 44% of those surveyed had experienced symptoms consistent with anxiety or depression at some point between 2002 and 2018, while 25% of respondents had experienced symptoms consistent with both.² The prevalence of past-year posttraumatic stress disorder (PTSD) for members of the Canadian Armed Forces (CAF) also increased from 2.8% in 2002 to 5.3% in 2013. In 2016, 16.4% of surveyed Regular Force veterans released between 1998 and 2015 self-reported a diagnosis of PTSD.³

Similar increased rates of mental health disorders, compared to the general population, have been found for PSP. A recent national survey of almost 6000 Canadian PSP found that 44.5% screened positive for symptom clusters consistent with one or more mental health disorders.⁴ The frequency of positive screens among active and veteran military and public safety personnel (~44%) is significantly higher than the prevalence of diagnosed mental health disorders in the general Canadian population (~10%).⁵ While the specific demands of each career differ widely, commonalities between military and public safety occupations include the increased chance of repeated exposure to on-the-job traumatic experiences⁶⁻⁸ and an elevated risk of mental health concerns, including alcohol dependence, depression, PTSD and potential moral injury⁹⁻¹¹. Moral injury refers to the psychological distress or difficulties with functioning that individuals experience as a consequence of situations during which they or others have betrayed personal moral beliefs.^{12,13} Individuals exposed to events that transgress their personal morals commonly report symptoms of shame and guilt, which may influence the development of PTSD and other mental health disorders.^{14,15} These feelings of shame and guilt can be associated with acts of the self, such as actions leading to loss of life, and actions of others, including seeing ill

or injured people they are unable to help, a common experience during deployment.¹¹

Although successful evidence-based treatments for PTSD exist, their effectiveness seems to be reduced in combat-exposed individuals, who are more likely to be diagnosed with PTSD than the general public.^{2,16} Treatment dropout rates among military samples are higher than the general population, with one in four veterans not completing residential treatment and many others refusing to seek treatment because of perceived and experienced stigma, misconceptions about treatment and structural barriers.^{17,18} The high dropout rates indicate there is a missing component to effective treatment of military personnel with mental health concerns. Moreover, although data on treatment dropout rates among PSP are unavailable, commonalities (e.g. long shifts, stressful environments, high-risk situations) with the military suggest that dropout rates could be similar.

The literature is scarce on the mental health concerns of active and retired CAF members and PSP seeking treatment for PTSD and substance use disorders. By gaining in-depth understanding of the unique trauma and non-trauma-related issues among military and public safety personnel, we can work to enhance the effectiveness of focused treatment programs designed for active and retired CAF members and PSP.

The purpose of this study was to gain a comprehensive understanding of the experiences of treatment-seeking individuals in these occupations. Our sample included CAF members on medical leave, CAF veterans and PSP, all seeking inpatient mental health treatment.

This article provides a descriptive overview of the themes and issues identified as most relevant for PSP and military members and veterans relating to moral injury and their mental health.

Methods

Design

We used a phenomenological focus group-based approach to better understand participants' first-hand experiences in their military/PSP careers and the impact of these experiences on their relationships and mental health. We used focus group

discussions to draw out participants' lived experiences as CAF members and PSP, to elucidate how subjective experiences can reveal shared nuances and themes within these professions.¹⁹ We paired this method of data collection with a thematic analysis of the data, to descriptively identify similarities and differences in the data set, and to highlight key shared features.²⁰

Ethics approval

We obtained institutional ethics approval from Homewood Health Centre (REB #18-08).

Setting

We conducted the study in a private mental health and addictions inpatient residential treatment facility in Canada. The facility offers group-based treatment to adults (18+ years old) for substance use disorders, trauma and anxiety-related disorders. Treatment included emotion regulation skills, cognitive behavioural skills, dialectical behavioural interventions, group and individual therapy sessions, and creative activities such as gardening.

Demographics

We conducted 26 focus groups with 63 self-identified active or retired CAF members and PSP receiving treatment for trauma and/or substance use disorders. Participant recruitment was conducted in the treatment units. The only reason for exclusion from the focus groups was that participants could not be in their first week of inpatient treatment, to allow for a period of emotional adjustment to the facility environment.

Eligible individuals interested in participating in the focus groups were asked to meet with one of the researchers beforehand to learn about the purpose of the focus group interviews and to give informed consent. In total, 48 men and 15 women participated in at least one focus group, though many individuals participated in multiple groups.

Three different sets of question guides were used for the focus groups. The question guides were rotated each week, which is why some participants chose to engage in multiple focus group sessions. Of note, 2 male participants did not provide demographic data (see Table 1). Of the remaining participants, 19 were police

TABLE 1
Demographics of focus group participants (n = 63)^a

Demographics	n (%)
Median age: 45.5 (range: 29–80) years	–
Sex/gender (n = 63) ^a	
Male	48 (76)
Female	15 (24)
Marital status (n = 61)	
Married	34 (56)
Separated/divorced	14 (23)
Single	9 (15)
Declined to respond	4 (7)
Occupation (n = 61)	
Police	19 (31)
CAF (active member or veteran)	10 (17)
Correctional officer	10 (17)
Paramedic	9 (15)
Firefighter	6 (10)
Other (e.g. emergency dispatch, CBSA)	7 (11)
Work status (n = 61)	
Full-time/disability	45 (74)
Retired/suspended/unemployed	11 (18)
Declined to respond	5 (8)
Ethnicity (n = 61)	
White	50 (82)
Other	6 (10)
Declined to respond	5 (8)
Mean PCL-5 Score (SD) (n = 59)	53 (14.75)
Mean ACE Score (SD) (n = 59)	3.1 (2.42)

Abbreviations: ACE, Adverse Childhood Experiences; CAF, Canadian Armed Forces; CBSA, Canada Border Services Agency; PCL-5, posttraumatic stress disorder checklist for the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5); SD, standard deviation.

^aTwo focus group participants gave no demographic information other than their sex/gender. Therefore, unless noted, all other rows n = 61, and percentages are calculated based on the number of respondents to that question.

officers (including municipal forces, provincial police services and Royal Canadian Mounted Police); 10 were CAF members/veterans, 10 were correctional officers; 9 were paramedics; 7 were in the “other” category, meaning that they had multiple PSP roles (e.g. began career in CAF, then became a police officer; emergency dispatch); and 6 were firefighters. Active and retired PSP and CAF members took part in the study.

The median age of participants was 45.5 (range: 29–80) years.

Focus groups were conducted once per week, lasted approximately one hour, and included 4 to 16 participants each. Because anyone who had consented to participate was welcome to attend as

frequently as they wanted, the focus groups included a mix of occupations, ages (18+) and sex/genders.

Groups were facilitated by two clinicians (CO and SV) trained to a master’s or doctoral level, with multiple years of experience working with these populations. Interviewers adopted a facilitative rather than interrogative stance to encourage rich discussion and participation. While one researcher facilitated, the other observed, noting any non-verbal cues; the observer was also available for any questions to do with the research study.

The clinicians facilitated the focus groups using semistructured question guides. The discussions were audiorecorded with participant consent, and the recordings

professionally transcribed verbatim. The questions asked about specific challenges and stressors associated with participants’ jobs that affected their lives, including effects on relationships, stigma, potential moral injury, treatment expectations and treatment experiences.

In addition to informed consent forms, participants were asked to complete a demographics form, the PTSD checklist for the *Diagnostic and Statistical Manual of Mental Disorders* (PCL-5)²¹ and the Adverse Childhood Experiences (ACE) questionnaire²². The PCL-5 is a 20-item self-report questionnaire assessing symptoms of PTSD as per *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) criteria.^{21,23} The ACE questionnaire is a 10-item self-report measure designed to identify experiences of childhood abuse and neglect.²² These questionnaires were included as part of the treatment intake battery to clarify participants’ history of trauma. Results of these self-report questionnaires are included in order to account for the severity of trauma history in this sample.

We used an inductive, interpretive phenomenological approach to qualitatively examine the transcripts for further thematic analysis. Interpretive phenomenology is commonly used to explore insights from a given person on how a phenomenon relates to personally significant experiences. We chose a phenomenological approach because we were particularly interested in understanding participants’ interpretations of their experiences as CAF members and/or PSP. This approach allowed us to group together individual interpretations of events to establish a broader understanding of the daily life conditions of members of these populations using an inductive approach.²⁴ Sampling was purposive, as participants were chosen because of their experience as military members or PSP and their current engagement in inpatient psychiatric care.

Three members of the research team (AB, BE, HM) independently assessed transcripts, noting initial ideas for terms that represented dominant themes in the data. A coding scheme was developed using Miles and Huberman’s techniques of data reduction, data display and conclusion drawing/verification.²⁵ The researchers identified primary themes based on participant

discussions throughout the process; they included these into a coding scheme once all three coders reached consensus agreement. Any disagreements between coders were resolved through team discussion. Independent parallel coding was conducted, with two coders evaluating the same sample of raw text to revise and refine the category system, ensuring transferability, dependability and conformability of the coding scheme.

Results

Demographics

Of the 59 participants who completed the questionnaires (4 individuals chose not to), the mean (standard deviation [SD]) total score on the PCL-5 was 53 (14.75). Of these 59 participants, 53 (90%) scored above the cutoff of 33 that indicates symptoms consistent with probable PTSD.²¹ In addition, 50 (85%) met the DSM-5 criteria for a provisional diagnosis of PTSD. The mean (SD) score on the ACE was 3.1 (2.42) out of 10 positive indications; 48 (82%) participants selected one or more items, and 24 (41%) selected four or more items. Individuals who experience four or more adverse childhood categories, when compared to those who experience none, have a 4- to 12-fold increased risk for substance use disorders, depression and other mental health disorders.²²

Qualitative themes

We extracted four primary themes from the data with supporting quotes: relationships; identity; mental health toll; and potential moral injury.

Relationships

Participants discussed relationships at length during the focus groups. The discussions were multifaceted, and experiences in one relationship domain (e.g. family) often seemed to blend into others (e.g. peers). Issues to do with trust and feelings of isolation and lack of understanding were pervasive throughout all relationship domains, while support from peers provided the benefit of understanding without judgment.

Family was a central point of discussion throughout many of the focus groups. Participants reported that demanding work schedules reduced their participation in family dynamics and made it difficult to separate work experiences from

home life. They attributed the difficulties in separating work and home life to shift work, long hours and the constant stress associated with the critical, typically time-sensitive decision-making often required in their work. Participants described their jobs as physically and emotionally exhausting, which made it difficult to be empathetic at home as the challenges faced in civilian life seemed trivial in comparison. As one participant explained:

You don't have empathy for [your spouse's problems at home] because you spend all day crushing all your feelings and empathy because you have to, because that's your job, so you don't—it's not like a switch you can turn on and off, it's too big of a stretch and a demand to be able to do that. You'd almost need a split personality to have an effective work life and an effective home life.

This quote exemplifies the frustration felt when trying to communicate with family and friends. Participants reported frequent communication breakdowns as it became increasingly challenging to interact and communicate with loved ones while coping with work-related stress. Many described a decrease in empathy, leading to noticeably reduced tolerance of others.

Relationships with friends and acquaintances were difficult to navigate for many participants, partly because they felt their occupations became their primary identity when they were in social situations. Many said that they had been asked to describe “the worst thing you've ever seen,” a potential trigger for those who have experienced PPTEs. The inability to escape the perception that their sole identity was as military or public safety personnel led many to feel that their civilian friends and acquaintances could not truly understand them because their experiences were “impossible” for civilians to relate to. Feeling misunderstood by the civilian community left many with a sense of isolation.

Many participants explicitly described difficulties drawing on their emotions to connect with others. Some explained that they used “dark humour,” such as jokes about dying or other PPTe, as a type of coping mechanism, which they felt further isolated them from their civilian

counterparts who saw no humour in such expressions.

Many participants found their coworkers and individuals in other military or public safety services to be a significant source of support. Several explained that their lived experiences were only truly understood by other military members or veterans and first responders, which made it easier to maintain these friendships. Many said that they could “be themselves” around others within CAF/PSP because they understood what it was like to work in high-stress environments where exposure to PPTe was common. Conversely, some individuals indicated that colleagues could also become sources of stress or triggers because their relationships with them centred around shared experiences.

Identity

Overwhelmingly, participants said that their occupations had become a critical part of their identity. Many had a great sense of pride in their work and an ingrained need to help others even if they were no longer on active duty. Feeling that their identity was so closely tied to their job made some feel unsure of their identity when they were no longer able to perform work-related duties. One participant's statement provided insight into how crucial individuals considered their identity as CAF members or PSP, especially those who were on medical leave and hoping to eventually return to work: “Firefighting is who I am and it's what I do, and when I can no longer do it ... life ends.”

Alongside a shift in identity, many participants described how their job had changed their view of the world. For example, “It's almost like you have a filter for the outside world now and your filter changes because it's been blocked by this [work experiences] and you can't help but see the world differently.”

Participants specifically noted that the challenges of their jobs had led them to hold a more negative world view than before they began their career in the CAF or as PSP. Many now expected the worst from the individuals with whom they interacted, and they were cynical of both the system in which they worked and of those whom they helped. In some, this lack of trust and cynicism decreased their capacity to be empathetic, “...like a callus over your emotions, just like you would

get from lifting, you know, calluses on your hands. It's the same thing, like a callosity over your emotions." This quote exemplifies the difficulty in expressing emotions that some participants felt was related to the PPTEs to which they were repeatedly exposed. The participants indicated that this difficulty expressing emotions was not something they had always had, but that it had developed over the course of their careers and caused them to become embittered about the utility of discussing their emotional reactions.

Mental health toll

Participants described the mental health toll of PSP and military careers as overwhelmingly negative. Many described having symptoms typically associated with emotional dysregulation, such as hypervigilance, agitation and disproportional anger:

Say the regular everyday stuff that people go through that is traumatic to them—whether it's my spouse or friends or somebody else—and they're talking about some stress that they've gone through and then I get angry because I think, "Well, that's your problem?! That's what your worst day is?!"

Some participants acknowledged that this "flip of the switch" anger was disproportional to the "inconsequential" stressors. Some individuals said that their emotional outbursts were driven by the need to protect loved ones, including attempting to shelter family from their symptoms of PTSD. "I'd rather be a disaster inside," a 30-year-old participant imparted, "than have, you know, my [spouse] or my family members be a disaster by having them see it as well."

Research indicates there may be an association between severity of veterans' PTSD symptoms and degree of intimate partners' caregiver burden.^{26,27} As 90% of focus group participants (n = 53/59) scored above threshold levels for symptoms of PTSD, it is likely that their intimate partners experienced caregiver burden, even if the participant attempted to shield their family from their PTSD symptoms. Although participants believed that keeping their work experiences from their family protected them from vicarious trauma, this secrecy also reduces the family's ability to provide support.²⁸ As levels

of perceived support decrease, levels of depression and traumatic stress symptoms among PSP appear to simultaneously increase.²⁸

Another emotional symptom discussed at length was the participants' current feeling of isolation. Participants said that they typically did not discuss their traumas with their families for fear of "burdening" them with the details, and that when their CAF/PSP colleagues were unavailable it was "just very isolating." While some said they understood the difficulties their peers face in reaching out, they nevertheless longed for a sense of connectedness. As many felt that their social circle primarily comprised individuals in the same career, lack of contact from those within the organizations, especially while the participant was in treatment or on medical leave, only served to increase feelings of isolation and abandonment related to their mental health diagnosis.

The participants talked about the different mechanisms used to cope with the mental health toll of their occupations, including the culture of using alcohol to deal with negative emotions surrounding difficult events. Although the participants were unanimous about the mental health toll of coping with exposure to PPTe, some of the coping mechanisms they had adopted, such as dark humour, had led to further isolation from relationships as these coping mechanisms were considered neither commonplace nor appropriate in civilian relationships.

Potential moral injury

Many participants said they had feelings of shame and guilt across relationships, mental health and sense of identity, as well as an overwhelming sense of betrayal by many different entities, including management. Feelings of shame and guilt were frequently identified in relation to decisions made while on the job or the inability to make critical decisions due to "red tape" and other administrative constraints. Such feelings of shame and guilt have been identified as crucial components of moral injury.²⁹

Some participants described potentially morally injurious situations and events they had experienced, including witnessing tragic outcomes or having to make decisions that resulted in loss of life. Others felt that it was the high frequency

of difficult decisions made over time that lead to their feelings of shame and guilt. For example, one participant explained how the consequences of smaller decisions made over the course of years could have a large, cumulative effect:

It's that moral, those moral injuries right...it's not one trauma, I liken it to, it's that getting that little rock in your shoe where you can walk 10 steps and kick it out, and it's okay, 10 more steps you get another pebble in your shoe... You do that over 10 years, you walk around with those pebbles in your shoes, it's going to irritate you after a while, and that's what I find in my experience, that's what kills me. And some of the big things are the straw that breaks the camel's back, [but] sometimes it's small.

A feeling of betrayal was a concept brought up in many different forms. Some participants said they felt that their organization did not care about them as people. According to one, "...they squeeze as much out of you as they can, then when you break, they just throw you away." Others felt a distinct difference between the supports purported to be offered and the supports that they received or that were available: "Like, just having the lack of support. Like, they say they do all these great things for us and, they don't. They don't care one single bit." These feelings of betrayal exacerbated their frustration with the "political red tape" associated with careers in the CAF and public safety organizations.

These insights provide evidence that potential moral injuries incurred during service in these professions may be prevalent in treatment-seeking populations, even if not explicitly discussed.

Discussion

The objective of this study was to gain a comprehensive understanding of the experiences faced by treatment-seeking active and retired military members and PSP who attended a single inpatient psychiatric facility. In this article, we provide an overarching synopsis of themes related to moral injury and mental health. To enhance the effectiveness of treatments for active and retired CAF members and PSP, it is critical to consider these themes

(i.e. relationships, identity, mental health toll and potential moral injury) throughout treatment and recovery, and to consider the role of these themes in successful therapeutic interventions in these populations.

Relationships

Research on the work–family lives of PSP is lacking.^{30,31} Existing research indicates that PSP employment has a negative impact on families, partners and relationships.^{30,32} Aspects of PSP employment that affect family life include occupational stress, exposure to PPTE and shift work.^{30,32} These factors are also associated with higher parenting stress and lower parenting satisfaction.³²

Our study expands current knowledge of work–family lives of PSP by providing details about the impacts PSP and military careers have on relationships and sense of personal identity. Our research also describes the importance of relationships developed within these occupations. Many participants described the social support of other military or public safety personnel as a positive influence through their ability to empathize without judgment and provide opportunities for emotional disclosure. Of note, interpersonal conflicts with coworkers and role-related stressors were both considered to be significant in affecting mental health. This aligns with current research showing that the social support of peers appears to be extremely beneficial, while interpersonal conflict with coworkers is associated with negative mental health outcomes, including increased rates of PTSD and substance use disorders.^{33,34} Social supports have also been cited as a robust factor negatively associated with PTSD symptoms³⁵ and positively associated with better dyadic functioning³⁶. Specific social supports associated with protective effects are therefore a critical area for future research in CAF and PSP populations.

Lack of mutual understanding was another relational factor echoed by participants in our focus groups; they had difficulty understanding “civilian problems,” and loss of meaning in life following discharge or retirement from service was commonplace. The perceived lack of understanding between military members/PSP and civilians may serve to isolate people in

these occupations and increase their feelings of identity loss when transitioning into civilian life.

Identity

This study provides insight into how being in public safety or military occupations can affect one’s identity. Participants frequently mentioned how their careers had shaped their personal identities and that no longer actively participating in CAF/PSP duties was tied to feelings of uncertainty and loss. Such feelings may be compounded by the perception of profound differences between CAF/PSP culture and civilian life, where caregiving, thrill seeking and sense of duty are less common career components.³⁷ For CAF veterans, successfully adjusting back into civilian society is often impeded by having negative perceptions of civilian society, feeling excluded as a result of their military service, feeling the loss of a military “brotherhood*” and having difficulties with finding meaning in the civilian world.^{38,39} It is therefore imperative that individuals transitioning to non-military or non-public safety careers reframe their views of and relationship with civilian life. Key areas of support include encouragement in shaping identities outside of the CAF/PSP spheres, and improving perceptions of civilian group belonging.

Mental health toll

Focus group participants described their difficulties with regulating emotions and actively engaging with others, being hypervigilant in scenarios where such behaviour was unnecessary and using substances as a method of coping with exposure to PPTE. The primary symptoms captured in the phenomenological experiences of this treatment population largely map onto the DSM-5 symptom criteria of PTSD and substance use disorders.⁴⁰ Specifically, participants described intrusion symptoms, avoidance reactions, marked changes in reactivity and negative alterations in their cognitions and mood following exposure to PPTEs throughout their careers. These experiences emerging as primary themes further validate the necessity of appropriate treatment strategies that adequately identify and mitigate these symptoms.

Further, avoidance of social interaction, which was a commonly discussed outcome in this study, may affect participants’ families in the form of ambiguous loss, that is, the experience of psychological absence while a loved one is physically present.⁴¹ Ambiguous loss has been associated with psychological distress in intimate partners⁴², and could further exacerbate feelings of isolation, as well as increase strain on familial relationships.

Potential moral injury

Participant discussions suggest that they may have been coping with potential moral injuries developed as a result of their experiences in the field. Many participants described pervasive feelings of shame, guilt, anger and betrayal due to their experiences during their time as CAF members or PSP; these feelings are critical components of moral injury.¹²

Previous studies indicate that 70.5% of CAF members know someone who was seriously injured or killed, and that 43% have seen “ill or injured women or children whom [they] were unable to help”^{11,p.4} during deployment. Similarly, surveyed law enforcement officers have reported that harming others (perpetrators or colleagues) would be the most stressful experience to cope with in their line of duty.^{43,44} Severely injuring a perpetrator has also been identified as a risk factor for development of PTSD among police officers.⁴⁵ Emergency Medical Service (EMS) personnel have also described seeing a family member or friend at the scene of an accident or seeing someone seriously injured or killed as extremely distressing.⁴⁶

Violent PPTEs are commonly considered the most distressing events for both CAF and PSP personnel, and may be involved in the development of moral injury and other mental health disorders in both populations.^{47,48} In addition, occupational stressors may further exacerbate mental health symptoms.⁴⁸ Although empirical evidence regarding prevalence of moral injury in PSP is lacking, many of our participants indicated feelings of shame or guilt related to events that could be classified as morally injurious. These analogous experiences provide anecdotal insights into the potential moral injuries associated with service in the CAF or as PSP and highlight the importance of further

* This term was used by both male and female participants.

examination of moral injury in both contexts. This also exemplifies the need to explicitly address moral injury during therapeutic treatment in CAF/PSP populations.

Limitations and future directions

Because research participants were inpatients recruited using a purposive sampling method, our findings cannot be generalized to all military members, veterans or PSP seeking inpatient psychiatric treatment. Secondly, the intent of a phenomenological approach is to examine how individuals perceive meaning of an event or phenomenon, rather than develop theories or generalizations about entire populations. In this case, we examined how active and retired CAF members and PSP, regardless of sex/gender or age, perceived their careers as influencing different areas of their lives. Critically, the conclusions of phenomenological inquiry depend on the participants chosen; as such, this study may have excluded information regarding experiences in different branches, municipalities or deployments.

Finally, we chose to combine the experiences of active and veteran military and public safety personnel because they were receiving treatment in a single, combined program, and because many of their difficulties were similar across careers (CAF vs. policing vs. firefighters). Despite responses being similar across occupations, research shows that CAF treatment outcomes differ from that of the general population and therefore may also differ from PSP expectations and outcomes.⁴⁹ As such, combining data from CAF veterans and PSP may have unintentionally diluted specific treatment experiences and concerns of each profession. Further research into treatment-seeking CAF and PSP populations is necessary to elucidate whether differences exist between them.

This article provides an overarching view of the areas that active and retired military members and PSP identify as having the greatest impact on their mental health. As the mean total score on the PCL-5 was 53 and a typical cutoff score for provisional diagnosis of PTSD is between 31 to 33,²¹ it is clear this sampled population was experiencing severe trauma-related symptoms. Future research should examine whether the themes discussed are equally important to active and retired military members and PSP, and to those experiencing less acute distress. In addition, each of

these themes requires further exploration. Future research is also needed to understand how to best include families and spouses in treatment to address the feelings of isolation participants identified.

Conclusion

Participants discussed relationships, identity, mental health toll and potential moral injury as critical areas that affect self-perception, evaluation of their role in society, and their ability to connect with civilians. These areas were identified as crucial to participants' recovery and should be addressed specifically during mental health treatment for these populations. Our findings affirm that treatment-seeking individuals view specific mental health programming for active and retired CAF members and PSP as beneficial, due, in part, to the unique challenges they face throughout their careers.

Conflicts of interest

None to declare.

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Authors' contributions and statement

SVB, RL, AH, MM, AB and CO were integral in the conceptualization and design of the project. AB, BE, SVB and CO conducted focus groups and collected the data. AB, HM and BE analyzed and interpreted the findings. BE drafted the initial manuscript. BE, AB, HM, SVB, AH, MM, RL and CO all revised the paper and approve its submission in its current form.

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Release notice

Updated Positive Mental Health Surveillance Indicator Framework for youth and adults in Canada, including updated Quick Stats and Data Tool

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The Public Health Agency of Canada has released the latest edition of the Positive Mental Health Surveillance Indicator Framework (PMHSIF) on the [Public Health Infobase](#) website.

The PMHSIF is used to monitor positive mental health and its determinants at the individual, family, community, and society levels, for youth (aged 12–17 years) and adults (aged 18 years and older) in Canada. The 2022 edition of the PMHSIF incorporates data from 2019 or earlier to provide updated estimates for many of its indicators.

Overall estimates from the latest edition of the PMHSIF can be found on the [Quick Stats](#) webpage, while detailed data breakdowns by various sociodemographic factors are available for users to explore in the interactive [Data Tool](#) on Infobase.

Other PHAC publications

Researchers from the Public Health Agency of Canada also contribute to work published in other journals. Look for the following article published in 2022:

Lang JJ, Pinault L, Colley RC, **Prince SA**, [...] **de Groh M**, et al. Neighbourhood walkability and mortality: findings from a 15-year follow-up of a nationally representative cohort of Canadian adults in urban areas. *Environ Int.* 2022;161:107141. <https://doi.org/10.1016/j.envint.2022.107141>

