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# Effects of the Community Paramedicine at Clinic (CP@clinic) program on the health behaviours of older adults residing in social housing: secondary outcomes of a cluster-randomized trial

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## Abstract

**Background** Community-dwelling, low-income older adults who reside in social housing are a vulnerable population with high rates of poor health behaviours that contribute to chronic health conditions and adverse health outcomes. This study investigates the impact of the Community Paramedicine at Clinic (CP@clinic), a chronic disease prevention, management, and health promotion program, on the health behaviours of this population.

**Methods** An open-label, pragmatic cluster-randomized controlled trial with parallel intervention and control groups was conducted for one-year within 30 social housing buildings in Ontario, Canada. Eligible buildings were required to have a postal code not shared with other addresses, a majority of tenants aged 55 years or older, at least 50 units, and a similar building available for matching. Buildings were paired and randomized to either intervention (CP@clinic program) or control (usual care) groups. The CP@clinic program was conducted in the common spaces of the intervention buildings and consisted of weekly drop-in sessions facilitated by trained community paramedics. Older adults met one-on-one with community paramedics who conducted evidence-based risk assessments, made referrals to community and healthcare resources, provided health education, and reported health assessment results back to family physicians. Pre- and post-intervention surveys were conducted. Descriptive statistics were used to describe demographic characteristics and health behaviours. Mann–Whitney U tests were conducted to compare individual-level change in health behaviours between intervention and control groups.

**Results** From the 15 intervention and 15 control buildings, 656 participants completed either the pre- and/or post-intervention survey; the mean age was 72.1 (SD 8.7) years, 75.6% were female, 91.6% were not married, 89% were white, 68.4% obtained a high school education or less, and 90% lived alone. After the intervention, the individual-level consumption of weekly fruit and vegetables and time spent watching TV improved significantly ($p < 0.05$) for the intervention group compared to the control group (z-scores = -2.467 and -2.194, respectively). The change in consumption of carbohydrate/grains increased significantly for the intervention group compared to the control group (z-score -2.023, $p < 0.05$).

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**Conclusion** The CP@clinic program is an innovative wellness program that had a significant impact in changing health behaviours, especially in weekly fruit and vegetable consumption, among a vulnerable older adult population.

**Trial registration** ClinicalTrials.gov NCT02152891, registered June 6, 2014.

**Keywords** Community paramedicine, Older adults, Social housing, Health behaviours, Fruit and vegetable consumption, Health promotion, Community-based intervention

## Introduction

In Canada, 73% of older adults have at least one chronic health condition that contribute to disproportionately high rates of poor health [1]. This population also has a high prevalence of modifiable health behaviours (e.g., unhealthy diets, lack of physical activity, smoking, and drinking) that are well-known risk factors for chronic disease development and progression [1, 2]. Previous studies have found that older adults with multiple health risk behaviours have an increased risk for adverse health outcomes [2, 3]. Specifically, a diet high in fruits and vegetables, regular physical activity, lower levels of sedentary behaviours, no smoking, and limited consumption of alcohol are considered to be protective health behaviours that reduce chronic disease risk and improve overall health outcomes [2]. The complex nature of individual lifestyles and social determinants of health can make changing health behaviours very difficult [4]. Given the difficulty and need to improve health behaviours, many interventions have been introduced, including community-based interventions targeted towards older adults [5–8]. However, few interventions have focused on changing the health behaviours of low-income older adults who reside in social housing, and those that do exist generally have not been tailored to meet the needs of this population.

Community-dwelling, low-income older adults residing in social housing are a particularly vulnerable subset of the older adult population that is at greater risk of chronic disease, poverty, social isolation, loneliness, depression, and falls [9–12]. Despite many older adults having a family physician, timely access to primary care is limited, resulting in delays in receiving necessary medical attention and higher rates of emergency medical service (EMS) calls (e.g. calling 911 for medical reasons) and emergency department visits [13, 14]. The natural clustering of low-income older adults in social housing provides an opportunity to efficiently deliver health-related programs and resources that address the high needs of this population and informed the decision to use a clustered study design [15].

The Community Paramedicine at Clinic (CP@clinic) program is an innovative and evidence-based program that was developed to address the high EMS call rates and needs of vulnerable populations [16, 17]. A cluster-randomized controlled trial (RCT) has shown the effectiveness and success of the CP@clinic program in significantly reducing EMS calls, improving quality of life, normalizing blood pressure, and reducing risk of diabetes [9, 16–18]. This study will investigate the secondary aim of the cluster RCT, which was to examine the impact of the CP@clinic program on the health behaviours of community-dwelling, low-income older adults living in social housing buildings in Ontario, Canada.

## Methods

### Study design

An open-label, pragmatic cluster RCT with parallel intervention and control groups was conducted in 2015 with staggered start dates, and all sites ran for 12 months. The trial was registered on ClinicalTrials.gov (NCT02152891) on 29/05/2014. Each social housing building was considered a cluster. Social housing buildings were eligible if at least 50% of tenants were older adults (55 years and older), had a unique postal code that was not shared with other addresses (required for the primary trial outcomes), and there was another building with similar characteristics for matching (e.g., based on building size, geographic location, resident age, prior 9–1-1 use). A detailed protocol with the study design has been published elsewhere [19] and the building matching has been presented in a prior publication [16]. The social housing buildings were matched into pairs, and within each pair, one building was randomly allocated using computer-generated randomization (randomizer.org) to either receive the intervention (CP@clinic for 12 months) or the control (usual care). The intervention was implemented at the building-level and all building residents were welcome to attend at any point throughout the year (i.e., they did not need to register nor attend by a certain date to participate). Pre- and post-intervention data was collected from all residents regardless of whether they attended the program since having the CP@clinic program available within the building may have had an impact on residents (e.g., reading health promotion material provided to another resident who had attended).

### Study setting and participants

The participants were older adults, aged 55 years old and above, living in seniors' social housing buildings from five Ontario communities (Hamilton, Guelph, Simcoe County, Sudbury, and York). We defined older adults as individuals aged 55 and older, which aligned with the minimum age set by some housing providers for eligibility in senior social housing buildings [12, 20]. For the pre-intervention surveying, residents were informed by the housing provider through multiple communication avenues (e.g., letters, posters, tenant meetings) that research staff would be in the building going door-to-door. Initially, surveying was conducted using random sampling, however since this population was hesitant to be approached or open their doors [20], even with advanced notice, the list of randomized units had to be continually expanded in an effort to survey enough residents. As a result, it was identified that this process would lead to a sample with similar biases to non-random sampling techniques. Therefore, using a consecutive sampling method was determined to be the best approach to recruit survey participants in this setting and to increase the sample size. Specifically, the research team found that the best approach to survey this population was to conduct the survey in a common space in the building and allow the residents to approach the team. Surveying was completed over multiple days at different times to provide the opportunity to as many residents as possible, and surveying sessions continued to be offered until there were very few or no residents approaching anymore. Post-intervention surveying was conducted using the same consecutive sampling approach in a common space within the building. A $10 gift card was provided to survey respondents. The intervention was open to all residents in the intervention buildings and was advertised using the same communication channels as the surveying. Ethics approval was granted from the Hamilton Integrated Research Ethics Board and written, informed consent was obtained from participants prior to each survey and during their first visit to the intervention program.

### Intervention: CP@clinic

The intervention buildings received the CP@clinic program, which consisted of free, weekly drop-in sessions hosted by trained community paramedics in common spaces of the social housing buildings. Community paramedics conducted one-on-one sessions with older adults, which involved using validated tools for evidence-based health risk assessments such as chronic diseases, falls, and social isolation. Additional assessments were conducted to evaluate quality of life, food and income security, and health behaviours. Community paramedics also provided appropriate and relevant health education and referrals to community and healthcare resources. All assessments were reported back to participants' family physicians with participant consent. The control group received usual care (no intervention).

### Measures

Participants completed the Health Awareness and Behaviour Tool (HABiT) survey through one-on-one interviews with trained research staff due to literacy challenges [20, 21]. HABiT is a reliable tool with good content and face validity used to evaluate health promotion and chronic disease prevention programs for older adults, including low-income older adults. The survey asked for self-reported demographics, physical measures, and health behaviour variables. The demographic variables included age, gender, education, marital status, ethnicity, and whether they had a family doctor.

#### *Healthy eating*

Fruit and vegetables (the number of times per week they eat fruits and vegetables and daily fruit and vegetable consumption); carbohydrate/grains (the times per week they eat bread, cereal, potatoes, rice or pasta); fatty foods (the times per week they eat fatty foods like fried food or savoury snacks like chips); sugary foods (the times per week they eat sugary foods like cookies or chocolate), adding salt to foods (5-point Likert scale ranging from 'Never' to 'Always', to describe the frequency of adding salt to food whether at the table or when cooking); and monitoring food intake (5-point Likert scale ranging from 'Not at all' to 'All the time' to describe the frequency that they monitor their food intake to reach or maintain a healthy weight) were used to understand healthy eating behaviours.

#### *Physical activity*

The Godin Leisure-Time Physical Activity Questionnaire was used to classify weekly physical activity levels into three categories: insufficiently active, moderately active, and active. The calculation was based on three questions that evaluate how many times per week an individual is active for more than 15 min at three different intensities (mild, moderate, and strenuous). The activities provided as examples included relevant activities for the older adult population such as brisk walking, gardening, or water aerobics. In addition, consistency of daily physical activity was assessed by asking if they "usually do some physical activity such as brisk walking for at least 30 min every day," which is a single question that has been associated with reduced diabetes risk [22].

#### *Sedentary behaviours*

The time spent in a typical day of the week, sitting on the internet/computer (includes playing computer games and using the internet, with answers ranging from 'less than 3 h/not applicable' to 'more than 12 h') and watching TV/videos (answers ranging from 'less than 3 h' to 'more than 12 h') were used to determine sedentary behaviours.

#### *Smoking and alcohol use*

Smoking status was categorized into either current smoker, former smoker who quit, or never smoked. Alcohol consumption was assessed based on the number of alcoholic drinks per week.

### Sample size

The sample size was calculated for the building-level primary outcome (9–1-1 calls for EMS), as detailed in the published protocol [19]. This calculation was based on an observed clustering of EMS calls among individuals within buildings (intracluster correlation coefficient [ICC] = 0.07), a 15% difference in EMS calls between intervention and control groups, and standard parameters (power = 0.80, alpha = 0.05). The minimum sample size required was 1108 participants or 11 buildings with 100 units in each arm, which was achieved [16]. This study is focused on the secondary outcomes reported at the individual-level, which are exploratory and do not require a separate sample size calculation.

### Data analysis

Descriptive statistics were used to examine the demographic characteristics of the participants. Health behaviours were described for a sub-sample of the participant population who completed both the pre-intervention and post-intervention surveys. Where response options had low frequencies, categories were collapsed for analysis. Missing responses were excluded from analyses. ICCs were calculated for each outcome using Generalized Estimating Equations with an exchangeable correlation structure. Since the ICCs for the outcomes were small, to compare the health behaviour outcomes post-intervention between the intervention and control arms, chi-square and Fisher's exact tests were executed for the nominal variables and Mann–Whitney U tests for the ordinal variables. To evaluate the degree of improvement (number of categories changed) from pre-intervention to post-intervention, Mann–Whitney U tests were conducted, comparing the intervention and control groups. All analyses were performed using IBM SPSS Statistics v 28.0 [23].

## Results

From the 15 intervention and 15 control sites, 656 participants completed either the pre- and/or post-intervention survey. The participants had a mean age of 72.1 years (8.7 SD), 75.6% were female, 45.6% had less than a high school education, 91.6% were not married, 89.0% were white, 90.0% lived alone, and 92.4% reported having a family doctor (see Table 1).

Of the 656 participants, 281 (42.8%) completed both pre- and post-intervention surveys (see Fig. 1). For participants who completed both the pre- and post-intervention surveys, the dietary health behaviour outcomes are described in Table 2 and the remaining health behaviour outcomes (physical activity, sedentary behaviour, smoking, and alcohol consumption) are described in Table 3. The ICCs ranged from 0.001 to 0.056 depending on the outcome. At post-intervention, residents of the intervention buildings ate fruit and vegetables on significantly more days in a week ($p = 0.006$) compared to the control building residents. There was an overall trend of improving health behaviours in the intervention group compared to the control group.

The degree of change (number of categories improved/worsened) in health behaviours from pre-intervention to post-intervention between intervention and control groups is shown in Table 4. The results showed that the intervention group had a significantly greater change in increasing weekly fruit and vegetable consumption (mean rank = 141.11) compared to the control group (mean rank = 121.12) ($z = -2.467$, $p < 0.05$). Similarly, the intervention group had a significantly greater increase in carbohydrate/grains consumption (mean rank = 129.83) compared to the control group (mean rank = 121.12) ($z = -2.023$, $p < 0.05$). The change in time spent watching TV improved for the intervention group (mean

**Table 1** Demographic characteristics of the participants

| Demographic Characteristics | Frequency, n (%) |
|---|---|
| **Gender** ($n = 656$) | |
| Female | 496 (75.6) |
| Male | 160 (24.4) |
| **Education** ($n = 652$) | |
| Less than high school | 297 (45.6) |
| Completed high school | 149 (22.9) |
| Any postsecondary | 206 (31.6) |
| **Marital Status** ($n = 652$) | |
| Married | 55 (8.4) |
| Separated/Divorced/Widowed | 502 (77.0) |
| Never Married | 95 (14.6) |
| **Ethnicity** ($n = 598$) | |
| White | 532 (89.0) |
| Non-white | 66 (11.0) |
| **Lives Alone** ($n = 652$) | 587 (90.0) |
| **Has Family Doctor** ($n = 656$) | 606 (92.4) |
| | **Mean (SD)** |
| **Age, in years** ($n = 656$) | 72.1 (8.7) |

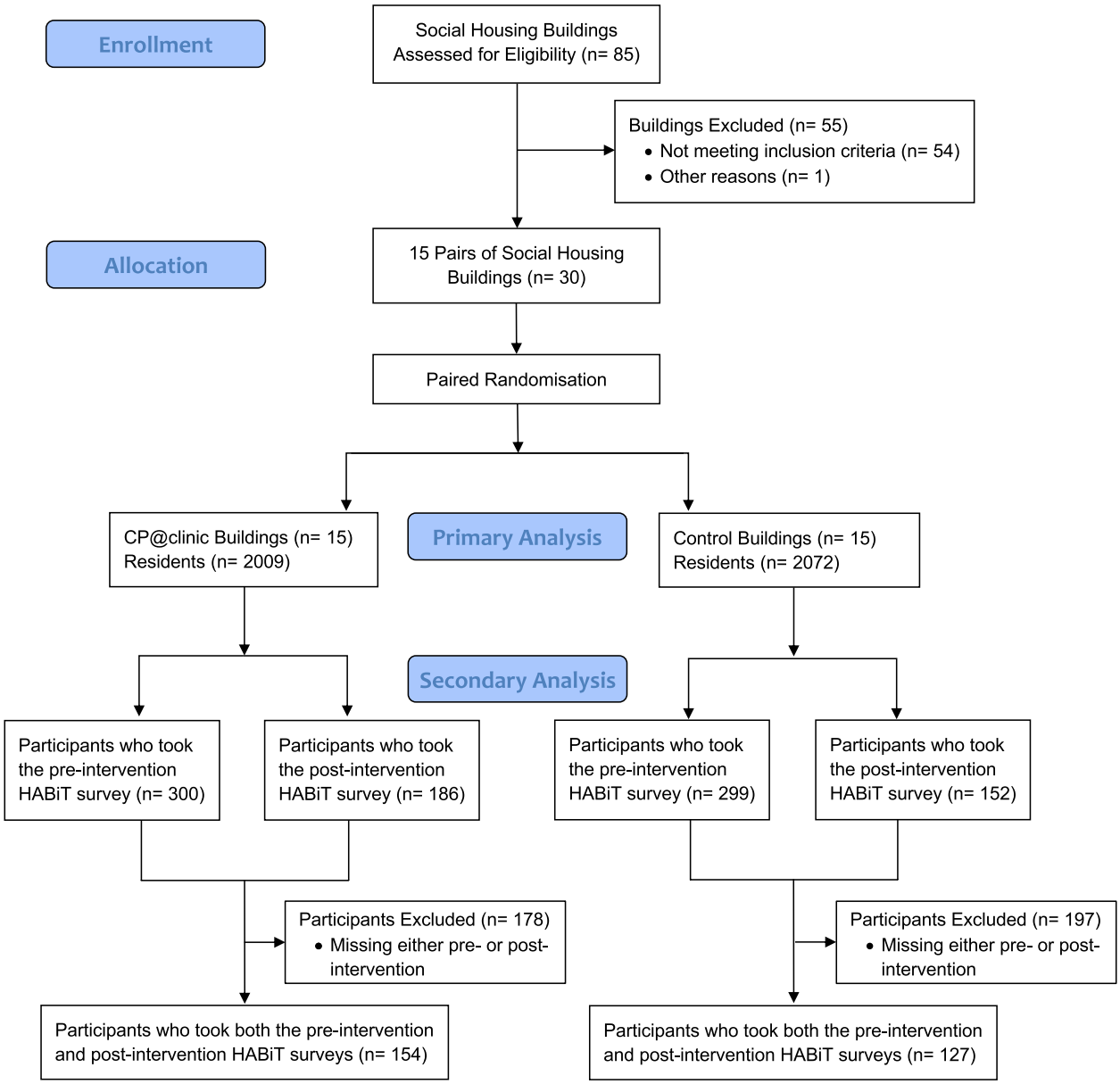


**Fig. 1** CONSORT flow diagram of the CP@clinic RCT with secondary analysis

rank = 139.34) in comparison to the control group (mean rank = 148.82) ($z = -2.194$, $p < 0.05$). These findings suggest that the CP@clinic program was effective in promoting changes in weekly fruit and vegetable consumption, carbohydrate/grains consumption, and time spent watching TV.

## Discussion

This study found that the CP@clinic program led to changes in the health behaviours of community-dwelling, low-income older adults residing in social housing. The program increased weekly fruit and vegetable consumption, and reduced the time spent watching TV in the intervention group compared to the control group. The CP@clinic program also increased carbohydrate/grains consumption, although it is difficult to determine whether the increase was driven by changes in whole grains or refined carbohydrates.

Our study findings are consistent with our expectations based on previous research. Community-based interventions with educational components have demonstrated the ability to improve fruit and vegetable

**Table 2** Dietary health behaviour descriptives for participants who completed both the pre-intervention and post-intervention surveys

| Variable | Categories | Pre-intervention | | Post-intervention | | |
|---|---|---|---|---|---|---|
| | | Frequency in intervention (%) | Frequency in control (%) | Frequency in intervention (%) | Frequency in control (%) | Mann Whitney U *p*-value |
| **Weekly fruit and vegetable consumption** (*n* = 262) -Intervention: *n* = 136 -Control: *n* = 126 ICC = 0.023 | Less than once a week | 5 (3.7) | 7 (5.6) | 3 (2.2) | 5 (4.0) | .006* |
| | Once a week | 5 (3.7) | 5 (4.0) | 3 (2.2) | 8 (6.3) | |
| | 2–3 times/week | 17 (12.5) | 20 (15.9) | 24 (17.6) | 28 (22.2) | |
| | 4–5 times/week | 17 (12.5) | 7 (5.6) | 12 (8.8) | 19 (15.1) | |
| | Everyday | 92 (67.6) | 87 (69.0) | 94 (69.1) | 66 (52.4) | |
| **Daily portions of fruits and vegetables** (*n* = 277) -Intervention: *n* = 152 -Control: *n* = 125 ICC = 0.021 | None | 10 (6.6) | 6 (4.8) | 7 (4.6) | 8 (6.4) | .800 |
| | 1 to 2 | 58 (38.2) | 63 (50.4) | 69 (45.4) | 62 (49.6) | |
| | 3 to 4 | 64 (42.1) | 31 (24.8) | 63 (41.4) | 33 (26.4) | |
| | 5 to 7 | 19 (12.5) | 19 (15.2) | 9 (5.9) | 16 (12.8) | |
| | 7 + | 1 (0.7) | 6 (4.8) | 4 (2.6) | 6 (4.8) | |
| **Monitor food intake** (*n* = 268) -Intervention: *n* = 146 -Control: *n* = 122 ICC = 0.024 | Not at all | 33 (22.6) | 44 (36.1) | 48 (32.9) | 37 (30.3) | .997 |
| | Rarely | 15 (10.3) | 13 (10.7) | 23 (15.8) | 22 (18.0) | |
| | Sometimes | 43 (29.5) | 24 (19.7) | 23 (15.8) | 20 (16.4) | |
| | Frequently | 28 (19.2) | 24 (19.7) | 23 (15.8) | 23 (18.9) | |
| | All the time | 27 (18.5) | 17 (13.9) | 29 (19.9) | 20 (16.4) | |
| **Carbohydrate/grains consumption** (*n* = 276) -Intervention: *n* = 150 -Control: *n* = 126 ICC = 0.003 | Part of every meal | 18 (12.0) | 17 (13.5) | 21 (14.0) | 20 (15.9) | .622 |
| | Part of 1–2 meals a day | 42 (28.0) | 58 (46.0) | 64 (42.7) | 54 (42.9) | |
| | 4–6 times/week | 51 (34.0) | 35 (27.8) | 21 (14.0) | 18 (14.3) | |
| | 1–3 times/week | 24 (16.0) | 10 (7.9) | 40 (26.7) | 31 (24.6) | |
| | Never/hardly every | 15 (10.0) | 6 (4.8) | 4 (2.7) | 3 (2.4) | |
| **Fatty foods consumption** (*n* = 274) -Intervention: *n* = 148 -Control: *n* = 126 ICC = 0.019 | Everyday | 19 (12.8) | 8 (6.3) | 8 (5.4) | 11 (8.7) | .190 |
| | 3–4 times/week | 12 (8.1) | 13 (10.3) | 16 (10.8) | 17 (13.5) | |
| | 1–2 times/week | 34 (23.0) | 48 (38.1) | 47 (31.8) | 35 (27.8) | |
| | 2–3 times/month | 44 (29.7) | 32 (25.4) | 38 (25.7) | 41 (32.5) | |
| | Never | 39 (26.4) | 25 (19.8) | 39 (26.4) | 22 (17.5) | |
| **Sugary/sweet foods** (*n* = 278) -Intervention: *n* = 151 -Control: *n* = 127 ICC = 0.015 | Everyday | 35 (23.2) | 34 (26.8) | 18 (11.9) | 30 (23.6) | .132 |
| | 3–4 times/week | 18 (11.9) | 23 (18.1) | 32 (21.2) | 13 (10.2) | |
| | 1–2 times/week | 37 (24.5) | 29 (22.8) | 34 (22.5) | 42 (33.1) | |
| | 2–3 times/month | 38 (25.2) | 25 (19.7) | 42 (27.8) | 22 (17.3) | |
| | Never | 23 (15.2) | 16 (12.6) | 25 (16.6) | 20 (15.7) | |
| **Salt addition** (*n* = 278) -Intervention: *n* = 151 -Control: *n* = 127 ICC = 0.018 | Always | 26 (17.2) | 23 (18.1) | 19 (12.6) | 21 (16.5) | .570 |
| | Often | 19 (12.6) | 8 (6.3) | 20 (13.2) | 5 (3.9) | |
| | Sometimes | 26 (17.2) | 19 (15.0) | 27 (17.9) | 24 (18.9) | |
| | Rarely | 38 (25.2) | 31 (24.4) | 33 (21.9) | 30 (23.6) | |
| | Never | 42 (27.8) | 46 (36.2) | 52 (34.4) | 47 (37.0) | |

* *p*-value is less than 0.05

consumption among older adults [6–8]. For example, a cluster RCT of a community-based program focused on improving the diet and physical activity of older adults also found a significant improvement in fruits and vegetable intake and no change in physical activity in the intervention group compared to baseline; carbohydrate/grains consumption was not assessed [6].

Previous interventions aimed at improving the physical activity of older adults have used different strategies with different outcomes and levels of success [24–26]. For instance, a cluster RCT aimed at improving nutrition and physical activity, guided by social cognitive theory and motivational interviewing, showed an improvement in changing the physical activity

**Table 3** Health behaviour descriptives for participants who completed both the pre-intervention and post-intervention surveys

| Variable | Categories | Pre-intervention | | Post-intervention | | |
|---|---|---|---|---|---|---|
| | | Frequency in intervention (%) | Frequency in control (%) | Frequency in intervention (%) | Frequency in control (%) | *p*-value[a] |
| **Daily physical activity** (*n* = 259) -Intervention: *n* = 135 -Control: *n* = 124 ICC = 0.008 | ≥ 30 min a day | 53 (39.3) | 71 (57.3) | 66 (48.9) | 73 (58.9) | .108 |
| | < 30 min a day | 82 (60.7) | 53 (42.7) | 69 (51.1) | 51 (41.1) | |
| **Weekly physical activity level** (*n* = 140) -Intervention: *n* = 87 -Control: *n* = 53 ICC = 0.047 | Insufficiently active | 25 (28.7) | 10 (18.9) | 27 (31.0) | 13 (24.5) | .430 |
| | Moderately active | 17 (19.5) | 13 (24.5) | 14 (16.1) | 20 (37.7) | |
| | Active | 45 (51.7) | 30 (56.6) | 46 (52.9) | 20 (37.7) | |
| **Time spent sitting on the computer/internet** (*n* = 264) -Intervention: *n* = 145 -Control: *n* = 119 ICC = 0.001 | More than 12 h/day | 3 (2.1) | 4 (3.4) | 3 (2.1) | 3 (2.5) | .802 |
| | 10–12 h/day | 2 (1.4) | 0 (0.0) | 1 (0.7) | 1 (0.8) | |
| | 7–9 h/day | 6 (4.1) | 3 (2.5) | 3 (2.1) | 3 (2.5) | |
| | 3–6 h/day | 28 (19.3) | 17 (14.3) | 17 (11.7) | 14 (11.8) | |
| | Less than 3 h/not applicable | 106 (73.1) | 95 (79.8) | 121 (83.4) | 98 (82.3) | |
| **Time spent watching TV** (*n* = 260) -Intervention: *n* = 142 -Control: *n* = 118 ICC = 0.013 | More than 12 h/day | 10 (7.0) | 7 (5.9) | 14 (9.9) | 12 (10.2) | .847 |
| | 10–12 h/day | 8 (5.6) | 5 (4.2) | 3 (2.1) | 8 (6.8) | |
| | 7–9 h/day | 26 (18.3) | 11 (9.3) | 20 (14.1) | 20 (16.9) | |
| | 3–6 h/day | 58 (40.8) | 47 (39.8) | 69 (48.6) | 41 (34.7) | |
| | Less than 3 h/day | 40 (28.2) | 48 (40.7) | 36 (25.4) | 37 (31.4) | |
| **Smoking status** (*n* = 264) -Intervention: *n* = 138 -Control: *n* = 126 ICC = 0.056 | Current Smoker | 37 (26.8) | 47 (37.3) | 32 (40.5)[b] | 43 (46.7)[b] | .434[b] |
| | Former Smoker | 47 (34.1) | 46 (36.5) | 47 (59.5)[b] | 49 (53.3)[b] | |
| | Never Smoked | 54 (39.1) | 33 (26.2) | –– | –– | |
| **Alcohol consumption** (*n* = 260) -Intervention: *n* = 135 -Control: *n* = 125 ICC = 0.029 | > 15 drinks/week | 2 (1.5) | 3 (2.4) | 0 (0.0) | 2 (1.6) | .934 |
| | 11–15 drinks/week | 0 (0.0) | 4 (3.2) | 2 (1.5) | 1 (0.8) | |
| | 6–10 drinks/week | 13 (9.6) | 7 (5.6) | 11 (8.1) | 11 (8.8) | |
| | 1–5 drinks/week | 23 (17.0) | 16 (12.8) | 23 (17.0) | 18 (14.4) | |
| | Non-drinker | 97 (71.9) | 95 (76.0) | 99 (73.3) | 93 (74.4) | |

[a] Based on chi-square test for the nominal outcomes and Mann–Whitney U test for the ordinal outcomes

[b] *n* = 171 (intervention *n* = 79, control *n* = 92), excludes those who reported never smoking pre-intervention

behaviours of older adults in retirement villages [24]. In contrast, while the CP@clinic program does include health education, SMART goal setting, and facilitating access to appropriate community resources, it takes a broader chronic disease prevention and management approach and, as a result, participants may have directed more attention towards other health behaviours. Notably, our findings showed a significant improvement in time spent watching TV, a common sedentary behaviour among older adults. Although a systematic review of interventions aimed at reducing sedentary behaviours among community-dwelling older adults was inconclusive due to the low certainty of evidence, our rigorous RCT demonstrated that sedentary behaviour can be improved in this population through the CP@clinic intervention [26].

The impact of the intervention varied across behaviours due to a combination of program and individual-related factors. While some health behaviours unexpectedly did not improve during the study period (e.g., daily fruit/vegetable consumption, sugary food consumption, smoking, daily physical activity), there was an overall trend of health behaviours improving in the intervention group compared to the control group. As such, we can surmise that if the program were to be delivered for a longer period of time there would be greater improvements in additional health behaviours related to diet and physical activity. To further improve physical activity, the CP@clinic program could also facilitate the implementation of group exercise sessions, establish personalized fitness goals, and strengthen community partnerships to promote local fitness programs [27]. Smoking is noted as a

**Table 4** Degree of change in health behaviours for participants who completed both the pre-intervention and post-intervention surveys, comparing residents of the intervention and control buildings

| Variable | Intervention Mean Rank Score | Control Mean Rank Score | Z-value |
|---|---|---|---|
| **Weekly fruit and vegetable consumption (*n* = 262)** | | | |
| -Intervention: *n* = 136<br>-Control: *n* = 126<br>Range: (−4 to 4) | 141.11 | 121.12 | −2.467* |
| **Daily portions of fruits and vegetables (*n* = 277)** | | | |
| -Intervention: *n* = 152<br>-Control: *n* = 125<br>Range: (−3 to 3) | 137.76 | 140.50 | −0.303 |
| **Monitor food intake (*n* = 268)** | | | |
| -Intervention: *n* = 146<br>-Control: *n* = 122<br>Range: (−4 to 4) | 127.36 | 143.05 | −1.685 |
| **Carbohydrate/grains consumption (*n* = 276)** | | | |
| -Intervention: *n* = 150<br>-Control: *n* = 126<br>Range: (−4 to 4) | 129.83 | 148.82 | −2.023* |
| **Fatty foods consumption (*n* = 274)** | | | |
| -Intervention: *n* = 148<br>-Control: *n* = 126<br>Range: (−4 to 4) | 137.19 | 137.87 | −0.073 |
| **Sugary/sweet foods (n = 278)** | | | |
| -Intervention: *n* = 151<br>-Control: *n* = 127<br>Range: (−4 to 4) | 141.66 | 136.93 | −0.505 |
| **Salt addition (*n* = 278)** | | | |
| -Intervention: *n* = 151<br>-Control: *n* = 127<br>Range: (−4 to 4) | 142.74 | 135.65 | −0.784 |
| **Daily physical activity (*n* = 259)** | | | |
| -Intervention: *n* = 135<br>-Control: *n* = 124<br>Range: (−1 to 1) | 134.22 | 125.40 | −1.150 |
| **Weekly physical activity level (*n* = 140)** | | | |
| -Intervention: *n* = 87<br>-Control: *n* = 53<br>Range: (−2 to 2) | 74.80 | 63.43 | −1.723 |
| **Time spent sitting on the computer/internet (*n* = 264)** | | | |
| -Intervention: *n* = 145<br>-Control: *n* = 119<br>Range: (−4 to 4) | 138.62 | 125.04 | −1.532 |
| **Time spent watching TV (*n* = 260)** | | | |
| -Intervention: *n* = 142<br>-Control: *n* = 118<br>Range: (−4 to 4) | 139.34 | 119.86 | −2.194* |
| **Smoking status (*n* = 171)** | | | |
| -Intervention: *n* = 79<br>-Control: *n* = 92<br>Range: (−3 to 2) | 86.85 | 85.27 | −0.350 |
| **Alcohol consumption (*n* = 260)** | | | |
| -Intervention: *n* = 135<br>-Control: *n* = 125<br>Range: (−2 to 3) | 132.56 | 128.27 | −0.725 |

* *p*-value is less than 0.05

more challenging and resource-intensive health behaviour to address and the CP@clinic program may need to expand the resources offered (e.g., nicotine replacement therapy) to have a meaningful impact on this risk factor [28, 29]. As well, in this study population, the majority of participants did not consume alcohol, which might explain the lack of change observed in alcohol consumption rates. Individual factors such as self-efficacy, health literacy, and health knowledge significantly influence behaviour change. Among older adults in social housing, participants reported the highest confidence in increasing fruit and vegetable intake, while they expressed the least confidence in quitting smoking, a trend reflected in the study's findings [30]. The complexity of changing health behaviours and the strength of existing habits further influence participants' ability to make changes, emphasizing the importance of personalized, behaviour-specific strategies [4, 31].

This study used data from a pragmatic cluster-RCT, which demonstrated a significant reduction in the risk of developing chronic disease and EMS calls, while also proving to be cost-effective [32]. It is plausible that the changes in the health behaviours found in the current study could have contributed to those previously published results [16]. Furthermore, the changes seen in this study could be expanded with wider implementation to a more general population and with the provision of more resources to address health behaviours that are difficult to change. For example, the introduction of additional supports such as buses to regularly drive individuals to grocery stores and

promoting health literacy through reading materials and classes could facilitate further improvements in health behaviours, however these areas warrant further research [33, 34]. In addition, participants appreciated the program for providing timely access to health information and services, supporting personal health goals, fostering a better understanding of the healthcare system, promoting a sense of community, offering a familiar setting for health discussions, and strengthening connections with healthcare professionals [35].

### Strengths and limitations

A key strength of this study is that it provided novel findings by using validated measures to assess the impact of the CP@clinic program on the health behaviours of low-income older adults living in social housing, an underrepresented population in research that is difficult to access and survey. The study also included participants from multiple geographical locations in Ontario, Canada, increasing the generalizability of the findings to most suburban communities across Ontario. The use of data from a cluster-RCT allowed for causal inferences while the randomization process helped minimize selection bias. Despite previous literature that examined similar outcomes, this study is unique and the first of its kind to investigate the impact of a community paramedicine program on health behaviours. In terms of study limitations, the data was collected using self-reported outcomes, introducing the potential for response and social desirability bias. There may have also been self-selection bias as building residents chose to participate in the surveying and drop-in intervention.

## Conclusion

The CP@clinic program is an innovative community paramedicine program that has demonstrated a significant impact on changing health behaviours among low-income older adults. The cost-effective CP@clinic program shows promise not only in reducing the burden of chronic diseases and their associated complications, but also in improving fruit and vegetable intake and reducing sedentary behaviour. The results of this study will guide and improve future CP@clinic program adaptations and implementation. Given the high prevalence of chronic diseases and their impact on the growing older adult population in Canada, the findings of this study may have substantial implications for chronic disease prevention and management programs tailored for older adult social housing residents.

#### Abbreviations

| | |
|---|---|
| EMS | Emergency medical service |
| CP@clinic | Community Paramedicine at Clinic |
| RCT | Randomized controlled trial |
| HABiT | Health Awareness and Behaviour Tool |
| ICC | Intracluster correlation |

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#### Authors' contributions

G.A., R.A., and F.M. were involved in the development, design, and implementation of the study. G.A., R.A., M.P., and J.B. conducted the statistical analysis. J.B. and L.A. were major contributors in writing the manuscript. J.B. created the tables for the manuscript. All authors reviewed, edited, and approved the final manuscript.

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#### Data availability

The dataset used and analysed during the current study is available from the corresponding author on reasonable request.

## Declarations

#### Ethics approval and consent to participate

This study was approved by the Hamilton Integrated Research Ethics Board (#14–210) and conducted in accordance with the Declaration of Helsinki and the Tri-Council Policy Statement of Ethical Conduct for Research Involving Humans. Written informed consent to participate was obtained from each survey participant.

#### Consent for publication

Not Applicable.

#### Competing interests

The authors declare no competing interests.

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## Publisher's Note