SYSTEMATIC REVIEW

Physical functioning limitations and physical activity of people experiencing homelessness: A scoping review [version 1; peer review: 1 approved, 1 approved with reservations]

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Abstract

Background: Adults who are experiencing homelessness suffer higher levels of premature mortality and age-related medical conditions compared to the general population, but little is known about physical factors that influence their health experience. This review aimed to evaluate what is known about physical functional limitations and physical activity levels, and how these constructs are measured in adults experiencing homelessness.

Methods: This review was conducted in accordance with the Joanna Briggs Institute’s methodology for scoping reviews. Suitable quantitative and qualitative articles were searched using PubMed, CINAHL, EMBASE, PsychInfo, Web of Science and SCOPUS databases using a combination of keywords and medical subject headings and a grey literature search was also performed. Two reviewers independently screened articles for inclusion. Inclusion criteria were studies that examined physical functional limitations and/or physical activity among homeless adults (with/without co-occurring mental illness, infectious disease, substance use disorder), as a primary or secondary outcome measure.

Results: We identified 15 studies for inclusion including 2,018 participants. Studies were primarily quantitative (n=11) and there were 4 qualitative studies. The following physical focused measures were evaluated across studies; mobility levels (n=2), frailty (n=1), flexibility (n=2), strength (n=1), physical symptom burden (n=3), physical activity levels (n=6) and exercise capacity (n=3). The majority of studies reported high levels of functional limitations among participants and low physical activity levels although a spectrum of abilities was noted.

Conclusion: This review showed that many adults who are homeless appear to show a high burden of physical functional limitations and
low physical activity levels but more objective and consistent measures should be applied to examine these factors in future studies. This will help address and plan future care, physical rehabilitation and housing needs for this vulnerable cohort. This scoping review will help direct research and future systematic reviews in this emerging area.

Keywords
Functional status, physical activity, homeless adults, homelessness

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Author roles: Kiernan S: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; Mockler D: Conceptualization, Data Curation, Investigation, Resources, Validation, Writing – Review & Editing; Ní Cheallaigh C: Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; Broderick J: Data Curation, Formal Analysis, Investigation, Software, Supervision, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing

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Introduction

The number of people experiencing homelessness is significant and increasing, with estimates of 307,000 people in the UK\(^1\), 550,000 in the USA\(^2\) and 235,000 in Canada\(^3\) at any one point. A ‘person experiencing homelessness’ is someone without stable housing who may live on the streets, in a shelter, in temporary accommodation, or in some other unstable or non-permanent situation\(^4\).

Life expectancy is greatly reduced among people who are homeless. Recent data from the UK reports a mean age of death among people who died homeless of 45 years among men and 43 years among women, which compares with 76 and 81 years respectively, in the general population\(^5\). In Ireland the median age at death for people experiencing homelessness in Dublin is devastatingly low at 44 years for males and 36 years for females\(^6\). Contributing factors to lowered mortality levels are complex. People who are homeless people experience a ‘tri-morbidity’ of mental illness, physical illness, chronic disease and addiction as well as complex interwoven factors related to social exclusion, higher rates of accidental, violent death and poor access to healthcare\(^7\).

Common chronic diseases such as chronic obstructive pulmonary disease, asthma, epilepsy, heart disease and stroke are substantially more prevalent among people experiencing homelessness compared to housed individuals\(^8\). External factors as well as chronic diseases have a multi-system effect with reported accelerated ageing\(^9\) and early onset of geriatric conditions\(^10\). Reflective of disease prevalence and other factors related to extreme socioeconomic deprivation, people who are homeless present for acute hospital care disproportionately compared to housed individuals\(^11\).

An abundance of epidemiological highlights physical inactivity as a significant predictor of cardiovascular disease, type 2 diabetes mellitus, obesity, some cancers, poor skeletal health, some aspects of mental health, and overall mortality, as well as poor quality of life\(^12\). Despite this, information on physical activity levels among homeless individuals is largely unexplored\(^13\).

Physical performance and functional limitation measures may provide an insight into early signs of disability, poor health, hospitalization and increased death risk\(^8,12\). These measures give an indication of a person’s ability to perform everyday tasks making them good indicators of overall ability to live independently as ageing occurs\(^7\). To date there has been no prior effort to characterize the overall physical status of people experiencing homelessness. Improved understanding of physical variables is important, as this may guide the development of screening tools to identify, and interventions to attenuate declines in people experiencing homeless. This will also help direct research as well as future systematic reviews in this topic area.

The protocol was developed and peer-reviewed locally and then registered in the PROSPERO database (CRD42019124306). In order to address the breadth of this area however, a scoping review rather than a ‘pure’ systematic review\(^14\) was conducted. Although some consider a scoping review a form of systematic review\(^15\), subtle differences are, for example, the breadth of the research question and the lack of risk of bias assessment\(^14,15\).

Based upon the PCC (Population, Concept and Context) elements\(^16\), the overall aim of this scoping review was to evaluate the magnitude and scope of physical functioning limitations and physical activity levels of people experiencing homelessness as well as their measurement methods. Due to the anticipated dearth of literature on physical functioning limitations and scoping nature of this review, related secondary outcomes measures which were reported in included studies such as frailty and cardiovascular fitness were also considered for inclusion in this review.

Methods

This review was informed by the Joanna Briggs Institute’s (JBI) methodology for scoping reviews\(^14\) and guided by the original framework of Arksey and O’Malley\(^17\), and enhancements proposed by Levac et al.\(^18\). This review was checked against the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist\(^19\) (see reporting guidelines\(^20\)).

Data sources and searches

A comprehensive search strategy was developed collaboratively with a skilled research librarian (D.M.) and a subject expert (C.N.C.) was consulted. The following electronic databases were searched without date restrictions; MEDLINE/PubMed, EMBASE, PEDro, AMED, CINAHL, PsycINFO, SCOPUS (see extended data\(^20\)). A grey literature search using Google Scholar and WorldCat search engines was performed; government reports were searched using the Google search engine and a combination of key word text.

Physical focused definitions employed in this review

We employed the definition of functional limitation proposed by Nagi ‘‘limitations in performance at the level of the whole organism or person” such as restrictions in mobility\(^21\). Although not the specific focus of this review, factors that relate to physical functioning limitations such as, but not limited to, frailty, physical symptom burden and cardiovascular fitness were included in this review if reported in studies sourced. Physical activity was defined as any bodily movement produced by skeletal muscles that results in energy expenditure from light physical activity to vigorous levels of physical activity, including incidental movements\(^22\).

Inclusion/exclusion criteria

This review included English language studies only. To meet the objective of the scoping review questions in this study, both qualitative and quantitative study designs were included. Studies that examined physical functioning or physical activity (separate searches for each were conducted and later combined) among homeless adults (>18 years) as a primary or secondary outcome measure were included. The following criteria for homeless from the European Typology for Homelessness and Housing Exclusion (ETHOS) criteria\(^23\): roofless, houseless, living in...
insecure housing, living in inadequate housing was employed in this review.

Selection of studies
Duplications were removed and relevant studies were imported into Covidence for title and abstract screening which took place independently by two reviewers (J.B. and S.K.). Both authors then conducted a full-text evaluation of selected studies. If necessary, any discrepancies were resolved by consensus by including a third author (C.N.C.).

Data extraction
Two reviewers (S.K. and J.B.) independently extracted data using a specifically designed data extraction sheet. Any differences were resolved by consensus discussion. A third author (C.N.C) was available if disparities emerged between reviewers.

Data analysis
Descriptive analysis was performed for all demographic data and data was grouped according to outcome evaluated. Due to the heterogeneity of study design, interventions and outcomes, a narrative synthesis was conducted.

Results
Studies identified
After the removal of duplicates, 2832 studies were identified. After full-text screening, a total of 15 studies were deemed eligible for inclusion in this review. The PRISMA flow chart\textsuperscript{24} summarizes the search strategy (Figure 1). Quantitative (n=11) studies predominated and the remaining were qualitative in design (n=4). Over 2000 participants were included in this review (n=2,018). Over 70\% of participants were male. Four studies were limited to male only participants\textsuperscript{25-28}, while only two were female only\textsuperscript{29,30}. Characteristics of the included studies are shown in Table 1. The majority of studies took place in North America (12/15) with the remainder in Australia (n=1) and Denmark (n=2).

Participant characteristics are shown in Table 2. The following physical variables were evaluated in studies included in this review; mobility status, frailty, flexibility, physical symptom burden, physical activity levels and exercise intensity achieved and fitness. Table 3 summarizes physical focused variables and Table 4 summarizes physical activity/sedentary behavior variables.
<table>
<thead>
<tr>
<th>Author and year</th>
<th>Study Location</th>
<th>Listed study type</th>
<th>Inclusion criteria</th>
<th>Living arrangement</th>
<th>Physical Focused Outcomes (measure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ballard, 2009</td>
<td>North Carolina, U.S.</td>
<td>Cross sectional</td>
<td>Age &gt;18 years Understood and spoke English</td>
<td>Resident in homeless shelters</td>
<td>Physical activity (questionnaire adapted from the Behavioral Risk Factors Surveillance Survey, qualitative exploration)</td>
</tr>
<tr>
<td>Bazari et al. 2018</td>
<td>California, U.S.</td>
<td>Qualitative study including semi-structured interviews</td>
<td>Age &gt;50 years Able to give consent English speaking Homeless</td>
<td>Unsheltered locations</td>
<td>Symptom burden (semi-structured interviews)</td>
</tr>
<tr>
<td>Brown et al. 2012</td>
<td>Boston, U.S.</td>
<td>Cross sectional</td>
<td>Age &gt;50 years Able to communicate in English Able to give consent</td>
<td>Emergency, transitional and day centers</td>
<td>Geriatric syndromes (Fried frailty criteria, Self-reported falls and mobility impairments)</td>
</tr>
<tr>
<td>Brown et al. 2016</td>
<td>California, U.S.</td>
<td>Prospective cohort study</td>
<td>Age &gt;50 years Able to give consent English speaking Homeless</td>
<td>Overnight shelters, Unsheltered locations</td>
<td>Functional status (self-reported falls and mobility impairments)</td>
</tr>
<tr>
<td>Chau et al. 2002</td>
<td>Los Angeles, U.S.</td>
<td>Qualitative</td>
<td>Homeless English-speaking &gt;18 years New to study</td>
<td>Homeless shelters</td>
<td>Daily exercise habit (self-report)</td>
</tr>
<tr>
<td>Gaderman et al. 2014</td>
<td>Vancouver, Toronto, Ottawa, Canada</td>
<td>Cross sectional</td>
<td>Age &gt;18 years</td>
<td>Homeless shelters</td>
<td>Physical and mental health conditions (SF12)</td>
</tr>
<tr>
<td>Gregg and Bedard 2016</td>
<td>Winnipeg, Canada</td>
<td>Cross sectional</td>
<td>Not specified</td>
<td>Homeless shelter</td>
<td>Exercise intention and attitudes (Intention to exercise Questionnaire) Fitness (1 mile treadmill walk test) Strength (grip strength) Flexibility (sit and reach)</td>
</tr>
<tr>
<td>Kendzor et al. 2015</td>
<td>Dallas, U.S.</td>
<td>Pilot study</td>
<td>&gt;6th grade English literacy, Willingness to quit smoking Age &gt;18 years Willingness to attend weekly smoking cessation treatment sessions</td>
<td>Homeless shelter</td>
<td>Physical activity (7 items from the Behavioral Risk Factor Surveillance System Questionnaire: Physical Activity)</td>
</tr>
<tr>
<td>Patanwala et al. 2017</td>
<td>California, U.S.</td>
<td>Cross sectional analysis</td>
<td>Age &gt;50 years English speaking Able to give informed consent</td>
<td>Overnight shelters, Unsheltered locations</td>
<td>Physical symptom burden (Patient Health Questionnaire-15)</td>
</tr>
<tr>
<td>Marmolejo et al. 2018</td>
<td>Los Angeles, US</td>
<td>2 group cross-sectional comparative study</td>
<td>Ability to give consent</td>
<td>Homeless young adults</td>
<td>Flexibility (sit and reach test)</td>
</tr>
<tr>
<td>Author and year</td>
<td>Study Location</td>
<td>Listed study type</td>
<td>Inclusion criteria</td>
<td>Living arrangement</td>
<td>Physical Focused Outcomes (measure)</td>
</tr>
<tr>
<td>--------------------</td>
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</tr>
<tr>
<td>Quine et al. 2004</td>
<td>Sydney, Australia</td>
<td>Qualitative study</td>
<td>Older men ≥ 50 years, In receipt of a pension or benefit Effectively single Non-home owners Living alone</td>
<td>No fixed abode</td>
<td>Physical activity levels (semi structured interviews)</td>
</tr>
<tr>
<td>Randers et al. 2010</td>
<td>Copenhagen, Denmark</td>
<td>Cross sectional</td>
<td>NS</td>
<td>Shelters</td>
<td>Fitness (VO_{2\text{max}})</td>
</tr>
<tr>
<td>Randers et al. 2012</td>
<td>Copenhagen, Denmark</td>
<td>Controlled study</td>
<td>NS</td>
<td>Shelters</td>
<td>Fitness (VO_{2\text{max}})</td>
</tr>
<tr>
<td>Raven et al. 2017</td>
<td>California, U.S.</td>
<td>Cross sectional</td>
<td>English speaking Age &gt;50 years Homeless encampments, all overnight homeless shelters</td>
<td>Homeless shelters</td>
<td>Functional limitations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Short physical performance bettery)</td>
</tr>
<tr>
<td>Wilson, 2004</td>
<td>Midwest, U.S.</td>
<td>Cross-sectional study</td>
<td>Homeless women Registered residents of the shelters Could read and understand the English language</td>
<td>Homeless shelters</td>
<td>Physical activity levels (HPLPII)</td>
</tr>
</tbody>
</table>

Table 2. Details of participant characteristics.

<table>
<thead>
<tr>
<th>Citation</th>
<th>Number of participants</th>
<th>Age mean (SD)</th>
<th>Gender</th>
<th>Race/Ethnicity</th>
<th>&lt;High school education</th>
<th>Comorbid conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ballard, 2009</td>
<td>126</td>
<td>41.99 ± 9.42 years</td>
<td>Female only</td>
<td>African American (54%), White (32.5%), American Indian (4.8%), Mixed race (4.8%), Asian (1.6%), Other/Unsure (4.4%)</td>
<td>31.8%</td>
<td>High blood pressure: 41.1%, Asthma: 26.8%, Arthritis: 25%, STDs: 22.4%</td>
</tr>
<tr>
<td>Bazari et al. 2018</td>
<td>20</td>
<td>62 years</td>
<td>Male= 65%</td>
<td>African American (85%)</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Brown et al. 2012</td>
<td>247</td>
<td>56 years</td>
<td>Male= 92%</td>
<td>White (39.7%)</td>
<td>26.1%</td>
<td>Hypertension (59%), arthritis (44.9%), depression (59.6%)</td>
</tr>
<tr>
<td>Brown et al. 2017</td>
<td>350</td>
<td>58 (54-61 years)</td>
<td>Male= 77.1%</td>
<td>African American (79.7%), White (10.9%), Latino (4.6%), Other (4.9%)</td>
<td>25.7%</td>
<td>Hypertension (56%), Coronary artery disease or myocardial infarction (9.1%), Congestive heart failure (7.1%), Diabetes (14%), Stroke (11.2%), Respiratory disease (26.3%), Arthritis (44.6%), HIV/AIDS (5.5%)</td>
</tr>
<tr>
<td>Citation</td>
<td>Number of participants</td>
<td>Age mean (SD)</td>
<td>Gender</td>
<td>Race/ Ethnicity</td>
<td>&lt;High school education&gt;</td>
<td>Comorbid conditions</td>
</tr>
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<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Chau et al. 2002</td>
<td>221</td>
<td>46.7 years</td>
<td>Male=54%</td>
<td>African-American (57%) Caucasian (26%) Other (17%)</td>
<td>60%</td>
<td>NS</td>
</tr>
<tr>
<td>Gadermann et al. 2014</td>
<td>100</td>
<td>43.3 +/- 11.9 years</td>
<td>Male= 69%</td>
<td>White (55%), Aboriginal (30%), Other (15%)</td>
<td>27.2%</td>
<td>Arthritis/rheumatism, joint problems (43.9%), Hepatitis C (31.6%), Migraines (28.6%), Mental health conditions (52.5%), Substance abuse (40.2%), Depression (34%), Substance dependence (26.6%), GAD (15.6%), PTSD (12.5%)</td>
</tr>
<tr>
<td>Gregg and Bedard 2016</td>
<td>18</td>
<td>41.05 ± 11.32 years</td>
<td>Male = 100%</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Kendzor et al. 2015</td>
<td>57</td>
<td>49.4 +/- 7.7 years</td>
<td>Male = 66.6%</td>
<td>African-American (54.4%) Latino (3.5%) Mixed race(5.3%)</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Marmolejo et al. 2018</td>
<td>40</td>
<td>21.4 ± 2.3 years</td>
<td>Male = 67.5%</td>
<td>White (30%), Hispanic (27.5%), African American (20%), American Indian/ Alaska Native 3(7.5%), Native Hawaiian/ Pacific Islander 1(2.5%), Missing (12.5%)</td>
<td>15%</td>
<td>NS</td>
</tr>
<tr>
<td>Pantalawa et al. 2017</td>
<td>283</td>
<td>59 (51–82)*</td>
<td>Male=75.6%</td>
<td>African American (82.4%), White (9.6%), Other (21.9%)</td>
<td>21.9%</td>
<td>Heart related (17.2%), Respiratory related (23.7%), Diabetes (18.3%), Arthritis (46.8%), Cirrhosis/liver disease (21.0%), Kidney disease (5.4%), Cancer (5.9%), HIV/AIDS (6.2%)</td>
</tr>
<tr>
<td>Quine et al. 2004</td>
<td>32</td>
<td>66 years</td>
<td>Male = 100%</td>
<td>Australian born (66%) Born overseas (33%)</td>
<td>NS</td>
<td>'Significant' health difficulties (66%)</td>
</tr>
<tr>
<td>Randers et al. 2010</td>
<td>15</td>
<td>29 ± 2 years</td>
<td>Male = 100%</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Randers et al. 2012</td>
<td>22</td>
<td>37 ± 10 years</td>
<td>Male = 100%</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Raven et al. 2017</td>
<td>350</td>
<td>58 (54–61)*</td>
<td>Male = 77.1%</td>
<td>African American (79.7%), Non-African American (20.3%)</td>
<td>74.3%</td>
<td>Chronic illness (23.9%), Acute illness (21.6%), Pain (19.2%), PTSD (32.6%), Depression (53.3%)</td>
</tr>
</tbody>
</table>
Mobility status was evaluated in two studies. Overall results indicated that many people homeless experiencing homelessness have difficulty mobilizing. In two studies, mobility was measured by self-reported difficulty walking. Brown et al. 2012 sampled 247 homeless adults, and found that 102 (41.3%) self-reported difficulty walking. Brown et al. 2017 included 350 participants aged 50 or older and reported mobility impairments in over one quarter of participants (26.9%) and 33.7% reported one or more falls in the previous 6 months. Results of this study indicated that greater mobility impairments (defined as difficulty across a room) were found in participants < 50 years, compared to those ≥ 50 years.

Functional limitations
Raven et al. 2017 reported that over half (58.4%, n=204) of participants had limitations in lower extremity function measured by the Short Physical Performance Battery. This study included participants with a median (IRQ) age of 58 (54–61) years.

**Table 3. Physical focussed variables measured in systematic review studies.**

<table>
<thead>
<tr>
<th>Physical Variable</th>
<th>Type of Measure</th>
<th>Total number of studies</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>Self-reported difficulty walking</td>
<td>2</td>
<td>Brown et al. (2012) Brown et al. (2016)</td>
</tr>
<tr>
<td>Lower extremity functioning</td>
<td>Short Physical Performance Battery</td>
<td>3</td>
<td>Raven et al. (2017)</td>
</tr>
<tr>
<td>Frailty</td>
<td>Fried criteria</td>
<td>1</td>
<td>Brown et al. (2012)</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Sit and Reach Test</td>
<td>1</td>
<td>Marmolejo et al. 2018 Gregg and Bedard (2016)</td>
</tr>
<tr>
<td>Strength</td>
<td>Grip Strength</td>
<td>1</td>
<td>Greg and Bedard (2016)</td>
</tr>
<tr>
<td>Physical health/symptom burden</td>
<td>Physical symptom burden (self-report)</td>
<td>1</td>
<td>Bazari et al. (2018)</td>
</tr>
<tr>
<td></td>
<td>SF-12 (Physical component)</td>
<td>1</td>
<td>Gaderman et al. (2014)</td>
</tr>
<tr>
<td></td>
<td>Patient Health Questionnaire-15</td>
<td>1</td>
<td>Pantanwala et al. (2017)</td>
</tr>
<tr>
<td>Exercise capacity</td>
<td>1 mile walk test</td>
<td>1</td>
<td>Greg and Bedard (2016)</td>
</tr>
<tr>
<td></td>
<td>V0_max</td>
<td>2</td>
<td>Randers et al. (2010) Randers et al. (2012)</td>
</tr>
<tr>
<td>Author</td>
<td>Type of measure</td>
<td>Detail of measure</td>
<td>Subscale (if relevant)</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------</td>
<td>-------------------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Ballard, 2009</td>
<td>Questionnaire</td>
<td>Health Promotion Model Measures</td>
<td>Physical activity subscale [Health-promoting Lifestyle Profile II (HPLP II)]</td>
</tr>
<tr>
<td>Chau et al. 2002</td>
<td>Interview</td>
<td>Asked in interview if exercise was ‘daily’, ‘sometimes’ or ‘never’</td>
<td>N/A</td>
</tr>
<tr>
<td>Gregg &amp; Bedard, 2016</td>
<td>Reporting of frequency of exercise</td>
<td>Exercise defined as “at least three times per week, for at least 20–30 min in duration, and at least moderate-to-vigorous intensity”</td>
<td>N/A</td>
</tr>
<tr>
<td>Kendzor et al., 2015</td>
<td>Questionnaire</td>
<td>Behavioural Risk factor Surveillance System Questionnaire</td>
<td>Insufficient physical activity defined as &lt;150 minutes of moderate physical activity or &lt;75 minutes of vigorous physical activity (or less than an equivalent combination of the two)</td>
</tr>
<tr>
<td>Marmolejo et al. 2018</td>
<td>Self-report paper questionnaire but unclear exactly how physical activity measured</td>
<td>‘Low frequency’ physical activity 0–2 times per week</td>
<td>N=14, 36.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>‘High frequency’ Physical activity 3+ times/week</td>
<td>N=24, 63.2%</td>
</tr>
<tr>
<td>Quine et al. (2004)</td>
<td>Self-report</td>
<td>Semi-structured interview</td>
<td>N/A</td>
</tr>
<tr>
<td>Wilson</td>
<td>Questionnaire</td>
<td>Health Promotion Model Measures</td>
<td>Physical activity subscale [Health-promoting Lifestyle Profile II (HPLP II)]</td>
</tr>
</tbody>
</table>

N/A: not applicable

Frailty
Frailty was evaluated in one study\(^31\). Frailty was measured using the Fried criteria\(^33\) in which more than 3 of 5 characteristics were present: unintentional weight loss, low physical activity, exhaustion, slow walking speed and weak handgrip. In total, 40 participants (16%) met frailty criteria, bearing in mind that participants were aged between 50 and 69.

Flexibility
Flexibility was assessed in two studies\(^34,35\) and compared to control groups. The Sit and Reach test\(^36\) was used which targets hamstring and lower back flexion. Other flexibility tests employed were the butterfly test (targets adductor muscles), the trunk flexibility test and shoulder stretch\(^36\). Mean (SD) results for the sit and reach test, butterfly test, left shoulder, right shoulder, left trunk twist and right trunk twist were 26.2 (9.01), 17.83 (7.29), 0.59 (9.55), 2.42 (7.54), 8.89 (7.96), 12.22 (8.23) respectively\(^34\). It was noted that participants who were homeless were less flexible (p<0.05) in four stretch tests compared to a control group of university students. Similar low values were reported for the Sit and Reach test in the Gregg and Bedard (2016)\(^35\) study of 24.32 ± 8.07cm.

Strength
Strength was measured in one study\(^35\) using a grip strength test\(^37\) which was reported to be mean (SD) 43.24 (6.79). Values from the homeless cohort age 41.05 ± 11.32 years were reported to be comparable to a reference population.

Physical health/symptom burden
Physical symptom burden was evaluated in three studies, assessed in 3 different ways. Patanwala et al. (2017) evaluated physical...
symptoms in homeless aged ≥ 50 years using the Patient Health Questionnaire-15 (PHQ-15). They reported that over one-third (34%, n = 96) had a moderate-high physical symptom burden. The most common physical symptoms were joint pain, fatigue, back pain and sleep difficulties.

Similarly, Gaderman et al. (2014) using the SF-12 reported that the physical component summary scale was 43.6 (SD=11.0), which was ‘substantially lower’ than US population normative values. In this study is was found that 87.9% (n=53) of participants suffered at least one physical health condition.

These findings concur with a qualitative study included in this review. Bazari et al. (2018) reported that physical symptoms experienced by homeless adults interfere with daily functioning. They included 20 participants aged between 52 and 78 years (median age 62). It was found that daily challenges and physical conditions of homelessness caused and exacerbated symptoms.

“I can’t be active anymore like playing sports because I used to like to go play basketball or lift weights... but I can’t do nothing anymore...” (M, 63)

Some participants cited premature aging as the reason for their physical symptoms and decreased functional ability.

“It’s the arthritis.... Sometimes I feel I am carrying all my weight on my legs....I just feel like I’ve aged so quickly in my life” (F, 58)

Fatigue was also a factor.

“I guess every day that I have to walk I’m tired. I guess that’s the main thing: that I go from bench to bench and feel tired” (M, 58)

Physical activity levels

Physical activity levels were measured in six studies. Diverse methods were employed to assess this construct in each study. Insufficient physical activity levels among homeless adults were generally reported across studies (Table 4). Kendzor et al. (2015) examined modifiable health risk factors among homeless smokers (n = 57). The results showed that 26.3% did not meet recommended physical activity levels in the previous week. Chau et al. 2002 asked about exercise habits during an interview which mainly focused on cancer risk behaviours and screening. It was reported that 56% (n=125) performed daily exercise, but no details of the definition of exercise was supplied. Gregg and Bedard (2016) evaluated ‘regular exercise’ as per Courneya and Bobick, 2000 and reported that 44% (n=8) exercised “at least three times per week, for at least 20–30 min in duration, and at least moderate-to-vigorous intensity”. Wilson (2005) explored health-promoting behaviours of women who were living in shelter accommodation (n= 137). The study employed the Health-Promoting Lifestyle Profile II (HPLPII) and found that participants scored lowest in the physical activity subscale which is shown in Table 5 although overall it was reported that total levels of health-promoting behaviours were similar to another study of low income and homeless women.

Quine et al. (2004) employed semi structured interviews and a number of facets of physical activity emerged. It found that some participants were until recently physically active. However, deterioration in their health had reduced their activity levels.

“I used to walk about a quarter of a mile up and around the block” (M, 86)

Physical activity was also undertaken as a necessity.

“It’s a good walk [to a meals centre] and they put on a hot breakfast” (M, 68)

Physical activity was also used as a time filler

“if there’s something on like a movie worthwhile I’ll watch that and if there’s not I’ll for out for a walk for an hour and come back” (M, 75).

Exercise capacity

Randers et al. (2010) reported VO2 max levels for 15 people experiencing homelessness who were engaging in a football training program. Reported VO2 max levels were 33.5 +/- 2.0 ml.kg.min. Similarly, Randers et al. 2012 reported VO2 max levels for 22 men experiencing homelessness before and after a 12 week soccer training program. Reported VO2 max levels

| Table 5. Health-Promoting Lifestyle Profile - Physical activity subscale. |
|-----------------------------------------------|-------------------|
| Health-Promoting Lifestyle Profile - Physical activity subscale (From Wilson, 2004) | Mean (SD) |
| Follow a planned exercise program                | 1.78 (0.77)       |
| Exercise vigorously for 20 or more minutes at least three times a week (such as brisk walking, bicycling, aerobic dancing, using a stair climber) | 2.05 (0.98)       |
| Take part in light to moderate physical activity (such as sustained walking 30–40 minutes 5 or more times a week) | 2.28 (0.93)       |
| Rake part in leisure-time (recreational) physical activities (such as swimming, dancing, bicycling) | 2.02 (0.76)       |
| Do stretching exercises at least 3 times per week | 1.90 (0.89)       |
| Get exercise during usual daily activities (such as walking during lunch, using stairs instead of elevators, parking away from destination and walking) | 2.59 (0.94)       |
| Check my pulse when exercising                  | 1.53 (0.80)       |
| Teach my target heart rate when exercising      | 1.61 (0.76)       |
were 36.7 +/- 7.6 ml.kg.min⁻¹ which appeared higher than a control group (33.7 +/- 4.5)⁴⁶. One further study evaluated fitness using the 1 mile walk test³⁰ with a result of 16.48 +/- 2.42 minutes which was reported to be similar to reference values for age and gender.

**Discussion**

This review provided a snapshot of existing literature in the area of physical functioning limitations and physical activity levels in people experiencing homelessness. The scoping review methodology enabled a broad range of inter-related physical related variables (mobility status, functional levels, frailty, flexibility, physical symptom burden, physical activity levels and exercise capacity) to be usefully subsumed into one review which gives a broad overview of this topic area. It is clear from this review that the experience of homelessness negatively influences physical –focused parameters but the diversity of measures limited our ability to synthesize data for the purposes of this review.

This review included 2,018 participants, of which females were underrepresented so less appears to be known about the physical profile of females experiencing homelessness compared to males. The majority of studies included in this review were quantitative in design (n=11), while 3 were qualitative. Almost 80% of studies were based in North America, with the rest of studies from other high income countries of Denmark and Australia. There appears to be a large evidence gap in the evaluation of physical variables among people in low and middle income countries. Four studies were from the Hope Home study, a longitudinal study of middle aged homeless individuals based in California which also limited diversity of the study cohort within this review.

Studies predominately appeared to include people in shelter accommodation. The proportion of people sleeping rough who were included in studies within this review was low and it is probable that their physical health variables may be worse than individuals living in sheltered accommodation. Despite the frequency of hospital visits and stays in this population⁴¹,⁴⁹ no study profiled hospitalized homeless individuals. It is likely that this cohort may be especially vulnerable and debilitated and requires further evaluation with regard to physical focused variables.

Despite the disparity in measures, there generally appears to be a pattern of low physical functioning levels and poor physical activity levels among people experiencing homelessness compared to expected levels. A high physical symptom burden was also noted particularly in relation to joint pain, fatigue, back pain and sleep problems⁴⁸. Flexibility levels were also significantly lower than control group findings⁴⁴. This finding suggests a global decline or substandard level of physical fitness and function among homeless adults and an earlier onset of geriatric conditions which has been shown previously⁴⁰—the reasons for which need to be further elucidated. In the study by Brown et al., 2017, it was noted that despite a median age of 58 years, participants had rates of geriatric conditions similar or equivalent to adults in the general population with a median age of nearly 80 years⁴¹,⁴². Similarly, the study by Raven et al. included participants with a median age of 58 years and reported that almost 60% had limitations in lower extremity function. This was also shown in the earlier study by Brown and provides more evidence for the need for geriatric style rehabilitation services needed for people experiencing homelessness.

At odds with the majority of studies, two Danish studies⁴⁷,⁴⁸ which evaluated fitness in a population of people experiencing homelessness who were participating in street soccer showed comparable fitness levels to control group values but mean ages were in the 3rd decade in these studies. Gregg and Bedard also showed that fitness and strength were comparable to reference ranges among healthy populations⁴⁹ in also a relatively young cohort with an average age of 41.05 +/- 11.32 years. It is possible that these groups are not representative of the population as a whole, nonetheless the diversity of people experiencing homelessness and spectrum of ability is important to consider. It is also possible that physical functioning limitations may develop after the 3rd and 4th decades for some people experiencing homelessness.

While reported physical activity levels varied between studies, a large proportion of participants experiencing homelessness appeared to have low physical activity levels⁴⁴. Promoting physical activity may mitigate against some of the burden of physical and mental health issues suffered by people experiencing homelessness⁵⁰. One study²⁸ highlighted a nuanced view indicating that physical activity was undertaken not necessarily for health gain but by participants out of necessity to access meals and to fill in time.

The number of outcomes and measures suggests a lack of empirical data in the area to aid clinical decision makers and researchers about the overall physical health status of people experiencing homelessness. Physical focused measures included in this review were for the most part cursory in nature and were subsidiary to other study outcomes. While a diversity of outcomes were included in studies included in this review, self-report measures were predominantly used rather than more robust objective methods with the exception of two studies which employed a gold standard measure to evaluate V₀, max³³,³⁴. Studies by Brown et al. (2011), Brown et al. (2017) and Raven et al. (2017) were the only studies to examine mobility impairment. Only one study used the Short Physical Performance Battery, a useful battery of physical performance tests to assess functional status⁵¹. Only one study evaluated frailty and falls (Brown et al. 2011). All studies which evaluated physical activity used self-report measures which lack reliability and are prone to inaccuracies⁵².

The general lack of robust data which extensively evaluates physical functioning and physical activity among people experiencing homelessness may be also partly due to concerns regarding vulnerability and potential or perceived ability to participate in research can result in exclusion from research. This can lead to a lack of evidence on which to base policies and design suitable housing services.

**Strengths and limitations**

This review appears to be the first attempt to systematically present literature pertaining to physical functioning limitations and
physical activity levels in adults experiencing homelessness. The scoping review methodology employed in this review was suitably broad to bring together evidence from heterogeneous methodology sources including observational, mixed method and qualitative designs of the experience of physical limitations in people experiencing homelessness as well as the diverse reporting of outcomes. This scoping review allowed various inter-related physical aspects such as frailty, cardiovascular fitness, and flexibility among others. This methodology was also useful to examine emerging evidence in this relatively new field of research. In a topic as broad as physical functioning limitations it has helped focus on where future research and eventual systematic reviews should be targeted.

A number of limitations pertained to this review, however. Firstly, studies lacked a consistent definition of homelessness. As diverse study designs were included in this review, this resulted in strong heterogeneity which precluded the ability to quantitatively analyse results. A formal assessment of methodological quality of the included studies was not performed as scoping reviews aim to include a broad overview of available evidence, irrespective of quality. Finally, potentially relevant evidence from other languages may have been missed as this review only included English language papers.

Bearing in mind the prevalence of physical functioning limitations, we would advocate that all clinicians should screen this population for physical deficits so appropriate rehabilitation or other services can be initiated. We appreciate however, that the non-uniformity of outcomes and measurement tools applied presents a challenge to clinicians. Recommendations on appropriate physical functioning and physical activity measures are needed which are suitable to use in this population to prevent waste of valuable healthcare resources. Studies should focus on reliability, validity and responsiveness of physical functioning measures for people experiencing homelessness as a basis for more effective clinical assessment and management. Further research should determine a core outcomes set applicable to this population. Ideally this would be a quick standardized physical test battery so reliable consistent data can be collated to highlight at risk groups, inform clinical decision making and practice and advocate for better services. Further consistent primary research needs to be conducted before a comprehensive systematic review can be conducted. Factors possibly contributing to physical functioning limitations such as age, co-morbidities as well as a host of other factors also need further exploration.

**Conclusion**

This review shows that adults experiencing homelessness appear to suffer physical functioning limitations and low physical activity levels but the inconsistency in measurement methods limits our ability to extensively profile this population at this time. Given the low levels of physical functioning shown in people experiencing homelessness, greater prominence and robustness of measurement methods should be applied to fully interrogate this area. Further research is necessary so adequate rehabilitation regimes and support can be put in place for this vulnerable population. This scoping review will guide future research and systematic review development in this emerging area.

**Data availability**

Underlying data

All data underlying the results are available as part of the article and no additional source data are required.

**Extended data**

Open Science Framework: Physical functioning limitations and physical activity of people experiencing homelessness: A review. [https://doi.org/10.17605/OSF.IO/7VGZP](https://doi.org/10.17605/OSF.IO/7VGZP)

This project contains the following extended data:
- Supplementary File 2 Search Strategy - Copy.docx
  (Study search strategy)

**Reporting guidelines**

Open Science Framework: PRISMA-ScR checklist for ‘Physical functioning limitations and physical activity of people experiencing homelessness: A scoping review’. [https://doi.org/10.17605/OSF.IO/7VGZP]

Data are available under the terms of the Creative Commons Zero “No rights reserved” data waiver (CC0 1.0 Public domain dedication).

**References**

   [Reference Source](https://www.shelter.org.uk/)
   [Reference Source](https://www.endhomelessness.org)
   [Reference Source](https://www.gc.ca)
   [Reference Source](https://www.nlchc.org)
   [Reference Source](https://www.ons.gov.uk)
   [PubMed Abstract](https://pubmed.ncbi.nlm.nih.gov/30783752/) [Publisher Full Text](https://bmjopen.bmj.com/content/9/1/e023013)
   [Publisher Full Text](https://www.tandfonline.com/doi/abs/10.1080/00420982.2011.627846)


Overview
The study assessed the existing evidence on physical functioning limitation and physical activity among homeless adults using the scoping review framework. The findings highlight that people who experience homelessness have a high level of physical functioning impairment and low physical activities, which provides evidence of this population's low health status. It also shows the need for effective community-based and clinical-based interventions to diminish their premature physical functioning decline and poor health and social well-being.

Overall, the paper is well-written and structured. However, I have some suggestions below that might strengthen the paper's quality, the interpretation of the findings and the derived knowledge translation process.

Abstract
1. In the statement, "This review aimed to evaluate what is known about physical functional limitations and physical activity levels and how these constructs are measured in adults experiencing homelessness", I think physical functional limitations and physical activity are more conditions and abilities than constructs.

2. In the abstract methods: I suggest including the period within which the reviewed literature was considered.

3. In the statement “The following physical focused measures ...” I suggest separating the specific outcomes related to physical functional limitations than those related to physical activity level by not putting all together in the same statement.

Introduction
1. The statistic of the figure of homelessness in the USA and Canada should be accompanied by the referring period. For example, for Canada, the figures refer to 2017 and for the USA
to 2016.

2. By 'tri-morbidity, do you mean: mental illness, physical illness(included chronic diseases) and substance use disorders? Since chronic diseases are communally referred to as physical diseases.

3. By housed individuals, do you mean people with stably housed or non-homeless people? I think it is essential to be more specific.

4. In the statement, "An abundance of epidemiological highlights physical inactivity as a significant predictor of cardiovascular disease, type 2 diabetes mellitus, obesity, some cancers, poor skeletal health, some aspects of mental health, and overall mortality, as well as poor quality of life" please specify the population.

5. The statement "Improved understanding of physical variables is important..." please specify what physical variable you are referring to. Perhaps, physical functioning and activity?

6. In the scoping review, it is important to specify that the study population is adults experiencing homelessness. As there are also youth and children who experience homelessness.

Methods
Data sources and searches
1. Who was that subject expert? An academic expert in homelessness? A person with lived experience of homelessness? Please, elaborate on it.

2. Please, report the period in which the research for studies was conducted. It will allow the replicability or update of the searching strategy.

Physically focused definitions employed in this review
1. "We employed the definition of functional limitation" do you mean the definition of physical functioning? Please specify.

Selection of studies
1. I wondered if you used any strategy or tool to perform the appraisal of the included studies' quality. Please elaborate on this matter.

Data analysis
1. As you well-know, the scope of a scoping review is not to pool empirical findings using statistical methods as it happens in a systematic and meta-analysis review. Instead, it is more synthesized or summarized the findings. Thus, the statement "Due to the heterogeneity of study design, interventions and outcomes, a narrative synthesis was conducted" is no application for the scoping review.

Results
1. In the result, you describe female and male as one of the demographic characteristics of the revised studies' participants. In Table 2, you report this characteristic as gender. Gender (e.g. men/women) is more a social and identity construct, while sex (female/male) more a biological characteristic. Considering these differences, please clarify whether all studies measure gender or biological sex or both. If both, please include them as two distinct characteristics. This health to inform any potential gender-based or biological sex-based differences and similitudes, and gaps in the review' findings.
2. Perhaps briefly summarize the definition of homelessness employed in the included studies could give a more comprehensive view of what groups of homeless people were more likely to be studied.

3. Please state clearly in the results (text and Table 1) which of the findings you are presented as "Physical Focused Outcomes (measure)" are those referring to physical functioning measures only and which to the physical activity only. This is important as they are the two primary distinct outcomes assessed in your review. You may consider two add one column for the physical functioning outcome and the other for the physical activity outcomes. In Table 3, if the measures you are presented there are those regarding physical functioning, please state that clearly in the table's title and the variable level within the table.

4. As you included both qualitative and quantitative studies, it would better to present the characteristics and findings of those two groups of designed papers separately in the tables. Moreover, the number of studies with qualitative design reported in the results text do not concord with the number of qualitative studies present in Table 1.

5. Perhaps the synthesis of the studies' results could be organized under two main headings: Physical functioning and physical activity, as they are the two primary outcomes, you were assessed. Under these two main subheadings, you can summarise the related physical functional sub-outcomes and physical activity sub-outcomes as sub-headings.

6. In the results, perhaps before summarising the physical functioning and physical activity-related findings, presenting a brief description of the participants' comorbid profile could contribute to having a more comprehensive view of the health status of the study population. As many of those comorbid conditions are directly related to their physical functioning and physical activity status/levels.

**Discussion**

1. "...but the diversity of measures limited our ability to synthesize data for the purposes of this review." I think this part of the statement is unnecessary. As I may have said previously, a scoping review aims to present a broad view and synthesize of what has been studied, how it has been studied, identify gaps and give some recommendation on the reviewed topic, but not too pool results.

2. Please considering my previous comment regarding differences between gender and biological sex. Please discuss the findings accordingly.

3. Discuss the potential ethno-racial gaps in the studied topic.

4. Please extend the potential implications of the findings for more community-based support services and policy, especially community-based (health, housing, social) interventions that can improve this population's physical functioning and physical activities.

**Figure 1:**

1. Please state the reason for excluding records. You only included those included in the database searching. Are those figures also include the studies identified by searching grey literature?

2. There are discrepancies between the numbers of records found reported in Figure 1 and
Are the rationale for, and objectives of, the Systematic Review clearly stated?
Yes

Are sufficient details of the methods and analysis provided to allow replication by others?
Partly

Is the statistical analysis and its interpretation appropriate?
Not applicable

Are the conclusions drawn adequately supported by the results presented in the review?
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Social epidemiology and public health scientist with expertise on health inequalities, social determinants of health, homelessness, housing and health.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 01 May 2020

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Jo Dawes

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**Introduction**

The background and rationale for this scoping review was clearly described and explains the importance of it being undertaken. The authors do address the aims of the paper, but are not explicit about the objectives (although objectives are mentioned later under “inclusion/ exclusion criteria”, so it would be useful to state these in introduction). The authors have rightly based their review on PCC (Populations, Concept, Context) rather than PICO (Participants, Interventions, Comparators, and Outcomes) as this is not a review of interventions. Their reasoning for this is adequately described.
Methods
Much of the methods are well described. The authors are clear that this is a scoping review and have described using appropriate frameworks and guidance to inform their procedures. The authors are clear about information sources, for example language, databases searched and inclusion of grey literature. They noted that a subject expert was consulted, but did the authors also contact study authors to identify further literature? Although no date restriction was applied in the search, it would be useful for authors to state the date of the last search. The current information given, it is not sufficiently detailed to be repeatable, for example, the authors could provide more detail of their search strategy, including limits used. Under “Physical focused definitions employed in the review” the authors provide definitions for functional limitation and physical activity. However, they also provide examples of functional limitations, but not physical activity, as physical activity is so broad, to add examples of search words used would add clarity.

The PRISMA diagram is helpful, though it would be more accurate to describe Figure 1 as “PRISMA flow diagram of selection for review”, as it covers the selection/inclusion process, not the whole review process. It might be more appropriate to make reference to Fig 1 earlier in “selection of studies” section. There was limited description of “data extraction” (it would be useful to hear more about what the specifically designed data extraction sheet contained). Again, limited information provided about data analysis - more detail on what was involved in the narrative synthesis would give greater transparency for the reader.

Results
It is shown (in Fig 1) and described (in text) how many studies were excluded at each stage, but apart from the removal of duplicates, reasons for exclusions are not described. Also, the number of studies identified after duplicates removed does not match what is stated in text/Figure 1. (n=2832 in text/ n=2833 in Fig 1). For clarity, it might help to add title and abstracts of to the box “Records screened (n=1815)” in Figure 1.

Authors have clearly expressed study characteristics in Table 1. However, it is stated in text they identified 11 quantitative studies and 4 qualitative studies, whereas only 3 studies are explicitly described as qualitative in Table 1. Was it the pilot study by Kendzor et al. (2015) which was also qualitative? If so, it would be useful if the authors made this clear. In Table 1, it would also be useful to be clearer about which studies addressed physical function, which addressed physical activity and which addressed both. For example, where Table 4 describes studies using physical activity measures, Gregg and Bedard (2016) and Marmolejo et al. (2018) feature, but in Table 1 the physical focused outcomes column does not clearly describe physical activity measures (for Gregg and Bedard (2016) exercise and intention to exercise are stated, but is not a measure of actual physical activity levels and Marmolejo et al. (2018) only a flexibility measure is described).

Only minor, but in Table 2, there is slight inconsistency in presentation of data in “gender” column. Sometimes % and numbers, but sometimes only %, is this because numbers were not always provided in studies? If so, you could use “NS”, like you have in other parts of that table. Also, there are typos on p 8, para 1, lines 2-3: “many people homeless experiencing homelessness“ and p 10, para 2, line 4: in this study is was”- replace “is” with “it”.

Due to the authors not formally assessing methodological quality of the studies, they were limited in how well they could acknowledge biases across studies.
Discussion and Conclusion
A clear and succinct summary of the main findings and their implications for understanding the knowledge base, clinical practice and future research. Strengths and limitations of the paper appropriately identified and described.

Are the rationale for, and objectives of, the Systematic Review clearly stated?
Yes

Are sufficient details of the methods and analysis provided to allow replication by others?
Partly

Is the statistical analysis and its interpretation appropriate?
Not applicable

Are the conclusions drawn adequately supported by the results presented in the review?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: My area of expertise is physiotherapy education and access to healthcare amongst homeless and excluded populations.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.