‘You can change your life through sports’—physical activity interventions to improve the health and wellbeing of adults experiencing homelessness: a mixed-methods systematic review

Jo Dawes 1, Raphael Rogans-Watson 2, Julie Broderick 3

ABSTRACT

Objectives Systematically synthesise evidence of physical activity interventions for people experiencing homelessness (PEH).

Design Mixed-methods systematic review.

Data sources EMBASE, Web of Science, CINAHL, PubMed (MEDLINE), PsycINFO, SPORTDiscus and Cochrane Library, searched from inception to October 2022.

Eligibility criteria PICO framework: population (quantitative/qualitative studies of PEH from high-income countries); intervention (physical activity); comparison (with/without comparator) and outcome (any health/well-being-related outcome). The risk of bias was assessed using Joanna Briggs Institute critical appraisal tools.

Results 3615 records were screened, generating 18 reports (17 studies, 11 quantitative and 6 qualitative (1 randomised controlled trial, 4 quasi-experimental, 1 analytical cross-sectional)) from the UK, USA, Denmark and Australia, including 554 participants (516 PEH, 38 staff). Interventions included soccer (n=7), group exercise (indoor (n=3), outdoor (n=5)) and individual activities (n=2). The risk of bias assessment found study quality to vary; with 6 being high, 6 moderate, 4 low and 1 very low. A mixed-methods synthesis identified physical and mental health benefits. Qualitative evidence highlighted benefits carried into wider life, the challenges of participating and the positive impact of physical activity on addiction. Qualitative and quantitative evidence was aligned demonstrating the mental health benefits of outdoor exercise and increased physical activity from indoor group exercise. Quantitative evidence also suggests improved musculoskeletal health, cardiovascular fitness, postural balance and blood lipid markers (p<0.05).

Conclusion Qualitative evidence suggests that physical activity interventions for PEH can benefit health and well-being with positive translation to wider life. There was limited positive quantitative evidence, although most was inconclusive. Although the evidence suggests a potential recommendation for physical activity interventions for PEH, results may not be transferable outside high-income countries. Further research is required to determine the effectiveness and optimal programme design.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ People experiencing homelessness suffer a higher burden of physical and mental health conditions than housed populations.

⇒ Limited studies suggest that regular physical activity may address many health conditions prevalent among people experiencing homelessness, although the evidence has not been systematically reviewed.

WHAT THIS STUDY ADDS

⇒ A variety of physical activity interventions have been designed and provided to engage people experiencing homelessness, including soccer, outdoor and indoor group activities, and individual activities.

⇒ The synthesis of qualitative and quantitative evidence suggests that physical activity can benefit the mental and physical health of people experiencing homelessness with positive translation of benefits to wider life.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Group physical activity interventions seemed to be the most beneficial to people experiencing homelessness, perhaps due to its facilitation of social support and connection.

⇒ Qualitative data highlighted the pressure some participants felt in competitive tournament settings. Organisers should recognise this and consider support to ameliorate impacts of pressure experienced.

⇒ Consideration should be given to the intensity level of physical activity interventions for this population. Given the high prevalence and poor health of many people experiencing homelessness, lower threshold activities are likely to be more inclusive for the population.

INTRODUCTION

Homelessness is an extreme form of social exclusion1, 2 related to poverty in high-income countries.3 People experiencing homelessness (PEH) are defined as those who are ‘roofless’ (eg, no fixed abode) and ‘houseless’ (eg, living in hostel, shelter, temporary accommodation) in accordance with the European Federation of National Organisations Working with the Homeless.4 Prior to the COVID-19 pandemic, homelessness in the UK had increased annually since 20105 with estimates of all categories of homelessness in England standing at 280 000 people,6 of which 4266 were estimated to be sleeping on the streets.7 The Organisation for Economic Co-operation and Development (OECD)
estimates that almost 2 million people are experiencing homelessness in 35 OECD countries. PEH have poorer health than the general population, often characterised by a tri-morbidity of mental health diagnoses, chronic physical health conditions and addiction. Poor health is thought to be both precipitated and exacerbated by poor living conditions, lack of resources, social exclusion, stigmatisation and difficulty accessing suitable health services.

Physical activity is beneficial for people with disabilities and chronic health conditions, both from a physical health and a social perspective. Guidance suggests that the type and amount of physical activity should be determined by a person’s abilities and the severity of their condition or disability, which may change over time. PEH live with a high burden of physical deficits, falls and frailty, respiratory disease, cardiac problems, stroke and diabetes, which could be positively influenced by physical activity. A recent scoping review found that among PEH, overall levels of physical activity appeared to be low, though the authors recognised that across studies reviewed, physical activity levels varied. Low levels of physical activity could be due to limited opportunities or barriers to accessing physical activity, rather than through choice. Consequently, PEH may miss out on health gains and a reduced risk of harm that physical activity affords people with these conditions. It is important that this population has opportunities for physical activity to stabilise or reverse physical declines associated with homelessness. Given the multiple barriers PEH face accessing services, it may be important that physical activity interventions are specifically tailored to their needs to optimise reach and participation. This perspective is consistent with public engagement activities with PEH and staff who care for them, which took place prior to the commencement of this research. This research poses two research questions: what is the range of physical activity interventions provided to PEH? And, what is the evidence supporting the effectiveness of these interventions?

Aims
This review aims to summarise the available evidence for physical activity interventions intended to improve health outcomes of adults experiencing homelessness, focusing on physical activity interventions and their effectiveness in improving health outcomes.

METHODS
Design
A preliminary scoping review revealed that published literature in the field of physical activity for PEH comprised both quantitative and qualitative research. Therefore, a mixed-methods systematic review was adopted. This allowed for the findings of effectiveness (quantitative evidence) and participant experiences (qualitative evidence) to be brought together, to facilitate a broader understanding of whether and how interventions worked. This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) 2020 guidelines and checklist, and the protocol was registered a priori in PROSPERO database (reference number: CRD42020216716).

Identification
Defining search terms
Initial search terms were generated by reviewers (JFD, RR-W and JB), who between them, have extensive clinical and research expertise and experience in the health of PEH, physical activity and systematic review methodology. The search terms were refined and tailored for a preliminary search of MEDLINE, and used to test the proof of concept and search strategy. The search syntax (online supplemental file 1) was designed by a professional librarian in collaboration with two reviewers (JFD and RR-W).

Searches
Search terms were refined, adapted and run in MEDLINE, EMBASE, Web of Science, CINAHL, PsycINFO, SPORTDiscus and the Cochrane Library. The searches were conducted on 17 February 2021, including literature from the previous 30 years (1991–2021) and restricted to English language only. The searches were re-run using the original search terms by a specialist librarian at Trinity College Dublin on 19 October 2022 to identify any new reports published between 21 October 2021 and 19 October 2022. All previous databases were searched, except SPORTDiscus, as it was unavailable in the institution’s library databases. Duplicates were removed at this stage. The reference lists of relevant systematic reviews and all included studies were hand-searched for reports to be added for screening. Corresponding authors of records that comprised an abstract only were contacted, where possible, to request full-text reports. Additionally, an expert reviewer suggested a study unidentified by searches, but met the inclusion criteria, so it was put forward for screening.

Screening
Title and abstract screening
On completion of the identification process, all report titles and abstracts were uploaded to the online systematic reviewing management system, Covidence. Two pairs of reviewers (JFD/RR-W and JFD/JB) independently performed (a) title and abstract screening and (b) full-text screening, judged against predetermined protocol criteria. In the event of disagreement, the third reviewer (JB or RR-W) was consulted for an additional opinion. The PICO framework was used to identify inclusion criteria. For inclusion, all the following criteria were to be met:

Population
Studies that included adults who were homeless under the European Typology of Homelessness and housing Exclusion (ETHOS) criteria for homelessness, that is rooflessness, houselessness, living in insecure housing or living in inadequate housing. Age > 18 years.

Intervention
Studies that included any physical activity intervention delivered as a stand-alone intervention or part of multimodal intervention, in any setting. Studies undertaken in high-income countries were included, where there is assumed consistency in health and social care infrastructure as well as in family and community support systems, which impact how homelessness is perceived and managed.

Outcome
This mixed-methods review included quantitative studies reporting any measures demonstrating health outcomes, including but not limited to primary measures such as cardiovascular fitness and strength, and qualitative findings describing participant perceptions linking physical activity intervention to health and/or well-being outcomes.
Comparison
The presence of a comparison group was not required as an inclusion criterion.

Study types
This review considered quantitative, qualitative and mixed-methods studies.

Risk of bias assessment
In recognition of the diverse study designs included in this review, the Joanna Briggs Institute (JBI) critical appraisal tool portfolio was a key resource for judging quality and risk of bias.25 24 These tools provide a criterion-based checklist for determining presence (yes), absence (no), a lack of clarity (unclear) or a lack of applicability (not applicable) of quality in studies across a variety of methods.25 To determine the dependability and credibility of qualitative reports, their ConQual ratings were calculated.26 Although Munn et al discourage cut-off values in determining the quality level in quantitative studies, for clarity and consistency of this mixed-methods review, a pragmatic decision was made to select cut-offs of <25% (very low), <50% (low), <75% (moderate) and >75% (high). Munn et al state that if cut-offs are preferred, these thresholds are best decided by the reviewers themselves.25 A summary of the quality assessment of all reports is given in online supplemental file 2.

Protocol deviation
This review was registered on PROSPERO, registration number: CRD42020216716. Found at https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=216716. In the PROSPERO protocol, we stated we would use Cochrane and Down's Black risk of bias tools. However, once the diversity of the final studies was identified, the review team recognised that JBI risk of bias tools were more suited to the studies within our review.

Data extraction
The following data were extracted to an excel spreadsheet: study design, inclusion criteria, participants (description, number, accommodation, age, education, employment, ethnicity, race, biological sex, mental health and physical health), intervention (setting, frequency, intensity, time, type, group or individual, presence of other non-physical activity intervention components), quantitative outcome measures and qualitative themes.

Initially, JFD carried out and collated data extraction from five reports. This was reviewed by RR-W and JB to ensure accuracy and consistency. Once all three team members agreed on the data extraction process, the remaining reports were divided among the team for completion of data extraction. Data from each report were checked for accuracy by another member of the research team. Any inconsistencies in interpretation or reporting were discussed, and consensus was reached.

Strategy for mixed-methods data synthesis
The synthesis followed the JBI methodology for mixed-methods systematic reviews,27 whereby established convergent, segregated, results-based mixed-methods frameworks for systematic reviewing were employed.28 29 First, qualitative and quantitative data were meaningfully categorised by JFD and JB, respectively. Each reviewer conducted their analysis separately, independently and concurrently. JFD adopted a reflexive thematic analysis approach to synthesise the qualitative data, by extracting all qualitative results into an excel spreadsheet and following the six processes of thematic analysis, namely: familiarisation; coding; generating initial themes; reviewing and developing themes; refining, defining and naming themes; and writing up.30 Details of themes are outlined in online supplemental file 3. Due to the heterogeneity of quantitative studies, it was not possible for JB to carry out a meta-analysis. So narrative synthesis was used. Quantitative findings were then ‘qualitised’ to transform them into a qualitative, descriptive format. Next, quantitative and qualitative evidence were linked and organised to produce an overall ‘configured analysis’32 and reported as a series of tables and combined narrative synthesis.

Equality and diversity statement
Our author and librarian team consisted of three women and two men. The author team included early and mid-career researchers and clinicians across two disciplines (medicine and physiotherapy) from two countries (UK and Ireland). This research explores physical activity interventions for PEH, an under-served, often marginalised and excluded population who experience extreme socioeconomic disadvantage. This population is known to have complex and chronic health needs and is an often-overlooked group in physical activity research.

RESULTS
Study selection
13 737 records were identified through searches. After the removal of duplicates (n=10 122), 3 615 records were screened by title and abstract, with 3 496 records excluded at this stage. 119 reports were sought for full-text review, 4 could not be found, so 115 full-text reports were reviewed. Of these, 97 reports were excluded at this stage (exclusions based on: 1 duplicate, 9 population, 59 intervention, 8 non-English language, 19 insufficient data, 1 protocol only). Finally, 18 reports were included for quality checking. Two reports described different aspects of a single study. Therefore, data were extracted from 18 reports describing 17 studies. The full identification, screening and inclusion process are outlined in a PRISMA diagram (figure 1).

Quality assessment
The majority of the 11 qualitative studies were high quality, with 8 reporting at least 7 out of 10 quality criteria on the JBI checklist for qualitative studies (online supplemental file 2). One study was of very low quality,31 with only the statement of researcher positionality being clear, and all other criteria either unreported or unclear. Of the quantitative studies, the one randomised controlled trial (RCT)32 was assessed as moderate quality due to methodological limitations, for example, lack of clarity regarding blinding of assessor and whether treatment groups were concealed. The analytical cross-sectional study was of moderate quality, and in general, quasi-experimental studies were of high quality.

Description of studies
Eighteen reports, describing 17 studies, were included (table 1). Of these studies, 7 were from the USA, 5 from the UK, 3 from Denmark and 2 from Australia. The variety of designs across these studies comprised 11 qualitative and 6 quantitative reports (4 quasi-experimental, 1 RCT and 1 analytical cross-sectional). The interventions addressed varied, including soccer (n=7); group outdoor exercise (n=5); group indoor multimodal exercise (n=3) and individual multimodal interventions (n=2) (online supplemental file 4).
Study populations

Online supplemental file 5 provides detail of each study population included in this systematic review. Across the 17 studies, 516 PEH were participants. Some studies included women only (n=5), men only (n=5) or mixed cohorts (n=7). Three qualitative studies reported staff/coaches’ perspectives (n=38). The age range of participants who were homeless was 16–65 years. It was specified in the review protocol that only studies with participants >18 years would be included. However, for pragmatic reasons, several studies33–37 were included despite containing participants from the age of 16 years. In these studies, proportions of participants <18 years were not specified, although one study38 stated that the ‘majority’ of participants were between the ages of 20 and 24 years. Descriptions of study participants’ experiences of homelessness varied but were mainly focused on: street homeless, living in hostel/shelter, transitional/social service accommodation or ‘homeless at time of intervention’. Studies that focused on Street Soccer and the Homeless World Cup invited participation from PEH and other socially excluded groups, for example, people attending unemployment offices or drug rehabilitation services. Although these studies did not define proportions of participants experiencing homelessness, for pragmatic reasons they were included, as the intervention had been specifically designed for PEH. Only one study specified exclusion criteria,32 which were based on reading ability and length of time staying in the shelter. In two studies, several participants were eligible but chose not to participate,39 40 the reasons for which was not specified. The number of study drop-outs was described in three reports/two studies,32 36 37 but the reasons for drop-out were not specified.

Physical activity interventions and their components

Online supplemental file 4 provides a description of all included interventions. The studies included seven soccer interventions (tournament focused (n=2), group training focused (n=3) and combining group training and tournament participation (n=2)); five group outdoor exercise (adventure training (n=3), running (n=1) and gardening (n=1)); three group indoor multimodal exercise (aerobic-based circuits (n=2) and dance (n=1)) and two individual multimodal interventions (pedometer with step goals and earn-a-bike scheme). Online supplemental file 4 also provides programming variables, including: setting; frequency; intensity; time; type and the presence of other non-physical activity components of multimodal interventions.

Soccer

Seven studies investigated the impact of soccer for PEH. These studies (eight reports) explored soccer group training (n=4),39 41–43 tournament participation (n=2)33 40 and interventions of training for and participating in tournaments (n=2).44 45 Studies that focused on Street Soccer and the Homeless World Cup invited participation from PEH and other socially excluded groups, for example, people attending unemployment offices or drug rehabilitation services. Although these studies did not define proportions of participants experiencing homelessness, for pragmatic reasons they were included, as the intervention had been specifically designed for PEH. Only one study specified exclusion criteria,32 which were based on reading ability and length of time staying in the shelter. In two studies, several participants were eligible but chose not to participate,39 40 the reasons for which was not specified. The number of study drop-outs was described in three reports/two studies,32 36 37 but the reasons for drop-out were not specified.

Group outdoor exercise

Five studies provided evidence of the value of group outdoor exercise. These included group outdoor adventure (n=3),34 35 46 women’s running groups (n=1)38 and women’s gardening groups (n=1).47 These studies described multimodal interventions, including outdoor adventure interventions which contained multiple activities (eg, archery, rock climbing, hiking), and all studies reported additional support, such as the provision...
## Table 1  Summary of included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Location</th>
<th>Study design</th>
<th>Description of homelessness/accommodation</th>
<th>Inclusion and exclusion criteria/study drop-outs</th>
<th>No of participants</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dawes et al, 2019[36]</td>
<td>UK</td>
<td>Qualitative (interview)</td>
<td>No fixed abode, living in hostel, temporary accommodation and permanent accommodation after being homeless</td>
<td>Attendees of one of two park-based running groups operated by the charity ‘A Mile in her Shoes’ in London for women defined as homeless, no specified exclusion criteria or study drop-outs reported</td>
<td>11</td>
<td>Outdoor Running (groups)</td>
</tr>
<tr>
<td>Grabbe et al, 2013[57]</td>
<td>USA</td>
<td>Qualitative (interview)</td>
<td>No fixed abode or living in shelters</td>
<td>Participation in at least eight gardening sessions in a daytime shelter for homeless women in a large south-eastern US city, no specified exclusion criteria or study drop-outs reported</td>
<td>8</td>
<td>Outdoor Gardening (groups)</td>
</tr>
<tr>
<td>Grimes and Smirnova, 2020[48]</td>
<td>USA</td>
<td>Qualitative (interview)</td>
<td>Temporarily housed and most had experienced two or three episodes of homelessness</td>
<td>Men experiencing homelessness who has completed the earn-a-bike programme in the previous year in Kansas, no specified exclusion criteria or study drop-outs reported</td>
<td>16</td>
<td>Mixed individual intervention (bicycle provision, cycle safety and maintenance training)</td>
</tr>
<tr>
<td>Helge et al, 2014 and Randers et al, 2012[31][33]</td>
<td>Denmark</td>
<td>Quasi-experimental (non-randomised controlled intervention study)</td>
<td>Recruited from homeless shelters and unemployment offices.</td>
<td>Men experiencing homelessness who were accessing services in shelters and unemployment offices in Copenhagen, no specified exclusion criteria, withdrawals football group (6/33 consented but did not show up for testing and 9/27 did not complete intervention), control group (4/22 consented but did not show up for testing and 8/18 completed the intervention), no differences in pre-test scores among drop-outs compared with the rest of the subjects</td>
<td>28</td>
<td>Soccer (group training)</td>
</tr>
<tr>
<td>Kendzor et al, 2017[71]</td>
<td>USA</td>
<td>Randomised controlled trial</td>
<td>Living in a transitional shelter for people experiencing homelessness (1) At least 18 years of age, (2) willing and able to attend study visits, (3) score &gt;4 on the Rapid Estimate of Adult Literacy in Medicine—Short Form (REALM-SF) indicating &gt;sixth-grade literacy level, (4) physically ambulatory, (5) residents of a transitional shelter in Dallas, Texas (able to show an ID badge) and (6) had been living in the transitional shelter for ≤3 months, exclusions (n=10) due to not reaching the minimum reading level (n=9) and/or staying at the shelter for more than 3 months (n=3), Drop-outs, control group (n=0), intervention (2/17). Reason for drop-out not stated.</td>
<td>32</td>
<td>Mixed Individual intervention (pedometer with step count goals, health education, provision of fruit and vegetables)</td>
<td></td>
</tr>
<tr>
<td>Knestaut et al, 2010[31]</td>
<td>USA</td>
<td>Qualitative (self-reported form, debrief and journal)</td>
<td>People living in homeless shelter adults who had taken part in shelter-based dance programme, no specified exclusion criteria or study drop-outs reported</td>
<td>11</td>
<td>Indoor multimodal exercise (Instructor-led dance group)</td>
<td></td>
</tr>
<tr>
<td>Magee and Jeanes, 2013[34]</td>
<td>UK</td>
<td>Qualitative (interview)</td>
<td>Living in social services, accommodation or hostels and spent time with no fixed abode</td>
<td>Male participants of the UK squad who attended the inaugural Homeless World Cup, no specified exclusion criteria or study drop-outs reported</td>
<td>6</td>
<td>Soccer (group training and Homeless World Cup participation)</td>
</tr>
<tr>
<td>Malden et al, 2019[36]</td>
<td>UK</td>
<td>Qualitative (interview)</td>
<td>Living in hostel accommodation or on the streets</td>
<td>Participants of the Street Fit Scotland intervention who attended both the fitness classes and peer support components of the intervention in March 2016, no specified exclusion criteria, 2/12 of those eligible did not participate—no reason specified.</td>
<td>10</td>
<td>Indoor multimodal exercise (Instructor-led, leisure centre-based group, with peer support)</td>
</tr>
</tbody>
</table>

Continued
### Table 1  Continued

<table>
<thead>
<tr>
<th>Study</th>
<th>Location</th>
<th>Study design</th>
<th>Description of homelessness/ accommodation</th>
<th>Inclusion and exclusion criteria/ study drop-outs</th>
<th>No of participants</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norton et al, 2020&lt;sup&gt;46&lt;/sup&gt;</td>
<td>USA</td>
<td>Quasi-experimental (non-equivalent groups longitudinal design)</td>
<td>Living at a shelter for women without housing</td>
<td>Women residents of a shelter in a large city in Texas, USA who had participated in the HOPE Adventure Therapy pilot programme, no specified exclusion criteria or study drop-outs reported</td>
<td>82</td>
<td>Outdoor Adventure (groups)</td>
</tr>
<tr>
<td>Parry et al, 2021&lt;sup&gt;18&lt;/sup&gt;</td>
<td>UK</td>
<td>Qualitative (realist evaluation: interviews, focus groups and diary room)</td>
<td>Young people experiencing or at risk of homelessness (no further details provided)</td>
<td>Young people with experience or at risk of homelessness who attended at least one MST4Life programme workshop (Phase 1) during the time of data collection and housing staff with one-to-one experience of working with the MST4Life participants, no specified exclusion criteria or study drop-outs reported</td>
<td>30 PEH</td>
<td>6 housing service staff 5 OAE staff</td>
</tr>
<tr>
<td>Parry et al, 2021&lt;sup&gt;18&lt;/sup&gt;</td>
<td>UK</td>
<td>Qualitative (diary room)</td>
<td>Living in supported accommodation for young people experiencing homelessness</td>
<td>Young people with experience or at risk of homelessness who attended and engaged in Phase 1 of MST4Life from different cohorts of MST4Life over a 5-year period (2014–2019). 50/113 eligible participants did not participate—reasons not specified, no drop-outs</td>
<td>54</td>
<td>Outdoor Adventure (groups)</td>
</tr>
<tr>
<td>Randers 2010&lt;sup&gt;42&lt;/sup&gt;</td>
<td>Denmark</td>
<td>Quasi-experimental (non-randomised controlled intervention study)</td>
<td>Nature of homelessness among ‘homeless participants’ undefined</td>
<td>Homeless men, no specified exclusion criteria or study drop-outs reported</td>
<td>15</td>
<td>Soccer (group training)</td>
</tr>
<tr>
<td>Randers et al, 2018&lt;sup&gt;46&lt;/sup&gt;</td>
<td>Denmark</td>
<td>Analytical cross-sectional (intervention study)</td>
<td>Described as homeless, no further details provided</td>
<td>Women experiencing homelessness from three countries (Denmark, Norway and Belgium) who participated in 4-a-side street soccer at Women’s Homeless World Cup in Amsterdam in December 2015, no specified exclusion criteria or study drop-outs reported</td>
<td>15</td>
<td>Soccer (Homeless World Cup tournament participation)</td>
</tr>
<tr>
<td>Sherry, 2010&lt;sup&gt;46&lt;/sup&gt;</td>
<td>Australia</td>
<td>Qualitative (interview)</td>
<td>Experience of homelessness in the preceding 2 years or were participating in a drug or alcohol rehabilitation programme</td>
<td>Team members of the ‘Street Socceroos’, the Australian Homeless World Cup team and, no specified exclusion criteria or study drop-outs reported</td>
<td>8</td>
<td>Soccer (group training and Homeless World Cup participation)</td>
</tr>
<tr>
<td>Sherry and Strybosch, 2012&lt;sup&gt;41&lt;/sup&gt;</td>
<td>Australia</td>
<td>Qualitative (Ethnographic case study)</td>
<td>Past or current experience of homelessness and associated social disadvantage</td>
<td>Team members of Australia’s Community Street Soccer Programme (CSSP) over a 4-year period, which is for people who are homeless or experience of homelessness/social disadvantage, staff from the CSSP and key stakeholder or support workers involved in the development and delivery of the programme, no specified exclusion criteria, no study drop-outs</td>
<td>165 players 11 Coaches 10 (support workers)</td>
<td>Soccer (group training)</td>
</tr>
<tr>
<td>Shors et al, 2014&lt;sup&gt;46&lt;/sup&gt;</td>
<td>USA</td>
<td>Quasi-experimental (intervention study)</td>
<td>‘Recently homeless’ with experience of poverty, trauma or addictive behaviours</td>
<td>Young mothers who were recently homeless then ‘rescued from the streets’ and given housing and food in a residential centre, where they lived with their children, no specified exclusion criteria or study drop-outs reported</td>
<td>15</td>
<td>Indoor multimodal exercise (Instructor-led meditation and choreographed aerobic group exercise)</td>
</tr>
<tr>
<td>Peachey et al, 2013&lt;sup&gt;31&lt;/sup&gt;</td>
<td>USA</td>
<td>Qualitative (focus groups)</td>
<td>Recruited from a tournament for homeless individuals. So, assumption that all participants were homeless—no further details supplied</td>
<td>Players and coaches who ‘represented the geographic areas’ of the US-based Street Soccer USA Cup, no specified exclusion criteria or study drop-outs reported</td>
<td>11 players 6 staff</td>
<td>Soccer (National Cup tournament participation)</td>
</tr>
</tbody>
</table>

PEH, people experiencing homelessness.
of education, debriefing, opportunities for reflection, childcare, food or clothing.

Group indoor multimodal exercise
All group indoor multimodal exercise studies (n=3) were instructor-led interventions provided to small groups in settings such as leisure centres or shelter recreation rooms. All studies were multimodal as they combined different types of activity, for example, stretching, cardiovascular exercise, dance, aerobic circuits, strength-based exercise to music and meditation.

Individual multimodal interventions
Two studies reported interventions for individuals. One involved participants wearing a pedometer and working towards a step goal. This was provided along with an educational newsletter and fruit/vegetable snacks. The other study described cycle training to learn road safety and cycle maintenance, alongside earning a bicycle for individual use.

Intervention and outcomes
Findings are described across four tables (tables 2–5). Table 2 shows all synthesised findings relating to mental health and table 3 shows all synthesised findings relating to physical health where the configured analysis identified qualitative and quantitative evidence supporting matched themes. Table 4 shows evidence that was identified in either quantitative or qualitative reports alone. For example, findings, where only quantitative data existed, were related to bone health and blood markers. Whereas qualitative evidence only was identified relating to other important aspects of physical activity, not specifically or directly health-related, such as the benefits carried into wider life, challenges of participation and addiction.

The impact of physical activity interventions on the mental health of PEH
There were several domains within mental health where both quantitative and qualitative evidence was synthesised, suggesting physical activity was beneficial (summarised in table 2). These included enhanced confidence, empowerment and self-esteem; resilience, coping and hope; independence, self-regulation and personal development; stress and anxiety; and mood and state of mind.

Enhanced confidence, empowerment and self-esteem
There was high quality qualitative evidence that group running, soccer and indoor group exercise, and moderate quality qualitative evidence that group outdoor adventure and earn-a-bike enhanced confidence, empowerment and self-esteem. However, the only quantitative study to assess outcomes in this domain used the Hope scale (agency subscale), finding no significant differences between groups. One soccer player suggested:

… when we went to Coniston, not even 10 min, we was there she wanted to come home, but she didn’t and she learned how to cope… she really enjoyed herself.

Independence, self-regulation and personal development
Qualitative evidence suggested that group running, and soccer (both high quality) and group outdoor adventure and earn-a-bike (both moderate quality) enhanced independence, self-regulation and personal development. This was supported by moderate quality quantitative evidence that outdoor adventure improved life functioning. An outdoor adventure participant describes how it impacted them:

… when I leave here, I face any challenges… in my life, then I know that I will be able to do them because I’ve become a stronger person from coming here.

Stress and anxiety
There was high quality qualitative evidence that group running, indoor group exercise and outdoor adventure and moderate quality qualitative evidence that soccer and earn-a-bike had a positive effect on stress and anxiety. The studies that used quantitative measures to assess stress/anxiety in soccer (moderate quality) and indoor group exercise (low quality) did not conclusively support the qualitative evidence. A participant at a gym-based programme said:

I… didn’t have the confidence to go outside, I felt a lot of like anxiety and this, the gym and stuff helps me with my anxiety really well.

Mood and state of mind
There was high quality qualitative evidence that soccer, group running and indoor group exercise and moderate quality qualitative evidence that earn-a-bike enhanced mood and state of mind. This was supported by moderate quality quantitative evidence that group outdoor adventure improved well-being.

The impact of physical activity interventions on the physical health of PEH
Changes were shown in the following physical health domains: body shape and weight loss; fitness levels; physical skills development and physical activity levels. The synthesised findings are summarised in table 3. Quantitative findings not corroborated by qualitative findings are summarised in table 4.

Body shape and weight loss
Synthesised findings showed that indoor group exercise and group running (both high quality qualitative evidence) were perceived as improving body shape and facilitating weight loss, while soccer was shown to significantly decrease weight-bearing fat mass and total fat mass (high quality quantitative evidence).

I took my measurements when I started street fit, and I took my measurements now, and I’m a lot more buff.

Fitness levels
Synthesised findings for fitness levels showed that group running, group indoor training and earn-a-bike (all high-quality qualitative evidence) significantly improved fitness and endurance levels, a finding backed up by a high-quality quantitative study of soccer. A person who cycled with earn-a-bike described trying to increase fitness:
Table 2  Summary of synthesised findings relating to mental health benefits of physical activity participation

<table>
<thead>
<tr>
<th>Qualitative</th>
<th>Quantitative</th>
<th>Synthesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overarching synthesised finding</td>
<td>Overarching synthesised finding</td>
<td>Overarching synthesised finding</td>
</tr>
<tr>
<td>Theme</td>
<td>Subtheme</td>
<td>Level of confidence in evidence for intervention type</td>
</tr>
<tr>
<td>Belief that physical activity facilitated people experiencing homelessness in self-development and their ability to cope with life situations</td>
<td>Confidence, empowerment and self-esteem</td>
<td>High (Group running, Soccer-group training and tournament participation, Indoor group instructor-led exercise)</td>
</tr>
<tr>
<td>Resilience, coping and hope</td>
<td></td>
<td>High (Group running, Group outdoor adventure)</td>
</tr>
<tr>
<td>Independence, focus, personal development and relationships</td>
<td></td>
<td>High (Group running, Soccer-group training and tournament participation)</td>
</tr>
</tbody>
</table>

Continued
Systematic review

Belief that physical activity resulted in people experiencing homelessness feeling mentally better

<table>
<thead>
<tr>
<th>Qualitative</th>
<th>Quantitative</th>
<th>Synthesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive effect on stress and anxiety</td>
<td>Positive changes to flow and worry, measured by the Flow Kurtz Scala (Flow Short scale)</td>
<td>People who anticipated in soccer tournament scored highly for flow (5.5±0.8) whereas the score for worry was moderate (4.6±1.3)</td>
</tr>
<tr>
<td></td>
<td>Decreased anxiety levels, measured by Beck Anxiety Inventory</td>
<td>A significant decrease in anxiety in intervention group, but p value not supplied</td>
</tr>
<tr>
<td>Belief that physical activity resulted in people experiencing homelessness feeling mentally better</td>
<td>Positive changes in life functioning, measured by (Outcomes rating scale), including personal and overall well-being</td>
<td>An increase in overall well-being at a faster rate in intervention group compared with control group (p&lt;0.05)</td>
</tr>
<tr>
<td>Positive effect on mood and state of mind</td>
<td>Decreased depression levels, measured by Beck Depression Inventory</td>
<td>Significant decrease in depression in intervention group, p value not supplied</td>
</tr>
</tbody>
</table>

The impact of physical activity interventions on the mental health of PEH.

CG, control group; IG, intervention group; PEH, people experiencing homelessness.

Table 2 Continued
<table>
<thead>
<tr>
<th>Theme</th>
<th>Subtheme</th>
<th>Level of confidence in evidence for intervention type</th>
<th>Description of outcome and measurement tool</th>
<th>Outcome data</th>
<th>Level of confidence in evidence for intervention type</th>
<th>Synthesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belief that physical activity improves the body shape of people experiencing homelessness</td>
<td>Improved body shape and self-image</td>
<td>High (Running groups&lt;sup&gt;38&lt;/sup&gt;, Indoor group instructor-led exercise&lt;sup&gt;39&lt;/sup&gt;)</td>
<td>Positive changes to body composition, measures using X-ray absorptiometry (DXA)</td>
<td>Weight bearing fat mass decreased by 13% from 14.0±7.2 kg to 12.2±6.5 kg. This change was significantly different (p=0.008) in the intervention group compared with the control group.</td>
<td>High (Soccer-group training&lt;sup&gt;39&lt;/sup&gt;)</td>
<td>High quality qualitative evidence that group running and indoor group exercise can improve body shape and weight loss. This is supported by high quality quantitative evidence that soccer significantly decreases fat mass.</td>
</tr>
<tr>
<td>Belief that physical activity improves the physical condition of people experiencing homelessness</td>
<td>Perception of improved fitness levels</td>
<td>High (Running groups&lt;sup&gt;38&lt;/sup&gt;, Soccer-group training and Tournament participation&lt;sup&gt;44&lt;/sup&gt;, Indoor group instructor-led exercise&lt;sup&gt;39&lt;/sup&gt;)</td>
<td>Positive changes to cardiovascular fitness, measured using cycle ergometer test to exhaustion</td>
<td>Maximal oxygen uptake was elevated from 2.69±0.47 to 2.95±0.52 L O&lt;sub&gt;2&lt;/sub&gt;/min (95% CI: 6.7 to 13.1%) after 12 weeks. This change was significantly different (p&lt;0.01) compared with the control group.</td>
<td>High (Soccer-group training&lt;sup&gt;39&lt;/sup&gt;)</td>
<td>High quality qualitative evidence that group running, soccer and indoor group exercise and moderate quality qualitative evidence that earn-a-bike improves fitness levels. This is supported by high quality quantitative evidence that soccer improves cardiovascular fitness and endurance.</td>
</tr>
<tr>
<td>Belief that physical activity improves the physical condition of people experiencing homelessness</td>
<td>Physical skill development</td>
<td>Moderate (Group Outdoor adventure&lt;sup&gt;39&lt;/sup&gt;)</td>
<td>Positive changes to cardiovascular fitness, measured using yo-yo endurance test</td>
<td>Endurance was improved by 45% which was 81 s (1034±218 to 1116±225 s, 95% CI: 47 to 128) after 12 weeks. This change was significantly different (p=0.05) in the intervention group compared with the control group.</td>
<td>High (Soccer-group training&lt;sup&gt;39&lt;/sup&gt;)</td>
<td>High quality qualitative evidence that group running and indoor group exercise can improve body shape and weight loss. This is supported by high quality quantitative evidence that soccer significantly decreases fat mass.</td>
</tr>
<tr>
<td>Belief that physical activity improves the physical condition of people experiencing homelessness</td>
<td>Physical skill development</td>
<td>Low (Soccer-group training&lt;sup&gt;39&lt;/sup&gt;)</td>
<td>Positive changes to cardiovascular fitness, measured using submaximal treadmill exercise test</td>
<td>There was a significant pre-post difference in maximal oxygen consumption (VO&lt;sub&gt;2&lt;/sub&gt;peak) in the intervention group (p&lt;0.05). No between group comparison was available.</td>
<td>Low (Indoor group aerobic-based dance&lt;sup&gt;34&lt;/sup&gt;)</td>
<td>Continued</td>
</tr>
<tr>
<td>Belief that physical activity improves the physical condition of people experiencing homelessness</td>
<td>Physical skill development</td>
<td>Very low (Group instructor-led dance&lt;sup&gt;39&lt;/sup&gt;)</td>
<td>No changes to postural balance, assessed by single legged flamingo balance test</td>
<td>Postural balance increased by 39% (p=0.004) and by 46% (p=0.006) in the right and left leg respectively in the intervention group only but no there was no difference between pre-post intervention changes in postural balance between intervention and control groups.</td>
<td>High (Soccer-group training&lt;sup&gt;39&lt;/sup&gt;)</td>
<td>Moderate quality qualitative evidence that group outdoor adventure improves physical skill development, this was not backed up by quantitative findings among a soccer cohort.</td>
</tr>
</tbody>
</table>
Table 3  Continued

<table>
<thead>
<tr>
<th>Qualitative</th>
<th>Quantitative</th>
<th>Synthesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belief that participating in physical activity interventions makes people experiencing homelessness more active in general</td>
<td>Participating in the physical activity intervention increased physical activity in everyday life</td>
<td>High (Running groups, Indoor group instructor-led exercise) Moderate (Earn-a-bike) Low (Soccer-group training)</td>
</tr>
<tr>
<td>Broader aspects of the intervention (clothes, equipment, skill) facilitated physical activity participation</td>
<td>Positive changes to physical activity levels, as measured by accelerometer</td>
<td>Min/day of moderate and vigorous physical activity was greater among participants in the intervention group (median 60 min/day) compared with the control group (median 41 min/day) (p=0.00036)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate (Pedometer with step-count)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High quality qualitative evidence that group running and indoor group exercise and moderate quality qualitative evidence that Earn-a-bike can positively influence physical activity levels among intervention participants. This is supported by moderate quality quantitative evidence that a pedometer with step-count goal significantly increased moderate/vigorous minutes per day of physical activity per day.</td>
</tr>
</tbody>
</table>

... after riding, you know, for an hour, two hours, and sometimes I’ll ride for four hours. You know, I really want to make sure that my body is fit.48

Physical skill development
While moderate quality qualitative evidence for group outdoor adventure was suggestive of positive changes in physical skills development, the quantitative research exploring this domain through measuring postural balance showed no significant difference between intervention and control groups. However, when comparing pre to post values in the intervention group, postural balance improved by 39% (p=0.004) in the right leg and 45% (p=0.006) in the left leg.

Physical activity levels
Synthesised findings showed that group indoor exercise and running groups (both high quality qualitative evidence) and earn-a-bike (moderate qualitative evidence) positively influenced physical activity levels. This was supported by a moderate quality quantitative pedometer and set a step count study. A woman from a running group described how since joining the group she now runs on her own:

I feel so much more body confident … I can actually run for the whole session without nearly dying. I also go out for runs on my own and I definitely think I’ve got faster.48

Bone health and cholesterol
A high quality study measured markers of bone health11 and cholesterol levels39 in PEH who played soccer. Although not all bone markers improved, increases in osteocalcin from pre-intervention to post-intervention were reported and this change was significantly different between controls and intervention groups. With regards to cholesterol markers (low-density lipoprotein-lipid (LDL)/high-density lipoprotein (HDL)) cholesterol was lowered and LDL:HDL ratios increased in the intervention group after 12 weeks of soccer—findings which were significantly different (p=0.05) from the control group.

Other considerations relevant to physical activity interventions for PEH
There were some findings relevant which described the impact of physical activity for PEH described in qualitative literature only. Themes include addiction, self-medication and medication; benefits carried into wider life and challenges to participation in physical activity when homeless (outlined in table 4).

Addiction, self-medication and medication
Across several qualitative studies of soccer (high quality) and earn-a-bike (moderate quality), physical activity positively influencing addiction was described. One person who played football stated:

I’m drinking less and do not think I need alcohol as much now... It’s great to feel this way and football is a focus for us.44

Benefits of physical activity participation carried into wider life
Most of the qualitative studies, including soccer, running groups, earn-a-bike, outdoor adventure, gardening and dance, described benefits to wider life. Subthemes included: development of life and interpersonal skills, improved social connectedness and relationships with others, practical and functional benefits, and physical activity as a catalyst for positive healthy life change. A participant who undertook leisure centre-based group indoor training said:

I’ve noticed a massive improvement in my fitness, and it’s definitely keeping me motivated to live a healthy lifestyle, because you don’t put in all that hard work and then want to ruin it, you know what I mean?36

... and similarly, how a participant of soccer described life change:

We can go back there and show that homelessness isn’t permanent and that you can change your life through sports.33

Challenges to participation in physical activity when homeless
Qualitative evidence demonstrated the importance of acknowledging specific challenges related to physical activity PEH faced, which impacted uptake and dropout rates across a variety of interventions. Those who participated in soccer tournaments described heavy defeats impacting on self-worth.44 Women who participated in running groups described lack of funds for transport or the unpredictability of homelessness as a barrier to attending.36 There was also worry about loss of donated kit (eg, running clothes)36.
and equipment (eg, bicycle) through theft and staff who led dance groups reported inconsistent attendance among shelter-dwellers. An overall summary of available evidence for physical activity interventions categorised by intervention type, findings and evidence quality is provided in Table 5.

**DISCUSSION**

This review identified evidence for diverse physical activity interventions for PEH. The mixed-methods methodology enabled a meaningfully configured synthesis of the breadth of available evidence. This review demonstrated positive impacts of physical activity for PEH in relation to mental and physical health outcomes with translation of benefits to wider life.

Physical activity interventions were heterogeneous, grouped into broad categories of soccer, group outdoor exercise, group indoor multimodal exercise and individualised multimodal interventions. In terms of specific sports, soccer predominated (7/17). This is unsurprising considering its global resonance. The mental health benefits of physical activity participation identified in our review align with research carried out in non-homeless populations, for example, the psychological state of

<table>
<thead>
<tr>
<th>Theme</th>
<th>Subtheme</th>
<th>Level of confidence in evidence for intervention type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belief that the benefits of physical activity interventions carry into wider life of people experiencing homelessness</td>
<td>Development of life and interpersonal skills</td>
<td>High (Group running, Group outdoor adventure) Moderate (Soccer-tournament participation, Earn-a-bike, Group outdoor adventure) Low (Soccer-group training and tournament participation, soccer-group training, Gardening group) Very low (Group instructor-led dance)</td>
</tr>
<tr>
<td>Improved social connection and building relationships with others</td>
<td>Physical activity as a catalyst for positive healthy life change</td>
<td>High (Group outdoor adventure) Moderate (Soccer-tournament participation) Low (Soccer-group training and tournament participation, soccer-group training, Gardening group)</td>
</tr>
<tr>
<td>Practical and functional benefits developed from participation</td>
<td>Homelessness presents specific barriers to PA participation</td>
<td>High (Group running) Moderate (Earn-a-bike) Low (Soccer-group training and tournament participation, soccer-group training)</td>
</tr>
<tr>
<td>Perception of challenges related to physical activity participation while homeless</td>
<td>Participating in soccer tournaments can be stressful</td>
<td>High (Soccer-group training and tournament participation) Moderate (Soccer-tournament participation) Very low (Group instructor-led dance)</td>
</tr>
<tr>
<td>Belief of physical activity positive impact on self-medication, prescribed medication and addiction for people experiencing homelessness</td>
<td>Perceived poor performance/aptitude can negatively impact confidence and coping</td>
<td>High (Soccer-group training and tournament participation) Moderate (Soccer-tournament participation) Very low (Group instructor-led dance)</td>
</tr>
</tbody>
</table>

### Quantitative findings

<table>
<thead>
<tr>
<th>Description of outcome and measurement tool</th>
<th>Outcome data</th>
<th>Level of confidence in evidence for intervention type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive bone health, measured from a blood sample and X-ray absorptiometry (DXA) in context of physical activity participation in people experiencing homelessness</td>
<td>Osteocalcin increased by 27% from pre to post intervention. This change was significantly different between the control and intervention groups (p=0.042) Pre-post trunk bone mineral density increased by 1% (p=0.02) in the intervention group. There was no difference between intervention and control groups.</td>
<td>High (Soccer-group training)</td>
</tr>
<tr>
<td>No change to bone health, measured by X-ray absorptiometry (DXA), from participation in physical activity among people experiencing homelessness</td>
<td>Pre-post weight-bearing z-score increased from 0.6±1.1 to 0.7±1.1 (p=0.07) in the intervention group. There was no difference between intervention and control groups.</td>
<td>High (Soccer-group training)</td>
</tr>
<tr>
<td>No post-pre changes in TRACP5b (bone resorption), plasma leptin or bone mineral density in intervention group (p&gt;0.05)</td>
<td></td>
<td>High (Soccer-group training)</td>
</tr>
<tr>
<td>Positive changes to blood markers after participation in physical activity among people experiencing homelessness</td>
<td>LDL cholesterol was lowered by 0.4 mmol/L (95% CI: −0.7 to −0.2; 3.2±1.1 to 2.8±0.8 mmol/L) in intervention group after 12 weeks, this change was significantly different to the control group (p=0.05)</td>
<td>High (Soccer-group training)</td>
</tr>
<tr>
<td>HDL-LDL ratio increased by 0.06 (CI: 0.02 to 0.11) after 12 weeks in the intervention group (0.43±0.13 to 0.48±0.19), which was different to the control group (p=0.05)</td>
<td>High (Soccer-group training)</td>
<td></td>
</tr>
</tbody>
</table>

HDL, high-density lipoprotein; LDL, low-density lipoprotein; PA, physical activity.
<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-theme</th>
<th>Soccer</th>
<th>Group outdoor exercise</th>
<th>Group indoor multimodal</th>
<th>Individual multimodal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental health</td>
<td>Self-development and coping</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Independence, focus, personal development/relationships</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Feeling better mentally</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Physical health</td>
<td>Improved body shape/weight</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Physical condition (fitness and physical skill levels)</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Become more physically active</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Improved bone health</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Improved blood markers—cholesterol</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Wider life benefits</td>
<td>Interpersonal skills and social connectedness</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Catalyst for healthy life</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Practical and functional (employment/education/travel)</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Medication/self-medication/addiction</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Positive impact on addiction issues</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Challenges associated with participation</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Tournament participation can increase stress</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
</tbody>
</table>

Table 5: Summary of available evidence for physical activity interventions categorised by intervention type, findings and evidence quality.
flow’ (where a person feels simultaneously cognitively efficient, motivated and happy) has been found to be increased by soccer training and running. However, the majority (4/7) of soccer interventions included in our review included tournament participation. While benefits to tournament participation exist, negative experiences of pressure and fear of letting down teammates were qualitatively reported. Organisers of soccer tournaments for PEH should consider support to ameliorate impacts of possible pressure experienced, which could negatively impact mental health or self-management of addiction. Moreover, our review highlights that comparing the nuances of benefits and challenges of tournament participation and training warrants further research.

Group exercise appeared to be most beneficial for PEH. It is likely that group activities facilitated social support, which is especially pertinent for PEH whose social networks are often fragmented. Configured qualitative and quantitative findings highlighted most evidence for mental health benefits in group outdoor exercise. Specifically, these benefits related to an improvement in mood and state of mind and increased independence, focus, personal development and ability to foster relationships. This may be related to emerging evidence for optimised benefits of outdoor exercise. Corroboration of qualitative and quantitative evidence indicated that PEH who participated in physical activity interventions increased their physical activity levels. There is inherent difficulty comparing types of interventions for levels of benefit, as interventions and outcome measures were heterogeneous. Many physical activity interventions included additional intervention components such as counselling, food or sports kit. Consequently, it is not known if these additional components, enhanced or diluted the effect of physical activity. Moreover, descriptions of physical activity programme variables such as dosage were often lacking, limiting judgment of interventions.

Programme intensity deserves consideration. Soccer, which predominated, is a vigorous intensity sport (10 metabolic equivalent of task (METs) for competitive soccer and 7 METs for casual soccer) so it is likely this high entry level may be exclusionary for some PEH. It should also be considered that some participants may be content to participate on the field while exerting minimal energy, so a diversity in intensity levels is also possible. Given the high prevalence and early manifestation of non-communicable diseases and poor general physical health in many PEH, specifically focused lower threshold physical activity interventions should be also considered. Some low threshold programmes were identified such as gardening and dance. People designing physical activity interventions for PEH should consider a range of abilities and likely poor physical condition, perhaps offering a choice of low threshold activity, as well as higher intensity options, depending on ability and interest.

Qualitative studies dominated the evidence base, justifying the methodological decision of a mixed-methods review. The quality of evidence of most qualitative studies was judged to be high, with perspectives of staff enhancing credibility to the understanding of intervention impact. Significant changes were reported for the outcomes of weightbearing fat mass and overall fat mass in one soccer study, although changes in muscle mass were not reported. Cardiovascular fitness and endurance also improved significantly in soccer studies. While these findings were in small, uncontrolled studies, the implication of even minor changes to outcomes such as cardiovascular fitness and endurance may be of importance to PEH, as this group is significantly more likely than housed people to be hospitalised due to acute

### Table 5

<table>
<thead>
<tr>
<th>Theme</th>
<th>Subtheme</th>
<th>Study Population</th>
<th>Interventions</th>
<th>Programme Intensity</th>
<th>Programme Dose</th>
<th>Programme Duration</th>
<th>Programme Mode</th>
<th>Programme Setting</th>
<th>Programme Quality</th>
<th>Evidence Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soccer</td>
<td>Group training</td>
<td>PEH</td>
<td>Instructor-led exercise</td>
<td>Vigorous</td>
<td>Task-specific</td>
<td>10 hours</td>
<td>Indoor</td>
<td>Club setting</td>
<td>Very high</td>
<td>Very high</td>
</tr>
<tr>
<td>Group training</td>
<td>Tournament</td>
<td>PEH</td>
<td>Pedometer + step count</td>
<td>Low</td>
<td>Linear</td>
<td>12 weeks</td>
<td>Outdoor</td>
<td>Community centre</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Group outdoor exercise</td>
<td>Running</td>
<td>PEH</td>
<td>Gardening</td>
<td>Low</td>
<td>Non-linear</td>
<td>6 months</td>
<td>Indoor</td>
<td>Community garden</td>
<td>High</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

*Additional qualitative evidence, but of lower quality.†Additional quantitative evidence, but of lower quality.
trauma. Although not specifically explored in this population, it is likely that higher baseline fitness and strength levels may aid recovery post-hospitalisation, so multifaceted programmes addressing cardiovascular endurance and strength may be most beneficial for this population. A limitation of the evidence identified was that only one quantitative study was an RCT. While RCTs are considered the highest evidence level, this review attests to the usefulness of other study designs in this novel and emerging topic. It is acknowledged that RCTs may be especially difficult to undertake due to possible implementation barriers and complexities within this cohort. We propose that to build the evidence base, forms of controlled trials should be conducted where possible, with a view to including more randomised trials in the future. A further limitation was that feasibility outcomes such as adherence and retention rates were not well described, though challenges to participation were described in several qualitative studies. Feasibility analysis, including assessment of adherence and retention, should be included in future studies. Outcome measures employed were not consistent, for example, cardiovascular fitness was measured in three different ways: the Yo-Yo endurance test, cycle ergometry and maximal treadmill testing. The evidence base is limited in terms of the most suitable outcome measures to use in physical activity interventions for PEH. Future studies should explore the most suitable outcome measures with a view to improving consistency in their use to enable future evidence syntheses.

Strengths of this review were its mixed-methods design and the global spread of identified research including studies from the UK and Europe, North America and Australia. However, only high-income countries were included, as low-income and middle-income settings were considered to have different structural influences on homelessness. So a limitation of this systematic review is that the translation of findings to other settings is not known. With regards to descriptions of exclusion criteria, included studies appeared to be pragmatic with minimal reporting of these. For example, no studies listed addiction status or gender diversity as pre-specified barriers to inclusion. Notably, most studies described the outcomes of ‘real world’ established programmes for PEH. In these cases, study eligibility criteria were dependent on those who engaged with the specific programme in the first instance, the eligibility criteria for which were not described, and were most likely self-selection. Only a small number of drop-outs were reported and there was minimal detail about their characteristics. We recognise that a level of stability in addiction and overall socioeconomic status is required to enable engagement in any type of physical activity intervention. Consequently, conclusions drawn from our review may not be applicable to the full diversity of PEH.

A final strength was that the review team capitalised on expertise in inclusion health, physical activity interventions and evidence synthesis with input from expert medical librarians. Studies were quality assessed using a consistent ‘family’ of critical analysis tools from JBI.

CONCLUSION
This mixed-methods systematic review demonstrates the value in exploring literature across a wide variety of methodological domains to gain insights into the existence and impact of a variety of physical activity interventions for PEH. To confidently inform policy, more research in this topic is required, however, from a practice and research perspective, our results provide initial justification for the inclusion of this typically under-represented group in targeted physical activity interventions with benefits to multiple aspects of physical and mental health, and positive translation into wider life demonstrated. Future research should include larger-scale high quality quantitative research to provide more robust evidence regarding objective impact.

Twitter Jo Dawes @DawesJo

Acknowledgements The authors would like to thank Jacqui Smith, clinical librarian at UCL for sharing her extensive knowledge and supporting the team with their protocol design, searching strategy and carrying out the searches. Thanks also to and David Mockler, librarian, Trinity College Dublin, Dr Cliona Ni Cheallaigh and Professor Andrew Hayward for their advice and support of this work.

Contributors JFD, RR-W and JB all contributed to the planning, conduct and reporting of the work described in the manuscript. JFD is responsible for the overall content as guarantor. JFD and RR-W designed and contributed to the initial registration of the research and the identification of literature at the search stage. JFD, RR-W and JB all contributed to the screening, data extraction and reporting. All authors contributed to the writing up, review, editing and finalising of the manuscript.

Funding JFD was funded by a pre-doctoral fellowship from the National Institute for Health and Care Research (NIHR) School for Public Health Research (SPHR), Grant Reference Number PD-SPH-2015. The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is not commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

ORCID ID Jo Dawes http://orcid.org/0000-0003-0248-4160

REFERENCES
8 OECD. Better data and policies to fight homelessness in the OECD, policy brief on affordable housing. Paris: OECD; 2020. 3–11.
Systematic review

31 Knestaur M, Devine MA, Verleza B. “It gives me purpose”: the use of dance with people experiencing homelessness’. *Ther Recreation J* 2010;44:289–301.
Supplementary file 1: Search syntax
This document contains the search syntax used in Medline, EMBASE, Web of Science, CINAHL,
SPORTDiscus, the Cochrane Library and PsycINFO

Database: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed
Citations and Daily <1946 to December 14, 2020>
Search Strategy:

1  homeless persons/ or homeless youth/
2  (homeless person* or homeless* or street dwell* or rough sleep* or no fixed abode or temporary
   accommodation or temporary housing or insecure housing or hostel).tw.
3  exp Exercise/
4  (physical activit* or (bik* or bicycl* or cardio* cycl* or danc* fit* or garden* or jog* or run* or swim*
   or walk* or zumba or salsa or pilates or yoga or tai chi)).tw.
5  exp Sports/
6  (sport* or (badminton or boxing or ball or gym* or soccer or tennis)).tw.
7  (exercis* or ((exercise* adj therapy) or rehab*)).tw.
8  ((physical adj activ*) or educa* or train*).tw.
9  ((aerobic* or cadio* or physi*) adj (exercise* or rehab* or therap* or fit* or train*)).tw
10  ((resistance or strength* or weight*) adj (train* or exercis*)).tw.
11  Resistance Training/
12  (keep* adj (active or fit)).tw.
13  (High Intensity Interval Training or HIIT or (circuit* adj train*)).tw.
14  High-Intensity Interval Training/
15  Circuit-Based Exercise/
16  Pliability/
17  Anxiety/
18  Depression/
19  Accidental Falls/
20  Frailty/
21  "Quality of Life"/
22  (Balance or flexibility or strength or anxiety or depression or (exercise adj6 (tolerance or
   capacity)) or falls or (physical adj (fitness or function)) or frailty or function or independence or mood
   or quality of life or wellness or wellbeing)).tw.
23  1 or 2
24  3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15
25  16 or 17 or 18 or 19 or 20 or 21 or 22
26  23 and 24 and 25
Database: Embase <1980 to 2021 Week 05>
Search Strategy:

1  homeless person/ or homeless youth/ (2250)
2  (homeless person* or homeless* or street dwell* or rough sleep* or no fixed abode or temporary accommodation or temporary housing or insecure housing or hostel).tw. (14412)
3  exp exercise/ (347510)
4  (physical activit* or (bik* or bicycl* or cardio* cycl* or danc* fit* or garden* or jog* or run* or swim* or walk* or zumba or salsa or pilates or yoga or tai chi)).tw. (666192)
5  exp sport/ (167693)
6  (sport* or (badminton or boxing or ball or gym* or soccer or tennis)).tw. (143093)
7  (exercis* or ((exercise* adj therapy) or rehab*)).tw. (603637)
8  ((physical adj activ*) or educa* or train*).tw. (1520464)
9  ((aerobic* or cardio* or physi*) adj (exercise* or rehab* or therap* or fit* or train*)).tw. (99728)
10  ((resistance or strength* or weight*) adj (train* or exercis*)).tw. (25991)
11  resistance training/ (19850)
12  (keep* adj (active or fit)).tw. (298)
13  (High Intensity Interval Training or HIIT or (circuit* adj train*)).tw. (2875)
14  high intensity interval training/ (2645)
15  circuit training/ (250)
16  pliability/ (3082)
17  anxiety/ (211042)
18  depression/ (371712)
19  falling/ (42141)
20  frailty/ (13530)
21  "quality of life"/ (494839)
22  (Balance or flexibility or strength or anxiety or depression or (exercise adj6 (tolerance or capacity)) or falls or (physical adj (fitness or function)) or frailty or function or independence or mood or quality of life or wellness or wellbeing).tw. (4244181)
23  1 or 2 (14871)
24  3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (2548913)
25  16 or 17 or 18 or 19 or 20 or 21 or 22 (4530822)
26  23 and 24 and 25 (634)

Databases: Web of Science, CINAHL, Cochrane and SportsDISCUS Search strategy

"homeless person" or homeless* or "street dwell" or "rough sleep" or "no fixed abode" or "temporary accommodation" or "temporary housing" or "insecure housing" or hostel
And

"physical activit*" or bik* or bicycl* or cardio* cycl* or "danc* fit*" or garden* or jog* or run* or swim* or walk* or zumba or salsa or pilates or yoga or "tai chi" or sport* or badminton or boxing or ball or gym* or soccer or tennis or exercis* or "exercise* adj1 therapy" or rehab* or "physical adj1 activ*" or educa* or train* or aerobic* or cadio* or "physi* adj1 exercise*" or rehab* or therap* or fit* or train* or resistance or strength* or "weight* adj1 train*" or exercis* or "keep* adj1 active" or fit or "High Intensity Interval Training" or HIIT or "circuit* adj1 train*"

And

Balance or flexibility or strength or anxiety or depression or "exercise adj6 tolerance" or capacity or falls or "physical adj fitness" or "physical adj function" or frailty or function or independence or mood or "quality of life" or wellness or wellbeing

Database: APA PsycInfo <1806 to February Week 2 2021>
Search Strategy:

1. ("homeless person*" or homeless* or "street dwell*" or "rough sleep*" or "no fixed abode" or "temporary accommodation" or "temporary housing" or "insecure housing" or hostel).tw.
2. exp Exercise/
3. exp Sports/
4. (physical activit* or (bik* or bicycl* or cardio* cycl* or danc* fit* or garden* or jog* or run* or swim* or walk* or zumba or salsa or pilates or yoga or tai chi)).tw.
5. (sport* or (badminton or boxing or ball or gym* or soccer or tennis)).tw.
6. (exercis* or ((exercise* adj therapy) or rehab*)).tw.
7. (physical adj1 activ*) or Educa* or train*.tw.
8. ((aerobic* or cardio* or physi*) adj (exercise* or rehab* or therap* or fit* or train*)).tw.
9. ((resistance or strength* or weight*) adj (train* or exercis*)).tw.
10. (keep* adj (active or fit)).tw.
11. (High Intensity Interval Training or HIIT or (circuit* adj train*)).tw.
12. Anxiety/
13. "Depression (Emotion*)/"
14. Falls/
15. "Quality of Life*"
16. (Balance or flexibility or strength or anxiety or depression or (exercise adj6 (tolerance or capacity)) or falls or (physical adj (fitness or function)) or frailty or function or independence or mood or quality of life or wellness or wellbeing).tw.
17. 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11
18. 12 or 13 or 14 or 15 or 16
19. 1 and 17 and 18
### Supplementary Table 2a: Quality assessment of qualitative studies, using JBI critical appraisal checklists

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Congruity</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Q2: Congruity</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Q3: Congruity</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Q4: Congruity</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Q5: Congruity</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Unclear</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Q6: Location</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Q7: Influence</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Q8: Participants</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Q9: Research ethical</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Unclear</td>
<td>Unclear</td>
<td>No</td>
</tr>
<tr>
<td>Q10: Conclusions</td>
<td>Yes</td>
<td>Yes</td>
<td>Unclear</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### Dependability rating [Based on number of “yes” across Q2, 3, 4, 6 and 7][1]

- 4/5: Unchanged
- 3/5: Downgrade one level
- 2/5: Downgrade two levels
- 1/5: Downgrade three levels

### Credibility rating [Based on review of findings][1]

- Unequivocal
- Equivocal
- Low
- Moderate
- Very Low
- High
- Moderate
- V Low
- High

### Supplementary Table 2b: Quality assessment of quantitative studies, using JBI critical appraisal checklists

<table>
<thead>
<tr>
<th>Study</th>
<th>RCT</th>
<th>Quasi-experimental</th>
<th>Analytical Cross-sectional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kendzor 2017</td>
<td>8/13 = 61.5%</td>
<td>3/9 = 33.3%</td>
<td>5/8 = 62.5%</td>
</tr>
<tr>
<td>Shors 2014</td>
<td>7/9 = 77.7%</td>
<td>7/9 = 77.7%</td>
<td>6/9 = 66.7%</td>
</tr>
<tr>
<td>Helge 2014</td>
<td>7/9 = 77.7%</td>
<td>7/9 = 77.7%</td>
<td>6/9 = 66.7%</td>
</tr>
<tr>
<td>Randers 2010</td>
<td>7/9 = 77.7%</td>
<td>7/9 = 77.7%</td>
<td>6/9 = 66.7%</td>
</tr>
<tr>
<td>Randers 2012</td>
<td>6/9 = 66.7%</td>
<td>5/8 = 62.5%</td>
<td>6/9 = 66.7%</td>
</tr>
<tr>
<td>Norton 2020</td>
<td>7/9 = 77.7%</td>
<td>7/9 = 77.7%</td>
<td>6/9 = 66.7%</td>
</tr>
</tbody>
</table>


---

BMJ Publishing Group Limited (BMJ) disclaims all liability and responsibility arising from any reliance placed on this supplemental material which has been supplied by the author(s).
Supplementary file 3: Summary of qualitative thematic analysis

<table>
<thead>
<tr>
<th>Overarching theme</th>
<th>Theme</th>
<th>Sub theme</th>
<th>Level of confidence in evidence for intervention type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical health benefits of physical activity interventions for PEH</td>
<td>Belief that physical activity improves the body shape of people experiencing homelessness</td>
<td>Improved body shape and self-image</td>
<td>High (Running groups[1], Indoor group instructor-led exercise[2])</td>
</tr>
<tr>
<td></td>
<td>Belief that physical activity improves physical condition of people experiencing homelessness</td>
<td>Perception of improved fitness levels</td>
<td>High (Running groups[1], Soccer-group training and Tournament participation[4], Indoor group instructor-led exercise[2]) Moderate (Earn-a-bike[5]) Low (Soccer-group training[3]) Very Low (Group instructor-led dance[6])</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physical skill development</td>
<td>Moderate (Group Outdoor adventure[7]) Low (Soccer-group training[3]) Very Low (Group instructor-led dance[6])</td>
</tr>
<tr>
<td></td>
<td>Belief that participating in physical activity interventions makes people experiencing homelessness more active in general</td>
<td>Participating in the physical activity intervention increased physical activity in everyday life</td>
<td>High (Running groups[1], Indoor group instructor-led exercise[2]) Moderate (Earn-a-bike[5]) Low (Soccer-group training[3])</td>
</tr>
<tr>
<td>Mental health benefits of physical activity interventions for PEH</td>
<td>Belief that physical activity facilitated people experiencing homelessness in self-develop and their ability to cope with life situations</td>
<td>Confidence, empowerment and self-esteem</td>
<td>High (Group running[1], Soccer-group training and tournament participation[4], Indoor group instructor-led exercise[2]) Moderate (Earn-a-bike[5], Group outdoor adventure[7]) Low (Gardening group[8], Soccer-group training[3]) Very low (Group instructor-led dance[6])</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resilience, coping and hope</td>
<td>High (Group running[1], Group outdoor adventure[9]) Moderate (Group outdoor adventure[7]) Low (Gardening group[8], Soccer-group training[3]) Very low (Group instructor-led dance[6])</td>
</tr>
</tbody>
</table>
### Supplementary file 3: Summary of qualitative thematic analysis

<table>
<thead>
<tr>
<th>Theme</th>
<th>Effect Size</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Belief that physical activity resulted in people experiencing homelessness feeling mentally better | Independence, focus, personal development and relationships | High (Group running[1], Soccer-group training and tournament participation[4])  
Moderate (Group outdoor adventure[7], Earn-a-bike[5])  
Low (Gardening group[8], Soccer-group training and tournament participation[10])  
Very low (Group instructor-led dance[6]) |
| Positive effect on stress and anxiety                                 |                    | High (Group running[1], Indoor group instructor-led exercise[2], Group outdoor adventure[9])  
Moderate (Soccer-tournament participation[11], Earn-a-bike[5])  
Low (Gardening group[8], Soccer-group training and tournament participation[10])  
Very low (Group instructor-led dance[6]) |
| Development of life and interpersonal skills                          |                    | High (Group running[1], Group outdoor adventure[9])  
Moderate (Soccer-tournament participation[11], Earn-a-bike[5], Group outdoor adventure[7])  
Low (Soccer-group training and tournament participation[10], soccer-group training[3], Gardening group[8])  
Very low (Group instructor-led dance[6]) |
| Improved social connection and building relationships with others      |                    | High (Group running[1], Group outdoor adventure[9])  
Moderate (Soccer-tournament participation[11], Earn-a-bike[5], Group outdoor adventure[7])  
Low (Soccer-group training and tournament participation[10], soccer-group training[3], Gardening group[8]) |
| Physical activity as a catalyst for positive healthy life change       |                    | High (Group outdoor adventure[9])  
Moderate (Soccer-tournament participation[11])  
Low (Soccer-group training and tournament participation[10], Gardening group[8]) |
| Practical and functional benefits developed from participation         |                    | Moderate (Earn-a-bike[5])  
Low (Soccer-group training and tournament participation[10], soccer-group training[3]) |
Supplementary file 3: Summary of qualitative thematic analysis

| Perception of challenges related to physical activity participation whilst homeless | Homelessness presents specific barriers to PA participation | High (Group running[1])
| Moderate (Earn-a-bike[5])
| Low (Soccer- group training and tournament participation[10], soccer- group training[3])
| Very low (Group instructor-led dance[6]) |
| Participating in soccer tournaments can be stressful | High (Soccer- group training and tournament participation[4])
| Moderate (Soccer- tournament participation[11]) |
| Perceived poor performance/ aptitude can negatively impact confidence and coping | High (Soccer- group training and tournament participation[4])
| Moderate (Soccer- tournament participation[11])
| Very low (Group instructor-led dance[6]) |

| Belief of physical activity positive impact on self-medication, prescribed medication and addiction for people experiencing homelessness | Reduction in need for prescription medication and self-medication | Moderate (Earn-a-bike[4]) |
| Reduced substance misuse | High (Soccer- group training and tournament participation[10])
| Moderate (Earn-a-bike[4])
| Low (soccer- group training[7]) |
| Diversion from temptation of addiction | Low (soccer- group training[7]) |

Supplementary file 3: Summary of qualitative thematic analysis


## Supplementary file 4: Physical activity interventions for people experiencing homelessness

<table>
<thead>
<tr>
<th>Broad intervention theme</th>
<th>Physical activity intervention</th>
<th>Study</th>
<th>Number of participants receiving intervention and providing study data</th>
<th>Setting</th>
<th>Frequency</th>
<th>Intensity</th>
<th>Time</th>
<th>Type</th>
<th>Group/individual</th>
<th>Presence of other components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soccer</td>
<td>Soccer (group training)</td>
<td>Randers 2010</td>
<td>15</td>
<td>Outdoors four-a-side asphalt soccer pitch (22×16m)</td>
<td>Two sessions</td>
<td>NS</td>
<td>1 hour</td>
<td>Soccer: 4 vs 4 Soccer games</td>
<td>Group</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Helge et al, 2014 &amp; Randers et al, 2012</td>
<td>18</td>
<td>Soccer: Outdoors four-a-side asphalt pitch (22×16m) Supervised training: fitness centre</td>
<td>Soccer: mean of 2.2 ± 0.7 sessions per week Supervised training: mean of 0.5 ± 0.2 sessions per week, including 5 x strength exercises (one set of 10–12 repetitions)</td>
<td>Soccer: Verbally encouraged by coaches Supervised training: low intensity warm up, moderate intensity strength training, exercises at &gt; 15Repetition Maximum Supervised training: 15mins warm up + strength training time unclear</td>
<td>NS</td>
<td>Soccer: 4 vs 4 Soccer games</td>
<td>Group</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sherry &amp; Strybosch, 2012</td>
<td>144</td>
<td>NS</td>
<td>Weekly</td>
<td>NS</td>
<td>14min games with 1min half time break</td>
<td>Soccer</td>
<td>Group</td>
<td>Links to service</td>
</tr>
<tr>
<td>Soccer</td>
<td>(Tournament participation)</td>
<td>Randers et al, 2018</td>
<td>15</td>
<td>Outdoors four-a-side artificial turf street soccer</td>
<td>Majority of play at 70-100 %HRpeak</td>
<td>4 day tournament. Mean playing time per</td>
<td>Soccer</td>
<td>Group</td>
<td>International travel</td>
<td></td>
</tr>
<tr>
<td>Study, Year</td>
<td>Duration</td>
<td>Activity Details</td>
<td>Rate Perceived Exertion (x/10)</td>
<td>Game Duration</td>
<td>Services Provided</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>--------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>---------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welty, Peachey et al, 2013</td>
<td>4 days</td>
<td>Soccer, group tournament</td>
<td>4.8 ± 2.5</td>
<td>11.1 ± 2.6 min</td>
<td>Opening/closing ceremonies, awards</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magee &amp; Jeanes, 2013</td>
<td>10 weeks</td>
<td>Soccer, group training and Tournament participation</td>
<td>6</td>
<td>4.8 ± 2.5</td>
<td>Access to support services</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sherry, 2010</td>
<td></td>
<td>Soccer, group informal support, link to services</td>
<td>8</td>
<td>4.8 ± 2.5</td>
<td>Informal support, link to services</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norton et al, 2020</td>
<td>32 days</td>
<td>Group Outdoor Adventure, outdoors</td>
<td>32</td>
<td>4.8 ± 2.5</td>
<td>Debrief, reflection on experience, individual and therapy, childcare, ABC-R therapy model during outdoor activity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parry 2021a</td>
<td>30 days</td>
<td>Countryside, canoeing, hiking, high and low ropes course, and raft building</td>
<td>30</td>
<td>4.8 ± 2.5</td>
<td>Preceding phase of 10 x Positive Youth Development life skills workshops</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parry 2021b</td>
<td>54 days</td>
<td>Outdoors</td>
<td>54</td>
<td>4.8 ± 2.5</td>
<td>Preceding phase of 10 x Positive Youth Development life skills workshops and Team-based,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activity Type</td>
<td>Brand and Year</td>
<td>Duration</td>
<td>Setting</td>
<td>Participants</td>
<td>Frequency</td>
<td>Activity Details</td>
<td>Participants</td>
<td>Group Reflections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------</td>
<td>----------</td>
<td>----------------------------------</td>
<td>--------------</td>
<td>------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>--------------</td>
<td>--------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running groups</td>
<td>Dawes et al, 2019</td>
<td>1 hour/session</td>
<td>Local park</td>
<td>Participant self-selected</td>
<td>1 hour/session</td>
<td>Running Group, Running kit, healthy snack</td>
<td>Group</td>
<td>Running kit, healthy snack</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gardening groups</td>
<td>Grabbe et al, 2013</td>
<td>2 x per week</td>
<td>Vegetable garden in rear parking lot of daytime shelter for women</td>
<td>NS</td>
<td>“staffed sessions” 2 hours, but women could engage in gardening at any time during daylight hours when the shelter was open.</td>
<td>Group, but possible to undertake as an individual, if desired</td>
<td>Food preparation, health, nutrition, and horticulture education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group indoor multimodal exercise</td>
<td>Knestaut et al, 2010</td>
<td>Weekly</td>
<td>Recreation room of homeless shelter</td>
<td>Gentle warm up, exercise to elevate heart rate and raise core temperature</td>
<td>50 mins</td>
<td>Instructor-led group dance programme: stretching, cardiovascular exercise and dance genres including: hip hop, country line dance, ballet, and creative movement/improvisation</td>
<td>Group</td>
<td>Informal debrief</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group instructor-led, exercise</td>
<td>Malden et al, 2019</td>
<td>Weekly</td>
<td>Local leisure centre</td>
<td>Approx. 1 hour</td>
<td>instructor-led group fitness class: aerobic circuits and strength-based resistance training exercises to music</td>
<td>Group</td>
<td>peer support workshop and lunch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>Authors</td>
<td>Duration</td>
<td>Frequency</td>
<td>Intervention Details</td>
<td>Group</td>
<td>Frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------</td>
<td>----------</td>
<td>-----------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>----------------</td>
<td>-----------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitting/ walking meditation, aerobic-based dance exercise training</td>
<td>Shors et al, 2014</td>
<td>8</td>
<td>NS</td>
<td>2x per week for 8 weeks; Sitting meditation, walking, 30 mins aerobic-based dance</td>
<td>Group</td>
<td>NS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>exercise training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual multimodal intervention</td>
<td>Kendzor et al, 2017</td>
<td>15</td>
<td>NS</td>
<td>Shelter for homeless adults; Wear pedometer during waking ours and work towards</td>
<td>Individual</td>
<td>NS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10,000 daily step goal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earn-a-bike programme</td>
<td>Grimes &amp; Smirnova, 2020</td>
<td>16</td>
<td>NS</td>
<td>Partnership between pedestrian and bicycling advocacy organization and local</td>
<td>Unclear if</td>
<td>NS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>homeless outreach agency; Cycle safety training, including training on riding in</td>
<td>training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>heavy traffic and bicycle handling skills; Provision of bicycle and safety</td>
<td>delivered</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>equipment; Earning bicycle individual; Rules of the road and bicycle maintenance</td>
<td>in groups.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Supplementary File 5: Study populations within studies identified in systematic review

<table>
<thead>
<tr>
<th>Study</th>
<th>Description of participants</th>
<th>Number of Participants</th>
<th>Characteristics of participants who were homeless, does not include any participants who were staff</th>
<th>Biological Sex</th>
</tr>
</thead>
</table>
| Dawes et al, 2019             | Adult women with lived experience of homelessness, who had attended running groups for a minimum of 4 weeks.                                                                                                                                 | 11                     | **Age (years)** 23–57  
**Mean (SD):** NS  
**Educational achievement:** NS  
**Number in employment:** NS  
**Ethnicity/race:** NS  
**Physical/Mental health/psychological trauma:** NS  
**Biological Sex:** F 11, M 0, Other 0 |                |
| Grabbe et al, 2013            | Adult women living in shelters or on the street.                                                                                                                                                                                                                                        | 8                      | **Age (years):** Range: 20–59  
**Mean (SD):** NS  
**Educational achievement:** 4/8 high school or less  
4/8 some college or technical school  
**Number in employment:** NS  
**Ethnicity/race:** 4/8 ≥1 mental illnesses; including bipolar disorder, depression, obsessive-compulsive disorder, and borderline personality disorder  
**Physical/Mental health/psychological trauma:** NS  
**Biological Sex:** F 8, M 0, Other 0 |                |
| Grimes & Smirnova, 2020       | Adult men who had completed the "earn-a-bike" programme and had experienced homelessness at the time of participating in the programme.                                                                                                                                                 | 16                     | **Age (years):** Range: 30–65  
**Mean (SD):** 46.0  
**Educational achievement:** 1/16 less than high school  
9/16 high school  
4/16 some college  
2/16 completed college  
**Number in employment:** 2/8p  
**Ethnicity/race:** 4/8 African American  
4/8 White  
**Physical/Mental health/psychological trauma:** NS  
**Biological Sex:** F 0, M 16, Other 0 |                |
| Helge et al, 2014 & Randers et al, 2012 | Homeless adult men recruited from shelters and unemployment offices in Copenhagen.                                                                                                                                                                         | 28                     | **Age (years):** Range: NS  
**Educational achievement:** Football group:  
Mean (SD): 36.4 (10.0)  
Control group:  
Mean (SD): 42.7 (8.5)  
**Number in employment:** NS  
**Ethnicity/race:** NS  
**Physical/Mental health/psychological trauma:** NS  
**Biological Sex:** F 0, M 28, Other 0 |                |
| Kendzor et al, 2017           | Adults living in transitional shelters, a score of ≥4 on Rapid Estimate of Adult Literacy in Medicine-Short Form, physically ambulatory and resident at shelter for ≤3 months.                                                                                                               | 32                     | **Age (years):** Range: NS  
**Mean (SD):** 48.38 (8.12)  
**Educational achievement:** 12.63 (2.08)a  
**Number in employment:** NS  
**Ethnicity/race:** 27/32 African American  
**Physical/Mental health/psychological trauma:** NS  
**Biological Sex:** F 8, M 24, Other 16 |                |
<table>
<thead>
<tr>
<th>Study</th>
<th>Group Description</th>
<th>N</th>
<th>Range</th>
<th>Mean (SD)</th>
<th>Ethnicity</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knestaut et al, 2010</td>
<td>Adult men and women living in a homeless shelter</td>
<td>11</td>
<td>18-50</td>
<td></td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Magee &amp; Jeanes, 2013</td>
<td>Men who played in United Kingdom Homeless Word Cup squad. All of whom lived in either social services accommodation or hostels and had spent time living rough.</td>
<td>6</td>
<td>16-29</td>
<td>0/6</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Malden et al, 2019</td>
<td>Adults experiencing homelessness (living in hostel accommodation or on the streets) and had attended ≤10 Street Fit Scotland sessions.</td>
<td>10</td>
<td>21-36</td>
<td>1/10</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Norton et al, 2020</td>
<td>Adult women who, at the time of study, were living in a shelter for women without housing</td>
<td>82</td>
<td>18-63</td>
<td>41/83 Black 16/83 White 18/83 Hispanic 3/83 Other</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Parry et al, 2021a</td>
<td>Young people experiencing or at risk of homelessness who attended at least one My Strength Training for life (MST4Life) and consented/engaged with qualitative data collection; housing service staff with one-to-one experience with MST4Life participants; and, Outdoor Adventure Education (OAE) staff supporting phase 2 of MST4Life programme.</td>
<td>30 PEH 6 housing service staff 5 OAE staff</td>
<td>16-24</td>
<td>10/30</td>
<td>18/30 White 8/30 Mixed ethnicities 2/30 Black 2/30 Asian 1/30 Other</td>
<td>23/30 mental health condition</td>
</tr>
<tr>
<td>Parry et al, 2021b</td>
<td>Young people experiencing or at risk of homelessness who had participated in phase 1 of My Strength Training for life (MST4Life).</td>
<td>54</td>
<td>16-24</td>
<td>3/54***</td>
<td>33/54 White 11/54 mixed ethnic groups 2/54 Asian 2/54 Black 2/54 Other</td>
<td>NS</td>
</tr>
<tr>
<td>Study</td>
<td>Group Description</td>
<td>n</td>
<td>Range</td>
<td>Mean (SD)</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>----</td>
<td>----------------</td>
<td>-----------</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Randers et al, 2010</td>
<td>Homeless men</td>
<td>15</td>
<td>Range: 19-44</td>
<td>Mean, SD: 29 (2)</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Randers et al, 2018</td>
<td>Adult women participating in the Women’s Homeless World Cup.</td>
<td>15</td>
<td>Range: NS</td>
<td>Mean, SD: 30.3 ± 5.0</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Shors et al, 2014</td>
<td>Adult women (mothers) who were recently homeless and &gt;1 month poverty, trauma and addictive behaviour</td>
<td>15</td>
<td>Range: 18-36</td>
<td>Mean (SD): 25.0 (5.0)</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Sherry, 2010</td>
<td>Men, &gt;16 years old, who played in Australian 2006 Homeless World Cup team, had experienced homelessness in previous 2 years and/or in a drug or alcohol rehabilitation programme.</td>
<td>8</td>
<td>NS</td>
<td></td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Sherry &amp; Strybosch, 2012</td>
<td>Soccer program participants of the Community Street Soccer Programme; coaches and support workers of the programme.</td>
<td>165 players</td>
<td>Range: ‘under 18’-40</td>
<td>Most concentrated cohort 20-24 Mean (SD): NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Welty Peachey et al, 2013</td>
<td>Participants were players, coaches and administrators from Street Soccer USA Cup (SSUSA) who represented the geographic areas served by SSUSA</td>
<td>11 players</td>
<td>Range: 17-54</td>
<td>Mean (SD): NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

NS: not stated, SD: standard deviation, a mean(sd) years of education, b number in employment/education/training, c percentage supplied without accompanying numbers, closest whole number deduced relative to number of participants is reported, d identified as transgender