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

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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 qualitative and 6 quantitative (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.

INTRODUCTION

Homelessness is an extreme form of social exclusion^{1,2} related to poverty in high-income countries.³ People experiencing homelessness (PEH)

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.

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)



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estimates that almost 2 million people are experiencing homelessness in 35 OECD countries.⁸

PEH have poorer health than the general population,^{9,10} often characterised by a tri-morbidity of mental health diagnoses, chronic physical health conditions and addiction.⁹ 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.¹¹

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.¹² PEH live with a high burden of physical deficits,¹³ falls and frailty,¹⁴ respiratory disease, cardiac problems, stroke and diabetes,¹⁵ 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.¹⁶ 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.^{17,18} This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) 2020 guidelines¹⁹ and checklist,²⁰ 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,⁴ 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 countries²¹ 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.²²

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.^{23,24} 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 Downs and 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 'qualitized' to transform them into a qualitative, descriptive format. Next, quantitative and qualitative evidence were linked and organised to produce an overall 'configured analysis'²⁷ 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

13737 records were identified through searches. After the removal of duplicates (n=10122), 3615 records were screened by title and abstract, with 3496 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 records 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).

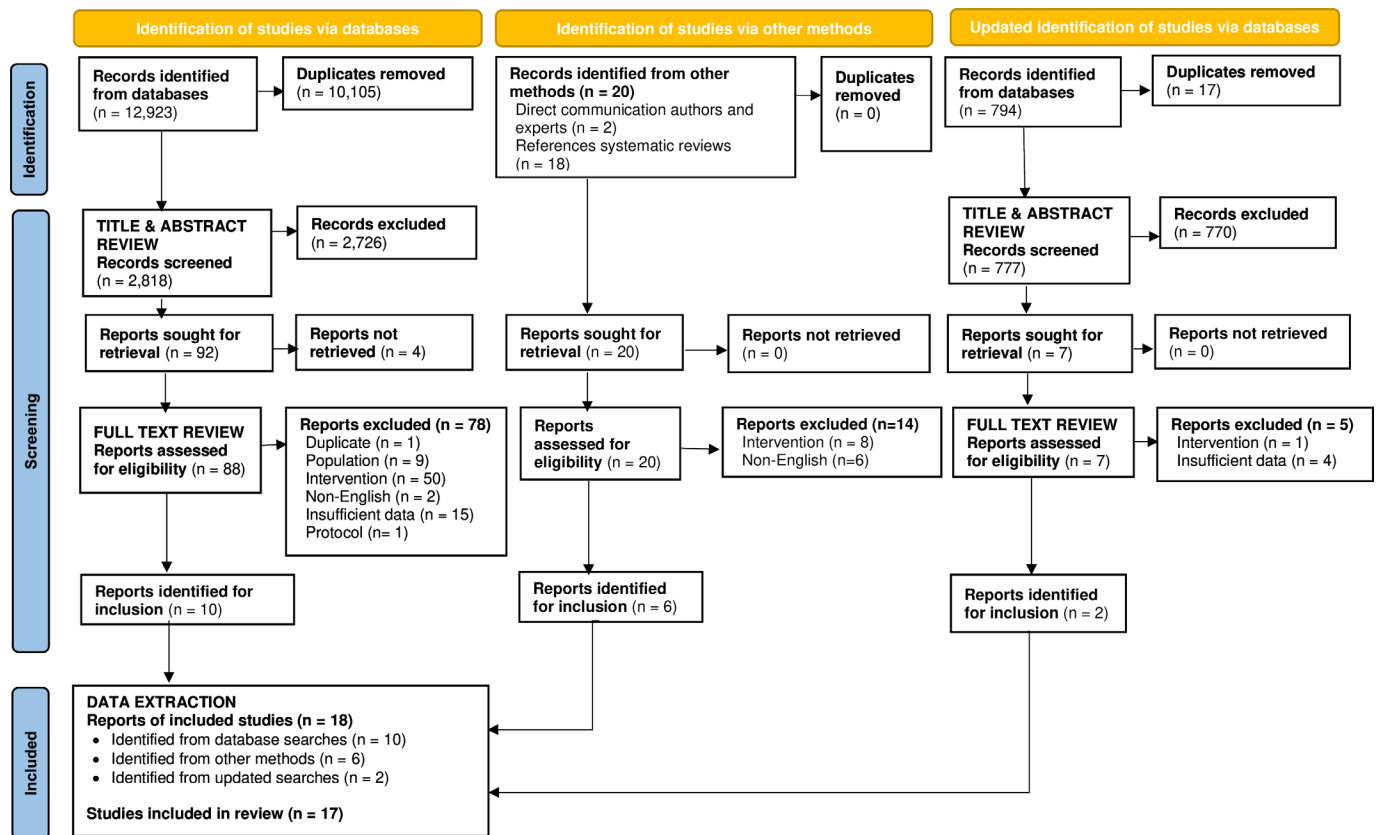


Figure 1 PRISMA flow diagram. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-analyses.

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 studies^{33–37} 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} The studies involving tournaments were focused around national or international tournaments such as the Homeless World Cup or Street Soccer USA Cup.^{33 40 44 45}

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

Study	Location	Study design	Description of homelessness/ accommodation	Inclusion and exclusion criteria/ study drop-outs	No of participants	Intervention
Dawes <i>et al</i> , 2019 ³⁸	UK	Qualitative (interview)	No fixed abode, living in hostel, temporary accommodation and permanent accommodation after being homeless	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	11	Outdoor Running (groups)
Grabbe <i>et al</i> , 2013 ⁴⁷	USA	Qualitative (interview)	No fixed abode or living in shelters	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	8	Outdoor Gardening (groups)
Grimes and Smirnova, 2020 ⁴⁸	USA	Qualitative (interview)	Temporarily housed and most had experienced two or three episodes of homelessness	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	16	Mixed individual intervention (bicycle provision, cycle safety and maintenance training)
Helge <i>et al</i> , 2014 and Randers <i>et al</i> , 2012 ^{39 41}	Denmark	Quasi-experimental (non-randomised controlled intervention study)	Recruited from homeless shelters and unemployment offices.	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	28	Soccer (group training)
Kendzor <i>et al</i> , 2017 ³²	USA	Randomised controlled trial	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 ≥ 4 on the Rapid Estimate of Adult Literacy in Medicine—Short Form (REALM-SF) indicating $>$ 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.	32	Mixed individual intervention (pedometer with step count goals, health education, provision of fruit and vegetables)
Knestaut <i>et al</i> , 2010 ³¹	USA	Qualitative (self-reported form, debrief and journal)	People living in homeless shelter	Adults who had taken part in shelter-based dance programme, no specified exclusion criteria or study drop-outs reported	11	Indoor multimodal exercise (Instructor-led dance group)
Magee and Jeanes, 2013 ⁴⁴	UK	Qualitative (interview)	Living in social services, accommodation or hostels and spent time with no fixed abode	Male participants of the UK squad who attended the inaugural Homeless World Cup, no specified exclusion criteria or study drop-outs reported	6	Soccer (group training and Homeless World Cup participation)
Malden <i>et al</i> , 2019 ³⁶	UK	Qualitative (interview)	Living in hostel accommodation or on the streets	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.	10	Indoor multimodal exercise (Instructor-led, leisure centre-based group, with peer support)

Continued

Table 1 Continued

Study	Location	Study design	Description of homelessness/ accommodation	Inclusion and exclusion criteria/ study drop-outs	No of participants	Intervention
Norton <i>et al</i> , 2020 ³⁴	USA	Quasi-experimental (non-equivalent groups longitudinal design)	Living at a shelter for women without housing	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	82	Outdoor Adventure (groups)
Parry <i>et al</i> , 2021 ³⁵	UK	Qualitative (realist evaluation: interviews, focus groups and diary room)	Young people experiencing or at risk of homelessness (no further details provided)	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	30 PEH 6 housing service staff 5 OAE staff	Outdoor Adventure (groups)
Parry <i>et al</i> , 2021 ⁴⁶	UK	Qualitative (diary room)	Living in supported accommodation for young people experiencing homelessness	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	54	Outdoor Adventure (groups)
Randers 2010 ⁴²	Denmark	Quasi-experimental (non-randomised controlled intervention study)	Nature of homelessness among 'homeless participants' undefined	Homeless men, no specified exclusion criteria or study drop-outs reported	15	Soccer (group training)
Randers <i>et al</i> , 2018 ⁴⁰	Denmark	Analytical cross-sectional (intervention study)	Described as homeless, no further details provided	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	15	Soccer (Homeless World Cup tournament participation)
Sherry, 2010 ⁴⁵	Australia	Qualitative (interview)	Experience of homelessness in the preceding 2 years or were participating in a drug or alcohol rehabilitation programme	Team members of the 'Street Socceroots', the Australian Homeless World Cup team and, no specified exclusion criteria or study drop-outs reported	8	Soccer (group training and Homeless World Cup participation)
Sherry and Strybosch, 2012 ⁴³	Australia	Qualitative (Ethnographic case study)	Past or current experience of homelessness and associated social disadvantage	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	165 players 11 Coaches 10 (support workers)	Soccer (group training)
Shors <i>et al</i> , 2014 ⁵⁶	USA	Quasi-experimental (intervention study)	'Recently homeless' with experience of poverty, trauma or addictive behaviours	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	15	Indoor multimodal exercise (Instructor-led meditation and choreographed aerobic group exercise)
Peachey <i>et al</i> , 2013 ³³	USA	Qualitative (focus groups)	Recruited from a tournament for homeless individuals. So, assumption that all participants were homeless—no further details supplied	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	11 players 6 staff	Soccer (National Cup tournament participation)

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 centres³⁶ or shelter recreation rooms.³¹ 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.^{32 48} One involved participants wearing a pedometer and working towards a step goal. This was provided along with an educational newsletter and fruit/vegetable snacks.³² The other study described cycle training to learn road safety and cycle maintenance, alongside earning a bicycle for individual use.⁴⁸

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:

... Football gave me confidence and took away feelings of depression as it made me more social.⁴⁴

Resilience, coping and hope

There was high quality qualitative evidence that group running, and group outdoor adventure enhanced resilience, coping and hope. However, the only quantitative study to measure relevant outcomes using the Hope Scale (pathway domain) found no significant difference between intervention and control groups. A member of staff involved in delivering group outdoor adventure described changes in a participant's ability to cope:

... when we went to Coniston, not even 10min, we was there she wanted to come home, but she didn't and she learned how to cope... she really enjoyed herself.³⁵

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.³⁵

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.³⁶

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.³⁶

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

Qualitative		Quantitative			Synthesis	
Theme	Subtheme	Level of confidence in evidence for intervention type	Description of outcome and measurement tool	Outcome data	Level of confidence in evidence for intervention type	Overarching synthesised finding
Belief that physical activity facilitated people experiencing homelessness in self-development and their ability to cope with life situations	Confidence, empowerment and self-esteem	High (Group running, ³⁸ Soccer-group training and tournament participation, ⁴⁴ Indoor group instructor-led exercise ⁵⁶) Moderate (Earn-a-bike, ⁴⁸ Group outdoor adventure ³⁵) Low (Gardening group, ⁴⁷ Soccer-group training ⁴³) Very low (Group instructor-led dance ³¹)	No change to goal directed energy, measured using The Hope scale (agency subscale)	No significant difference between intervention and control groups	Moderate (Group outdoor adventure ³⁴)	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 enhance confidence, empowerment and self-esteem. However, quantitative evidence does not support this.
	Resilience, coping and hope	High (Group running, ³⁸ Group outdoor adventure ⁴⁶) Moderate (Group outdoor adventure ³⁵) Low (Gardening group, ⁴⁷ Soccer-group training ⁴³) Very low (Group instructor-led dance ³¹)	No change to planning and accomplishing goals, measured using The Hope scale (pathway)	No significant difference between intervention and control groups	Moderate (Group outdoor adventure ³⁴)	High quality qualitative evidence that group running and group outdoor adventure enhances resilience, coping and hope, but quantitative evidence does not support this.
Independence, focus, personal development and relationships	Independence, focus, personal development and relationships	High (Group running, ³⁸ Soccer-group training and tournament participation ⁴⁴) Moderate (Group outdoor adventure, ³⁵ Earn-a-bike ⁴⁸) Low (Gardening group, ⁴⁷ Soccer-group training and tournament participation ⁴⁵) Very low (Group instructor-led dance ³¹)	Positive changes in life functioning, measured by (Outcomes rating scale), including interpersonal and social well-being	Significant difference between IG and CG for social wellness (p>0.01)	Moderate (Group outdoor adventure ³⁴)	High quality qualitative evidence that group running, and soccer and moderate quality qualitative evidence that group outdoor adventure and Earn-a-bike enhance independence, self-regulation and personal development. This is supported by moderate quality quantitative evidence that outdoor adventure improves life functioning.

Continued

Table 2 Continued

Qualitative		Quantitative		Synthesis
Belief that physical activity resulted in people experiencing homelessness feeling mentally better	Positive effect on stress and anxiety	High (Group running, ³⁸ Indoor group instructor-led exercise, ³⁶ Group outdoor adventure ⁴⁵) Moderate (Soccer-tournament participation, ³³ Earm-a-bike ⁴⁸) Low (Gardening group, ⁴⁷ Soccer-group training and tournament participation ⁴⁵) Very low (Group instructor-led dance ³¹)	Positive changes to flow and worry, measured by the Flow Kurtz Scala (Flow Short scale) Decreased anxiety levels, measured by Beck Anxiety Inventory	High quality qualitative evidence that group running, indoor group exercise and outdoor adventure and moderate quality qualitative evidence that soccer and Earm-a-bike have a positive effect on stress and anxiety. This is not supported by quantitative evidence.
	Positive effect on mood and state of mind	High (Group running, ³⁸ Soccer-group training and tournament participation, ⁴⁴ Indoor group instructor-led exercise, ³⁶ Group outdoor adventure ⁴⁵) Moderate (Earm-a-bike ⁴⁸) Low (Gardening group ⁴⁷) Very low (Group instructor-led dance ³¹)	Positive changes in life functioning, measured by (Outcomes rating scale), including personal and overall well-being Decreased depression levels, measured by Beck Depression Inventory	High quality qualitative evidence that group running, soccer and indoor group exercise and moderate quality qualitative evidence that Earm-a-bike enhances mood and state of mind. This is supported by moderate quality quantitative evidence that group outdoor adventure improves well-being.

The impact of physical activity interventions on the mental health of PEH. CG, control group; IG, intervention group; PEH, people experiencing homelessness.

Table 3 Summary of synthesised findings relating to physical health benefits of physical activity participation

Qualitative		Quantitative			Synthesis	
Theme	Subtheme	Level of confidence in evidence for intervention type	Description of outcome and measurement tool	Outcome data	Level of confidence in evidence for intervention type	Overarching synthesised finding
Belief that physical activity improves the body shape of people experiencing homelessness	Improved body shape and self-image	High (Running groups, ³⁸ Indoor group instructor-led exercise ³⁶)	Positive changes to body composition, measures using X-ray absorptiometry (DXA)	Weightbearing 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.	High (Soccer-group training ⁴¹)	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.
	Weight loss	High (Running groups ³⁶) Low (Soccer-group training ⁴³)		Total fat mass decreased by 13% from 1.7 kg (95% CI: -2.6 to -0.9 kg over 12 weeks. This change was significantly different (p<0.01) in the intervention group compared with the control group.	High (Soccer-group training ³⁹)	
Belief that physical activity improves physical condition of people experiencing homelessness	Perception of improved fitness levels	High (Running groups, ³⁸ Soccer-group training and Tournament participation, ⁴⁴ Indoor group instructor-led exercise ³⁶) Moderate (Earn-a-bike ⁴⁸) Low (Soccer-group training ⁴³) Very low (Group instructor-led dance ³¹)	Positive changes to cardiovascular fitness, measured using cycle ergometer test to exhaustion	Maximal oxygen uptake was elevated from 2.69±0.47 to 2.95±0.52 L O ₂ /min (95% CI: 6.7 to 13.1%) after 12 weeks in the intervention group. This change was significantly different (p<0.01) compared with the control group.	High (Soccer-group training ^{39,42})	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.
			Positive changes to cardiovascular fitness, measured using yo-yo endurance test	Endurance was improved by 45% which was 81 s (1034±218 to 1116±225 s, 95% CI: 47 to 128) s after 12 weeks. This change was significantly different (p=0.05) in the intervention group compared with the control group.	High (Soccer-group training ³⁹)	
			Positive changes to cardiovascular fitness, measured using submaximal treadmill exercise test	There was a significant pre-post difference in maximal oxygen consumption (VO ₂ peak) in the intervention group (p≤0.05). No between group comparison was available.	Low (Indoor group aerobic-based dance) ⁵⁶	
Physical skill development		Moderate (Group Outdoor adventure ³⁵) Low (Soccer-group training ⁴³) Very low (Group instructor-led dance ³¹)	No changes to postural balance, assessed by single legged flamingo balance test	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	High (Soccer-group training ⁴¹)	Moderate quality qualitative evidence that group outdoor adventure improves physical skill development, this was not backed up by quantitative findings among a soccer cohort.

Continued

Table 3 Continued

Qualitative		Quantitative		Synthesis		
Belief that participating in physical activity interventions makes people experiencing homelessness more active in general	Participating in the physical activity intervention increased physical activity in everyday life	High (Running groups, ³⁸ Indoor group instructor-led exercise ³⁶) Moderate (Earn-a-bike ⁴⁸) Low (Soccer-group training ⁴³)	Positive changes to physical activity levels, as measured by accelerometry	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)	Moderate (Pedometer with step-count ³²)	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.
	Broader aspects of the intervention (clothes, equipment, skill) facilitated physical activity participation	High (Running groups ³⁸) Very low (Group instructor-led dance ³¹)				

... 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.³⁸

Bone health and cholesterol

A high quality study measured markers of bone health⁴¹ 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.³⁸ There was also worry about loss of donated kit (eg, running clothes)³⁸

Table 4 Outcomes where quantitative only or qualitative only findings exist, no mixed-methods synthesis

Qualitative findings		
Theme	Subtheme	Level of confidence in evidence for intervention type
Belief that the benefits of physical activity interventions carry into wider life of people experiencing homelessness	Development of life and interpersonal skills	High (Group running, ³⁸ Group outdoor adventure ⁴⁶) Moderate (Soccer-tournament participation, ³³ Earn-a-bike, ⁴⁸ Group outdoor adventure ³⁵) Low (Soccer-group training and tournament participation, ⁴⁵ soccer-group training, ⁴³ Gardening group ⁴⁷) Very low (Group instructor-led dance ³¹)
	Improved social connection and building relationships with others	High (Group running, ³⁸ Group outdoor adventure ⁴⁶) Moderate (Soccer-tournament participation, ³³ Earn-a-bike, ⁴⁸ Group outdoor adventure ³⁵) Low (Soccer-group training and tournament participation, ⁴⁵ soccer-group training, ⁴³ Gardening group ⁴⁷)
	Physical activity as a catalyst for positive healthy life change	High (Group outdoor adventure ⁴⁶) Moderate (Soccer-tournament participation ³³) Low (Soccer-group training and tournament participation, ⁴⁵ Gardening group ⁴⁷)
	Practical and functional benefits developed from participation	Moderate (Earn-a-bike ⁴⁸) Low (Soccer-group training and tournament participation, ⁴⁵ soccer-group training ⁴³)
Perception of challenges related to physical activity participation while homeless	Homelessness presents specific barriers to PA participation	High (Group running ³⁸) Moderate (Earn-a-bike ⁴⁸) Low (Soccer-group training and tournament participation, ⁴⁵ soccer-group training ⁴³) Very low (Group instructor-led dance ³¹)
	Participating in soccer tournaments can be stressful	High (Soccer-group training and tournament participation ⁴⁴) Moderate (Soccer-tournament participation ³³)
	Perceived poor performance/aptitude can negatively impact confidence and coping	High (Soccer-group training and tournament participation ⁴⁴) Moderate (Soccer-tournament participation ³³) Very low (Group instructor-led dance ³¹)
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 ⁴⁸)
	Reduced substance misuse	High (Soccer-group training and tournament participation ⁴⁴) Moderate (Earn-a-bike ⁴⁸) Low (soccer-group training ⁴³)
	Diversion from temptation of addiction	Low (soccer-group training ⁴³)
Quantitative findings		
Description of outcome and measurement tool	Outcome data	Level of confidence in evidence for intervention type
Positive bone health, measured from a blood sample and X-ray absorptiometry (DXA) in context of physical activity participation in people experiencing homelessness	Osteocalcin increased by 27% from pre to post intervention. This change was significantly different between the control and intervention groups (p=0.042)	High (Soccer-group training ⁴¹)
	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.	High (Soccer-group training ⁴¹)
No change to bone health, measured by X-ray absorptiometry (DXA), from participation in physical activity among people experiencing homelessness	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.	High (Soccer-group training ⁴¹)
	No pre-post changes in TRACP5b (bone resorption), plasma leptin or bone mineral density in intervention group (p>0.05)	High (Soccer-group training ⁴¹)
Positive changes to blood markers after participation in physical activity among people experiencing homelessness	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)	High (Soccer-group training ³⁹)
	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)	High (Soccer-group training ³⁹)

HDL, high-density lipoprotein; LDL, low-density lipoprotein; PA, physical activity.

and equipment (eg, bicycle)⁴⁸ through theft and staff who led dance groups reported inconsistent attendance among shelter-dwellers.³¹

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.³⁷ 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 5 Summary of available evidence for physical activity interventions categorised by intervention type, findings and evidence quality

Theme	Subtheme	Soccer						Group outdoor exercise				Group indoor multimodal			Individual multimodal										
		Group training	Tournament	Training + Tournament	Outdoor adventure	Running	Gardening	Instructor-led dance	Instructor-led exercise	Aerobic-based dance	Pedometer + step count	Earn-a-bike	Group training	Tournament	Training + Tournament	Outdoor adventure	Running	Gardening	Instructor-led dance	Instructor-led exercise	Aerobic-based dance	Pedometer + step count	Earn-a-bike		
Mental health	Self-development and coping	🗨️		🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️										🗨️	🗨️
	Independence, focus, personal development/relationships			🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️										🗨️	🗨️
	Feeling better mentally		🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️										🗨️	🗨️
Physical health	Improved body shape/weight	📈		🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️												
	Physical condition (fitness and physical skill levels)	📈		🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️											🗨️	🗨️
	Become more physically active	🗨️		🗨️																				📈	🗨️
Improved bone health	📈																								
Improved blood markers—cholesterol	📈																								
Wider life benefits	Interpersonal skills and social connectedness	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️
	Catalyst for healthy life		🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️	🗨️
Medication/self-medication/addiction	Practical and functional (employment/education/travel)	🗨️		🗨️																					🗨️
	Reduced need for prescribed medication																								🗨️
Challenges associated with participation	Positive impact on addiction issues	🗨️		🗨️																					🗨️
	Homeless lifestyle a barrier to participation	🗨️		🗨️																					🗨️
	Tournament participation can increase stress		🗨️	🗨️																					🗨️

Continued

Table 5 Continued

Theme	Subtheme	Group outdoor exercise					Group indoor multimodal			Individual multimodal		
		Soccer	Group training	Tournament	Training + Tournament	Outdoor adventure	Running	Gardening	Instructor-led dance	Instructor-led exercise	Aerobic-based dance	Pedometer + step count
	Poor performance negatively impacts sense of self											
	Very low quality evidence.											
	Low quality evidence.											
	Moderate quality evidence.											
	High quality evidence.											
	Qualitative evidence.											
	Quantitative evidence.											
	*Additional qualitative evidence, but of lower quality.											
	†Additional quantitative evidence, but of lower quality.											

‘flow’ (where a person feels simultaneously cognitively efficient, motivated and happy) has been found to be increased by soccer training and running.⁴⁹ 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.⁵⁰ 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.⁵¹ 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)⁵² 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,⁵³ 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,⁴¹ although changes in muscle mass were not reported. Cardiovascular fitness and endurance also improved significantly in soccer studies.^{39, 42} 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

trauma.⁵⁴ 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 measures⁵⁵ 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.

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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 cadio* 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 adj activ*) or educa* or train*).tw.
 - 8 ((aerobic* or cadio* 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 File 2: Quality assessments of qualitative and quantitative studies using JBI critical appraisal checklists

Supplementary Table 2a: Quality assessment of qualitative studies, using JBI critical appraisal checklists

	Qualitative										
	Dawes 2019	Grabbe 2013	Grimes 2020	Knestaut 2010	Malden 2019	Magee 2013	Parry 2021a	Parry 2021b	Sherry 2010	Sherry 2012	Welty 2013
Q1: Is there congruity between the stated philosophical perspective and the research methodology?	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Unclear	Yes	Yes
Q2: Is there congruity between the research methodology and the research question or objectives?	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Unclear	Yes	Yes
Q3: Is there congruity between the research methodology and the methods used to collect data?	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Q4: Is there congruity between the research methodology and the representation and analysis of data?	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Q5: Is there congruity between the research methodology and the interpretation of results?	Yes	No	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Q6: Is there a statement locating the researcher culturally or theoretically?	Yes	No	No	Yes	Yes	Yes	No	Yes	No	No	No
Q7: Is the influence of the researcher on the research, and vice-versa, addressed?	No	No	No	No	Yes	Yes	No	Yes	No	No	Unclear
Q8: Are participants, and their voices, adequately represented?	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Q9: Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?	Yes	Yes	Yes	No	Yes	Yes	Yes	Unclear	Unclear	No	No
Q10: Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dependability rating (Based on number of "yes" across Q2, 3, 4, 6 and 7)[1]	4/5 Unchanged	2/5 Downgrade one level	3/5 Downgrade one level	1/5 Downgrade two levels	5/5 Unchanged	5/5 Unchanged	3/5 Downgrade one level	5/5 Unchanged	2/5 Downgrade one level	3/5 Downgrade one level	3/5 Downgrade one level
Credibility rating (Based on review of findings)[1]	Unequivocal	Equivocal	Unequivocal	Equivocal	Unequivocal	Unequivocal	Unequivocal	Unequivocal	Equivocal	Equivocal	Unequivocal
High, mod, low, v low	High	Low	Moderate	Very Low	High	High	Moderate	High	Low	Low	Moderate

1. Munn, Z., et al., *Establishing confidence in the output of qualitative research synthesis: the ConQual approach*. BMC Medical Research Methodology, 2014. **14**(1): p. 108.

Supplementary File 2: Quality assessments of qualitative and quantitative studies using JBI critical appraisal checklists

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

	RCT	Quasi-experimental					Analytical Cross-sectional
	Kendzor 2017	Shors 2014	Helge 2014	Randers 2010	Randers 2012	Norton 2020	Randers 2018
Was true randomization used for assignment of participants to treatment groups?	Yes						
Was allocation to treatment groups concealed?	Unclear						
Were treatment groups similar at the baseline?	Yes						
Were participants blind to treatment assignment?	No						
Were those delivering treatment blind to treatment assignment?	No						
Were outcomes assessors blind to treatment assignment?	Unclear						
Were treatment groups treated identically other than the intervention of interest?	No						
Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	Yes	Unclear	No	No	No	No	
Were participants analyzed in the groups to which they were randomized?	Yes						
Were outcomes measured in the same way for treatment groups?	Yes						
Were outcomes measured in a reliable way?	Yes	Unclear	Yes	Yes	Yes	Yes	Yes
Was appropriate statistical analysis used?	Yes	Unclear	Yes	Yes	Yes	Yes	Yes
Was the trial design appropriate, and any deviations from the standard RCT design accounted for in the conduct and analysis of the trial?	Yes						
Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?		Yes	Yes	Yes	Yes	Yes	
Were the participants included in any comparisons similar?		Unclear	Yes	Yes	Yes	Yes	
Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?		Yes	Yes	Yes	Yes	No	
Was there a control group?		Yes	Yes	Yes	Yes	Yes	
Were there multiple measurements of the outcome both pre and post the intervention/exposure?		No	No	No	No	No	
Were the outcomes of participants included in any comparisons measured in the same way?		Unclear	Yes	Yes	Yes	Yes	
Were the criteria for inclusion in the sample clearly defined?							Unclear
Were the study subjects and the setting described in detail?							Yes
Was the exposure measured in a valid and reliable way?							Yes
Were objective, standard criteria used for measurement of the condition?							Yes
Were confounding factors identified?							No
Were strategies to deal with confounding factors stated?							No
Quantitative quality rating: [2] (High: >75%/ Mod: 50-75%/ Low: 25-50%/ v low: <25%)	8/13 = 61.5% Mod	3/9 = 33.3% Low	7/9 = 77.7% High	7/9 = 77.7% High	7/9 = 77.7% High	6/9 = 66.7% Mod	5/8 = 62.5% Mod

2. Munn, Zachary; Barker, Timothy Hugh; Moola, Sandeep; Tufanaru, Catalin; Stern, Cindy; McArthur, Alexa; Stephenson, Matthew; Aromataris, Edoardo. Methodological quality of case series studies: an introduction to the JBI critical appraisal tool. JBI Evidence Synthesis 18(10):p 2127-2133, October 2020. | DOI: 10.11124/JBISIR-D-19-00099

Supplementary file 3: Summary of qualitative thematic analysis

Overarching theme	Theme	Sub theme	Level of confidence in evidence for intervention type
Physical health benefits of physical activity interventions for PEH	Belief that physical activity improves the body shape of people experiencing homelessness	Improved body shape and self-image	High (Running groups[1], Indoor group instructor-led exercise[2])
		Weight loss	High (Running groups[1]) Low (Soccer- group training[3])
	Belief that physical activity improves physical condition of people experiencing homelessness	Perception of improved fitness levels	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])
		Physical skill development	Moderate (Group Outdoor adventure[7]) Low (Soccer- group training[3]) Very Low (Group instructor-led dance[6])
	Belief that participating in physical activity interventions makes people experiencing homelessness more active in general	Participating in the physical activity intervention increased physical activity in everyday life	High (Running groups[1], Indoor group instructor-led exercise[2]) Moderate (Earn-a-bike[5]) Low (Soccer-group training[3])
		Broader aspects of the intervention (clothes, equipment, skill) facilitated physical activity participation	High (Running groups[1]) Very Low (Group instructor-led dance[6])
Mental health benefits of physical activity interventions for PEH	Belief that physical activity facilitated people experiencing homelessness in self-develop and their ability to cope with life situations	Confidence, empowerment and self-esteem	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])
		Resilience, coping and hope	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])

Supplementary file 3: Summary of qualitative thematic analysis

	Belief that physical activity resulted in people experiencing homelessness feeling mentally better	Independence, focus, personal development and relationships	<p>High (Group running[1], Soccer- group training and tournament participation[4])</p> <p>Moderate (Group outdoor adventure[7], Earn-a-bike[5])</p> <p>Low (Gardening group[8], Soccer- group training and tournament participation [10])</p> <p>Very low (Group instructor-led dance[6])</p>
		Positive effect on stress and anxiety	<p>High (Group running[1], Indoor group instructor-led exercise[2], Group outdoor adventure[9])</p> <p>Moderate (Soccer- tournament participation[11], Earn-a-bike[5])</p> <p>Low (Gardening group[8], Soccer- group training and tournament participation [10])</p> <p>Very low (Group instructor-led dance[6])</p>
The impact of physical activity interventions on the wider life of PEH	Belief that the benefits of physical activity interventions carry into wider life of people experiencing homelessness	Development of life and interpersonal skills	<p>High (Group running[1], Group outdoor adventure[9])</p> <p>Moderate (Soccer- tournament participation[11], Earn-a-bike[5], Group outdoor adventure[7])</p> <p>Low (Soccer- group training and tournament participation[10], soccer- group training[3], Gardening group[8])</p> <p>Very low (Group instructor-led dance[6])</p>
		Improved social connection and building relationships with others	<p>High (Group running[1], Group outdoor adventure[9])</p> <p>Moderate (Soccer- tournament participation[11], Earn-a-bike[5], Group outdoor adventure[7])</p> <p>Low (Soccer- group training and tournament participation[10], soccer- group training[3], Gardening group[8])</p>
		Physical activity as a catalyst for positive healthy life change	<p>High (Group outdoor adventure[9])</p> <p>Moderate (Soccer- tournament participation[11])</p> <p>Low (Soccer- group training and tournament participation[10], Gardening group[8])</p>
		Practical and functional benefits developed from participation	<p>Moderate (Earn-a-bike[5])</p> <p>Low (Soccer- group training and tournament participation[10], soccer- group training[3])</p>

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])

1. Dawes, J., C. Sanders, and R. Allen, "A Mile in Her Shoes": A qualitative exploration of the perceived benefits of volunteer led running groups for homeless women. *Health & social care in the community*, 2019. **27**(5): p. 1232-1240.
2. Malden, S., et al., A theory based evaluation of an intervention to promote positive health behaviors and reduce social isolation in people experiencing homelessness. *Journal of social distress and the homeless*, 2019. **28**(2): p. 158-168.
3. Sherry, E. and V. Strybosch, A kick in the right direction: longitudinal outcomes of the Australian Community Street Soccer Program. *Soccer & Society*, 2012. **13**(4): p. 495-509.
4. Magee, J. and R. Jeanes, *Football's coming home: A critical evaluation of the Homeless World Cup as an intervention to combat social exclusion*. *International Review for the Sociology of Sport*, 2011. **48**(1): p. 3-19.
5. Grimes, A. and M. Smirnova, *Perspectives on an earn-a-bike intervention on transportation, health and self- esteem among men experiencing homelessness*. *Journal of Transport & Health*, 2020. **18**: p. 11.
6. Knestaur, M., M.A. Devine, and B. Verlezza, 'It Gives Me Purpose': The Use of Dance with People Experiencing Homelessness. *Therapeutic Recreation Journal*, 2010. **44**(4): p. 289-301.

Supplementary file 3: Summary of qualitative thematic analysis

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8. Grabbe, L., J. Ball, and A. Goldstein, *Gardening for the mental well-being of homeless women*. Journal of holistic nursing : official journal of the American Holistic Nurses' Association, 2013. **31**(4): p. 258-66.
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10. Sherry, E., *(Re)engaging marginalized groups through sport: The Homeless World Cup*. International Review for the Sociology of Sport, 2010. **45**(1): p. 59-71.
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Supplementary file 4: Physical activity interventions for people experiencing homelessness

Broad intervention theme	Physical activity intervention	Study	Number of participants receiving intervention and providing study data	Setting	Frequency	Intensity	Time	Type	Group/individual	Presence of other components
Soccer	Soccer (group training)	Randers 2010	15	Outdoors four-a-side asphalt soccer pitch (22× 16m)	Two sessions	NS	1 hour	<u>Soccer</u> : 4 vs 4 Soccer games	Group	NS
		Helge et al, 2014 & Randers et al, 2012	18	<u>Soccer</u> : Outdoors four-a-side asphalt pitch (22× 16m) <u>Supervised training</u> : fitness centre	<u>Soccer</u> : mean of 2.2 ± 0.7 sessions per week <u>Supervised training</u> : mean of 0.5 ± 0.2 sessions per week, including 5 x strength exercises (one set of 10–12 repetitions)	<u>Soccer</u> : Verbally encouraged by coaches <u>Supervised training</u> : low intensity warm up, moderate intensity strength training, exercises at > 15Repetition Maximum	<u>Soccer</u> : 10min warm up, duration of soccer training unclear <u>Supervised training</u> : 15mins warm up + strength training time unclear	<u>Soccer</u> : 4 vs 4 Soccer games <u>Supervised training</u> : cardiovascular warm up, strength-based resistance training	Group	NS
		Sherry & Strybosch, 2012	144	NS	Weekly	NS	14min games with 1min half time break	Soccer	Group	Links to service
	Soccer (Tournament participation)	Randers et al, 2018	15	Outdoors four-a-side artificial turf street soccer	NS	Majority of play at 70-100 %HR _{peak}	4 day tournament. Mean playing time per	Soccer	Group	International travel

				pitch (22×16m with 4m wide goals)		Rate Perceived Exertion (x/10) 4.8± 2.5	game: 11.1 ± 2.6min			
		Welty Peachey et al, 2013	11	NS	NS	NS	4 day tournament	Soccer	Group	Opening/closing ceremonies, awards
	Soccer (group training and Tournament participation)	Magee & Jeanes, 2013	6	NS	NS	NS	10 weeks training + tournament	Soccer	Group	Access to support services
		Sherry, 2010	8	NS	NS	NS	NS	Soccer	Group	Informal support, link to services
Group outdoor exercise	Group Outdoor Adventure	Norton et al, 2020	32	Outdoors	NS	NS	NS	Archery, geocaching, rock climbing, and hiking	Group	Debrief, reflection on experience, individual and therapy therapy, childcare, ABC-R therapy model during outdoor activity
		Parry 2021a	30	Countryside, 170km from usual residence	NS	NS	4 days	Team based activities: canoeing, hiking, high ropes course, and raft building	Group	Preceding phase of 10 x Positive Youth Development life skills workshops
		Parry 2021b	54	Outdoors	NS	NS	3 to 4 days	canoeing, raft building, a mountain hike, high and low ropes courses, mountain biking, and caving.	Group	Preceding phase of 10 x Positive Youth Development life skills workshops and Team-based,

										structured reflections
	Running groups	Dawes et al, 2019	11	Local park	NS	Participant self-selected	1 hour/ session	Running	Group	Running kit, healthy snack
	Gardening groups	Grabbe et al, 2013	8	Vegetable garden in rear parking lot of daytime shelter for women	2 x per week	NS	“staffed sessions” 2 hours, but women could engage in gardening at any time during daylight hours when the shelter was open.	Gardening, including: planting seeds, pulling weeds, watering, harvesting, washing produce,	Group, but possible to undertake as an individual, if desired	Food preparation, health, nutrition, and horticulture education
Group indoor multimodal exercise	Group instructor-led dance	Knestaut et al, 2010	11	Recreation room of homeless shelter	Weekly	Gentle warm up, exercise to elevate heart rate and raise core temperature	50 mins	Instructor-led group dance programme: stretching, cardiovascular exercise and dance genres including: hip hop, country-line dance, ballet, and creative movement/ improvisation	Group	Informal debrief
	Group instructor-led, exercise	Malden et al, 2019	10	Local leisure centre	Weekly	NS	Approx. 1 hour	instructor-led group fitness class: aerobic circuits and strength-based resistance training exercises to music	Group	peer support workshop and lunch

	Sitting/ walking meditation, aerobic-based dance exercise training	Shors et al, 2014	8	NS	2x per week for 8 weeks	NS	1 hour total: 20 mins Sitting meditation, 10 mins walking, 30mins aerobic-based dance exercise training	Sitting meditation, walking, aerobic-based dance exercise training	Group	NS
Individual multimodal intervention	Pedometer with step count goals	Kendzor et al, 2017	15	Shelter for homeless adults	NS	NS	28 day period	Wear pedometer during waking hours and work towards 10,000 daily step goal	Individual	Educational newsletter, fruit/ veg snacks,
	Earn-a-bike programme	Grimes & Smirnova, 2020	16	Partnership between pedestrian and bicycling advocacy organization and local homeless outreach agency	NS	NS	NS	cycle safety training, including training on riding in heavy traffic and bicycle handling skills. Provision of bicycle and safety equipment	Unclear if training delivered in groups. Earning bicycle individual	Rules of the road and bicycle maintenance training

Supplementary File 5: Study populations within studies identified in systematic review

Study	Description of participants	Number of Participants	Characteristics of participants who were homeless, does not include any participants who were staff							
			Age (years)	Educational achievement	Number in employment	Ethnicity/ race	Physical/Mental health/ psychological trauma	Biological Sex		
								F	M	Other
Dawes et al, 2019	Adult women with lived experience of homelessness, who had attended running groups for a minimum of 4 weeks.	11	Range: 23-57 Mean (SD): NS	NS	NS	NS	NS	11	0	
Grabbe et al, 2013	Adult women living in shelters or on the street.	8	Range: 20-59 Mean (SD): NS	4/8 high school or less 4/8 some college or technical school	NS	NS	4/8 ≥ 1 mental illnesses; including bipolar disorder, depression, obsessive-compulsive disorder, and borderline personality disorder	8	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	Range: 30-65 Mean: 46.0 SD: NS	1/16 less than high school 9/16 high school 4/16 some college 2/16 completed college	2/8 ^b	4/8 African American 4/8 White	NS	0	16	
Helge et al, 2014 & Randers et al, 2012	Homeless adult men recruited from shelters and unemployment offices in Copenhagen.	28	Range: NS Football group: Mean (SD): 36.4 (10.0) Control group: Mean (SD): 42.7 (8.5)	NS	NS	NS	NS	0	28	
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	Range: NS Mean (SD): 48.38 (8.12)	12.63 (2.08) ^a	NS	27/32 African American	NS	8	24	

Knestaut et al, 2010	Adult men and women living in a homeless shelter	11	Range: 18-50	NS	NS	Caucasian (<i>n</i> = 9), Latina (<i>n</i> = 1) African American (<i>n</i> = 1)	NS	8	3	
Magee & Jeanes, 2013	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.	6	Range: 16-29 Mean (SD): NS	NS	0/6	NS	NS	0	6	
Malden et al, 2019	Adults experiencing homelessness (living in hostel accommodation or on the streets) and had attended ≤10 Street Fit Scotland sessions.	10	Range: 21-36 Mean (SD): NS	NS	1/10	NS	NS	5	5	
Norton et al, 2020	Adult women who, at the time of study, were living in a shelter for women without housing.	82	Range: 18-63 Mean (SD): 35.8 (11.4)	NS	NS	41/83 Black 16/83 White 18/83 Hispanic 3/83 Other	NS	82	0	
Parry et al, 2021a	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.	30 PEH 6 housing service staff 5 OAE staff	Range: 16-24 Mean (SD): 20 (2.04)	NS	10/30	18/30 ^c White 8/30 ^c Mixed ethnicities 2/30 ^c Black 2/30 ^c Asian 1/30 ^c other	23/30 ^c mental health condition	15	14	1 ^d
Parry et al, 2021b	Young people experiencing or at risk of homelessness who had participated in phase 1 of My Strength Training for life (MST4Life).	54	Range: 16-24 Mean, SD: 19.43 (2.18)	NS	3/54***	33/54 ^c White 11/54 ^c multiple or mixed ethnic groups 2/54 ^c Asian 2/54 ^c Black 2/54 ^c Other	NS	22	31	1 ^d

Randers et al 2010	Homeless men	15	Range: 19-44 Mean, SD: 29 (2)	NS	NS	NS	NS	0	15	
Randers et al, 2018	Adult women participating in the Women's Homeless World Cup.	15	Range: NS Mean, SD: 30.3 ± 5.0	NS	NS	NS	NS	15	0	
Shors et al, 2014	Adult women (mothers) who were recently homeless and >1 month poverty, trauma and addictive behaviour	15	Range: 18-36 Mean (SD): 25.0 (5.0)	NS	NS	NS	NS	15	0	
Sherry, 2010	Men, >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.	8	NS	NS	NS	NS	NS	0	8	
Sherry & Strybosch, 2012	Soccer program participants of the Community Street Soccer Programme; coaches and support workers of the programme.	165 players 11 Coaches 10 (support workers)	Range: 'under 18'-40 Most concentrated cohort 20-24 Mean (SD): NS	NS	NS	NS	66/165 ^c suffering from depression or other mental illness	23 ^c	142 ^c	
Welty Peachey et al, 2013	Participants were players, coaches and administrators from Street Soccer USA Cup (SSUSA) who represented the geographic areas served by SSUSA	11 players 6 staff	Range: 17-54 Mean (SD): NS	NS	NS	4/11 White 4/11 African-American 2/11 Hispanic 1/11 Mixed race	NS	3	8	

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