Usability of exergames as a home-based balance training tool for older adults: protocol for a systematic review

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ABSTRACT
Introduction Exergames are used in the clinical practice of geriatric rehabilitation to increase physical activity levels and motivate players/patients. Their use in the home environment makes it possible to perform fun, engaging and interactive training with a large number of repetitions, thereby reducing the negative repercussions of postural imbalance in older adults. The aim of this systematic review is to collate and analyse evidence on the usability of exergames as a tool for home-based balance training for older adults.

Methods and analysis We will include randomised controlled trials involving healthy older adults (aged 60 years or older) who are described as having impaired static or dynamic balance using any subjective or objective assessment criteria. We will search Web of Science, MEDLINE, Embase, Scopus, ScienceDirect and the Cochrane Library from database inception to December 2022. ClinicalTrials.gov, the WHO International Clinical Trials Registry Platform and ReBEC will be searched for ongoing or unpublished trials. Two independent reviewers will screen the studies and extract the data. The findings will be presented in the text and tables, and if possible, relevant meta-analyses will be performed. The risk of bias and the quality of evidence will be assessed based on the recommendations of the Cochrane Handbook and Grading of Recommendations, Assessment, Development and Evaluation, respectively.

Ethics and dissemination Ethical approval was not required because of the nature of this study. Findings will be disseminated through peer-reviewed publications, conference presentations and through clinical rehabilitation networks.

PROSPERO registration number CRD42022343290.

INTRODUCTION

Ageing is a universal, dynamic, progressive and heterogeneous process characterised by a series of biological, psychological, cognitive and social changes that occur throughout life.1 Postural control is directly influenced by these changes, causing static and dynamic imbalances in older adults and increasing the risk of falls.2 Several non-pharmacological strategies have been proposed to prevent the decline of or improve on the physiological repercussions of ageing on the functionality of older adults to reduce the risk of falling, including the promotion of physical exercise through technological tools such as exergames.

Exergames are used in clinical practice to increase the level of physical activity and motivation of both players and patients.3 As a fun, engaging and interactive form of exercise, exergames help to improve adherence in older adults and help overcome some traditional exercise barriers, such as lack of motivation and negative perception of exercise outcomes.2 Exergames can be used as an attractive and effective home-based training strategy,15 elicit high training adherence, and show acceptably high rates of feasibility and usability in terms of home-based use in older adults.6

Usability is defined in terms of effectiveness (accuracy and completeness), efficiency (resources needed for effectiveness) and satisfaction (comfort and acceptability) in a particular context or environment of use.7 8 Understanding the usability of exergame interventions in home-based environments for older adults and their impact on postural balance is essential for rehabilitation professionals to understand, disseminate and apply this therapeutic tool; analyse the types of exergames and games that can be safely used; understand the dosage, adherence and...
The study protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) — CRD42022343290. Available at: https://www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=343290.

Eligibility criteria
The PICO criteria (Participants, Interventions, Comparison, Outcomes and Study design) will be used to select studies.13

Types of studies
Randomised controlled trials will be included in this study. Studies that compare home-based balance training realised using exergames in older adults with health education interventions, usual care or no intervention will be reviewed. Relevant multiarm studies (those that compare diverse types of exergames with a control group) will also be included. Studies that did not provide detail of the interventions for the experimental and control groups or administered a specific intervention for the experimental or control group in a controlled environment (ie, not home based) will be excluded.

Types of participants
We will include studies on older adults (aged 60 years or older), who are described as having impaired static or dynamic balance using any subjective or objective assessment criteria (eg, Berg Balance Scale, Timed Up and Go, Tinetti scale and force plate centre of pressure). Studies conducted on older adults with associated neurological, orthopaedic, cardiac or rheumatic pathologies (eg, stroke, Parkinson’s disease, Alzheimer’s disease, neuromuscular and demyelinating diseases, neuropathies, osteoporosis, rheumatoid arthritis, lupus, and heart disease) will be excluded. Institutionalised, hospitalised and nursing-home older adults will also be excluded from this study.

Types of interventions
We will include studies that use home-based interventions with exergames, which are serious or commercial games aimed at improving postural balance and mobility in older adults. Studies using any form of non-immersive, semi-immersive or full-immersive exergames will be included. We will consider Nintendo Wii, Xbox and PlayStation as commercial games because they are the most common consoles used in rehabilitation.2 Serious games, including immersive systems, have a purpose beyond entertainment and have been developed to treat impaired conditions related to balance and functional mobility. The home-based environment will be characterised as the home of the older adult, and housing environments such as senior citizens’ clubs, elderly homes or retirement homes, residential care facilities, assisted living communities, and independent living centres will be considered.

Outcomes measures
The primary outcomes will be postural balance and usability. This may include assessments with: (1) postural balance (the Berg Balance Scale, Timed Up and Go, functional reach test, force platform measures, Tinetti test and balance master system) and (2) usability (eg, system usability scale or any kind of questionnaire, scale or relate that describes the level of usability and adherence to exergame therapies). The secondary outcomes will include: (3) safety (self-reported impression), (4) mobility (physical performance battery, functional ambulatory categories, 5-sit to stand, 30-s chair stand Timed Up and Go test), (5) quality of life (questionnaire or self-reported impression), (6) motivation (questionnaire or self-reported impression), (7) falls (self-reported impression) and (8) adverse events (cybersickness, pain, injury and fall).

Search strategy
Studies published from inception to December 2022 will be identified through systematic searches of the following electronic bibliographic databases: Web of Science, MEDLINE (PubMed), Embase (Elsevier), Scopus (Elsevier), ScienceDirect and the Cochrane Central Register of Controlled Trials (CENTRAL). We will also conduct a search on ClinicalTrials.gov (www.clinicaltrials.gov), the WHO International Clinical Trials Registry Platform Search Portal (apps.who.int/trialsearch/) and ReBEC (http://www.ensaiosclinicos.gov.br) for ongoing or...
unpublished trials. The search strategy will be guided by the PRISMA extension for Searches (PRISMA-S). A preliminary search strategy for MEDLINE (PubMed) was adapted for use in the other databases. The details of the search strategies are provided in online supplemental material 1.

We will search all databases from their inception and will not accept articles that are not fully published. Only studies reported in English, Portuguese or Spanish will be included. An expanded search for other resources to identify trials potentially missed through database searches, including ongoing or planned trials and trials from the grey literature, will be performed. We will check the reference lists of all the included studies, texts and any relevant reviews on this topic. We will contact authors and researchers active in this field and use cited reference searches (Web of Science and PubMed) to forward-track important articles.

**Study selection**

Two authors (CSPdM and LBAF) will independently screen titles and abstracts to identify studies for possible inclusion. The studies will be imported, managed and filtered using the RAYYAN online database (RAYYAN Intelligent Systematic Review tool). If the title or abstract does not provide sufficient information for inclusion, the full text will be obtained for a full review, and duplicate studies will be removed. The same two authors will then independently assess the eligibility of the studies based on full texts. Any disagreements will be resolved through discussion or, if necessary, by consulting a third person (JXS). We will document all the reasons for excluding these studies. The results will be recorded in detail using a PRISMA flow diagram (figure 1).

**Data extraction and management**

A data extraction form was developed to collect study characteristics and outcome data through discussions among all authors. Two review authors (CSPdM and DRR) will independently extract (in duplicate) study characteristics and compare the data. We will contact the primary authors of potentially eligible studies to provide data and clarify whether the required data are absent, ambiguous or unsuitably reported. If data remain missing after these efforts, we will assess the impact of introducing bias into our analyses.

The extracted data will be transferred by one reviewer (TBFP) to the Review Manager V.5.4.1 (RevMan), recording the study characteristics:

1. Study information: year, author information, funding or sponsorship information, study type, journal name, study duration, study location, population, intervention, control and outcome (PICO elements).
2. Methods: the study design, study setting, sample, randomisation method, participant recruitment methods, allocation method, inclusion and exclusion criteria, and risk of bias.

![Diagram](https://example.com/diagram.png)

**Figure 1** Preferred Reporting Items for Systematic Reviews and Meta-Analysis template flow diagram for the identification, screening and eligibility of included articles.

3. Participant detail: descriptive characteristics including age, gender, race and comorbidities.
4. Intervention: intervention type, exergame characteristics, immersion level and game information.
5. Outcomes: outcomes specified and collected, primary and secondary outcomes and adverse events.

We will verify that the data were entered correctly by comparing the data presented in the systematic review with those in data extraction form.

**Assessment of risk of bias**

The risk of bias of the included studies will be assessed by two independent researchers (CSPdM and DRR) using version 2 of the Cochrane Risk of Bias tool for randomised trials (RoB 2). Disagreements between the authors will be resolved through discussion or by involving another author (JXS). The risk of bias will be classified as ‘high’ or ‘low’ or be labelled ‘some concerns’ based on random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective outcome reporting, and other bias.

**Quality of evidence**

The quality of evidence will be assessed by two review authors (TBFP and FAdCC) using the Grading of Recommendations, Assessment, Development and Evaluation
(GRADE). The GRADE approach uses five domains (risk of bias, consistency of effect, imprecision, indirectness and publication bias) to assess the certainty of the body of evidence for each outcome. The GRADE specifies four levels of certainty (high, moderate, low and very low).

**Data analysis and synthesis**

We will perform meta-analyses only where this is meaningful; that is, if the interventions, participants and outcomes are sufficiently similar for pooling. When there are acceptable levels of heterogeneity, we will conduct a meta-analysis with the appropriate data using a random effects model in RevMan. The studies will be grouped to compare the following effects:

1. Home-based balance training realised by means of exergames versus no intervention.
2. Home-based balance training realised by means of exergames versus health education intervention.
3. Home-based balance training realised by means of exergames versus usual care.

If a meta-analysis is not appropriate owing to unacceptable heterogeneity, we will present a narrative summary of the study results. A systematic narrative synthesis will be used to present the results of the review in the form of text and tables to summarise and clarify the information from the studies. The data will be presented using descriptive statistics and visual plots. Categorical data will be described using numbers and percentages, and continuous data will be described using measures of central tendency, such as mean and SD for normally distributed data, and median and percentiles (25th and 75th) for non-normally distributed data. Data will be pooled in terms of mean differences or standardised mean differences. The risk of bias assessment will be summarised in a table.

**Assessment of heterogeneity**

Heterogeneity among studies will be determined with the application of the $\chi^2$ test within the forest plot (with a p value of 0.10, indicating statistical significance) and by applying the I² statistic. The Cochrane Handbook for Systematic Reviews of Interventions suggests using the following benchmarks for interpreting I²: (1) unimportant: 0%–40%; (2) moderate: 30%–60%; (3) substantial: 50%–90% and (4) considerable: 75%–100%. We will define the cut-off point for the interpretation of substantial heterogeneity as 50%. If we identify substantial heterogeneity, we will report it and explore the potential causes by using a prespecified subgroup analysis.

**Subgroup analysis**

We plan to carry out subgroup analyses where possible according to age, sex, type of exergame intervention used (eg, commercial or serious games), immersion level (eg, non-immersive, semi-immersive, full-immersive) and intervention characteristics (eg, dose, frequency). We will compare subgroups by using the test for subgroup differences in RevMan.

**Patient and public involvement**

None.

**ETHICS AND DISSEMINATION**

Ethical approval was not required due to the nature of the study. A data management plan will be implemented in cases in which data from specific studies can be accessed directly or obtained from the authors. The retrieved data will be stored in a database with protected access and will only be used by the authors. Our findings will be disseminated through peer-reviewed publications, conference presentations and through clinical rehabilitation networks.

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**Contributors**

CSPdM, TBFP and FAdCC conceptualised the review. CSPdM, DRR, JXS, LBAF, TBFP and FAdCC performed the search. All authors reviewed the search strategy and the retrieved publications. CSPdM prepared the draft of the manuscript text. All authors reviewed the manuscript and approved the final version.

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**Competing interests**

None declared.

**Patient and public involvement**

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication**

Not applicable.

**Provenance and peer review**

Not commissioned; externally peer reviewed.

**Supplemental material**

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