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Technology-Based Group Exercise Interventions for People Living with Dementia: A Scoping Review Protocol

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Manuscripts

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3 **Title: Technology-Based Group Exercise Interventions for People Living with Dementia: A**
4 **Scoping Review Protocol**
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ABSTRACT

Introduction More than 50 million people worldwide are living with dementia in 2020, and this number is expected to double every 20 years. Physical exercise has been a growing field in nonpharmacological interventions for dementia care. Due to public health measures during the COVID-19 pandemic, more people have considered adapting to technology-based exercise via digital devices. This scoping review will explore the evidence relating to the use of technology-based group exercise among people with dementia.

Methods and analysis This review will follow the Joanna Briggs Institute scoping review methodology between June 2021 and December 2021. This review will focus on all people with dementia with the intent to identify what types of technology-based group exercise interventions exist for people with dementia. The review will provide a synthesis of current evidence on the outcome and impacts of technology-based group exercise. The context of this review will include homes, assisted living facilities, and memory care services, and exclude hospitals. The review will include a three-step search strategy: (a) identify keywords from MEDLINE and Embase; (b) search using the identified keywords in databases (MEDLINE/PubMed, CINAHL, Web of Science, Embase, Cochrane Library, and PsychInfo, and Google); and (c) review references from included studies to identify additional studies. Only studies in English will be included. Two researchers will independently assess titles and abstracts and then review the full text of the selected articles, applying the inclusion criteria. The extracted data will be presented in tables and summarized narratively.

Ethics and dissemination Scoping review data will be collected from publicly available articles; research ethics approval is not required. The findings will be disseminated to healthcare practitioners and the public through a peer-reviewed publication and conference presentations.

KEYWORDS: Dementia, telemedicine, world wide web technology, geriatric medicine.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This scoping review will follow the Joanna Briggs Institute Scoping Review Manual to ensure scientific rigour
- Patient and family partners will be involved in conducting the scoping review study
- The review will be limited to literature published in English; publications in other language will not be considered.
- Because the focus of this review is on technology-based group exercise people with dementia living in the community, exercise programs in acute care services will not be captured.

INTRODUCTION

Dementia is a neurodegenerative condition characterized by progressive deterioration of cognitive function, often affecting memory, thinking, judgment, personality, and visuospatial skills, among many other possible deficits[1]. In addition to cognitive impairment, due to its progressive degenerative nature, dementia leads to physical decline in balance, gait, and movement coordination, behavioral and psychological symptoms of dementia (BPSD), and social disability[2,3]. Dementia can be divided based on etiology; Alzheimer's disease (AD) is the most common type of dementia, followed by other types, such as vascular dementia, Lewy body dementia, frontotemporal dementia, and Parkinson's disease[1]. It is a widespread health issue, globally affecting more than 50 million people, with more than 10 million new cases every year[4].

Although the number of people with dementia is increasing worldwide, no curative treatment is currently available and effective palliative treatments are lacking. Antipsychotic medications used to manage BPSD in people with dementia, in particular older adults, can cause adverse events such as oversedation, psychomotor impairment, Parkinsonian symptoms, stroke, or falls, all of which can contribute to admission to the emergency department or long-term care facilities, and increased health care costs[5,6]. Evidence-based, safe, and effective nonpharmacologic treatments are needed to relieve dementia symptoms and/or delay progression of the severity of the disease. Group exercise programs, such as chair yoga, and tai-chi, have shown positive effects in managing dementia symptoms[7-10].

Meta-analyses have shown overall benefits of various types of physical exercise on

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2
3 physical function and BPSD in people with dementia [11]. However, people living with
4 dementia face challenges to participate in exercise groups due to restricted range of motion,
5
6 declined cognition and balance, and risk of falls [2,8,9]. Major barriers to physical exercise in
7
8 this population could include lack of accessible opportunities, transportation to community sites
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10 where exercise classes are offered, and limited support from caregivers [7,12,13]. Compared to
11
12 people without cognitive impairment, people with dementia are more likely to experience social
13
14 isolation and loneliness, which has been linked to increased depression, cardiovascular risk, and
15
16 overall detrimental effects to quality of life[14,15]. Group exercise programs may not only help
17
18 improve mobility and function, they may support social engagement and reduce social isolation
19
20 and loneliness. Given the rapid growth of technology use by older people, technology-based
21
22 group exercise interventions offer opportunities for people living with dementia to participate in
23
24 exercise to manage dementia symptoms, improve social connections, and enhance their quality
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26 of life[16].
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33 In this scoping review study, ‘technology-based exercise intervention’ will refer to any
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35 exercise intervention in which technology is essential to the activity. Exergames, also known as
36
37 interactive exercise-based video games or virtual reality exercise games, have been used as an
38
39 acceptable intervention to increase physical activity in older adults [17,18]. In addition to
40
41 exergames and virtual reality exercise games, recent technological advances have created the
42
43 potential for an online exercise intervention with synchronous monitoring through a secure
44
45 videoconferencing platform (e.g., Zoom, WebEx) on a desktop or laptop computer or tablet
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47 [16,19]. Remotely delivered exercise interventions via video conferencing have been found to be
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49 feasible for improving physical activity in individuals with disabilities [16]. Group-based
50
51 exercise interventions could increase physical activity and improve emotional well-being.
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3 Synchronous online group exercise could develop social connections via the Internet among
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5 people with dementia, who are often isolated from society [16].
6
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8 With technology-based interventions, people with dementia and their caregivers can
9
10 experience socialization without the need to go to a community center [16]. Several systematic
11
12 reviews or meta-analyses have analyzed the effects of exergames (e.g., Swinnen et al., 2020;
13
14 Zhao et al., 2020) or virtual reality (Kim, Pang, & Kim, 2019) in people with major cognitive
15
16 neurocognitive disorder, mild cognitive impairment, or dementia [20–22]. However, a
17
18 preliminary search of MEDLINE, the Cochrane Database of Systematic Reviews and JBI
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20 Evidence Synthesis was conducted as of July 2021, and no current systematic/meta-analysis or
21
22 scoping review has been conducted on the topic of technology-based group interventions that
23
24 included virtual reality, exergame, or other Internet-based intervention (synchronous or
25
26 asynchronous) to support people with dementia. This gap is addressed in this comprehensive
27
28 review of the types of technology-based interventions across dementias and mild cognitive
29
30 impairment and their effects. The format of the scoping review is specifically appropriate to
31
32 mapping out the existing evidence on technology-based group interventions for people with
33
34 dementia [23].
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40 The main objective of the scoping review is to understand and summarize the extent of
41
42 evidence with respect to the existence of technology-based group exercise interventions for
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44 people with dementia and the outcome measures studied reported in the literature.
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46

47 **Review Questions**

48

- 49 1. What technology-based group exercise interventions exist for people with dementia?
 - 50 2. What outcomes and impacts of technology-based group exercise interventions for
51
52 people with dementia have been reported in the literature?
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METHODS

The proposed scoping review will be conducted in accordance with the JBI methodology for scoping reviews. [24]

Inclusion Criteria

Participants

We will include studies that focus on people with all types of dementia and/or all types of cognitive impairment, including mild cognitive impairment, and people of all ages. We will consider studies that involved people living with conditions that are subtypes of dementia, such as Parkinson's disease dementia. Studies that do not focus on any types of dementia will be excluded.

Concept

This review will focus on technology-based group exercise interventions for people with dementia. We will include studies that involved at least one group of people with dementia, and or any form of cognitive impairment including mild cognitive impairment (MCI). A group is defined as any collection of two or more people, including participant and caregiver dyads. Any interventions that are individual in nature and are not delivered in a group format will be excluded. Technology-based exercise includes any form of exercise in which technology is integral to the execution of the activity, such as interventions through video-sharing or online platforms, exergaming, and virtual reality exercises. We will also consider exercise intervention to include any sort of physical activity. Any studies that focus solely on cognitive-based interventions will be excluded. Although MCI is considered to be distinct from dementia, due to the relative difficulty of studying people with higher levels of cognitive impairment, as well as the fact that MCI is often considered a precursor to dementia, studies that focus on technology-

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2
3 based group exercise interventions for people with cognitive impairment will be included in this
4
5 review, as implications learned from MCI focused studies could be relevant for populations with
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7 dementia[25].
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10 Context

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12 We will include studies in which the intervention took place in homes, assisted living facilities,
13
14 memory care facilities, and research facilities. We will not include studies in which interventions
15
16 took place in a hospital facility.
17
18

19 Types of Studies

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21 This scoping review will consider both experimental and quasi-experimental study designs
22
23 including randomized controlled trials, nonrandomized controlled trials, before and after studies
24
25 and interrupted time-series studies. In addition, analytical observational studies including
26
27 prospective and retrospective cohort studies, case-control studies and analytical cross-sectional
28
29 studies will be considered for inclusion. This review will also consider descriptive observational
30
31 study designs including case series and descriptive cross-sectional studies. Qualitative studies
32
33 and systematic reviews that meet the inclusion criteria will also be considered. Text and opinion
34
35 papers will be considered for inclusion. Studies published in English will be included. Studies
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37 will be included with no time limit on publication date.
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42 Search Strategy

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44 The scoping review will follow the three step search strategy as recommended by the JBI
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46 methodology [24].The search strategy is designed to locate both published and unpublished
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48 studies. An initial limited search of MEDLINE and CINAHL Embase will be undertaken to
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50 identify articles on the topic. This preliminary search will use these selected keywords:
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53
54 (Dementia or (Alzheimer disease)) AND ((web-based intervention) OR (exergaming) OR
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(exergame) OR (virtual reality) OR (technology-based intervention) OR telehealth OR telemedicine) AND (Exercise OR (physical activity)). The text words contained in the titles and abstracts of relevant articles and the index terms used to describe the articles will be used to develop a full search strategy for selected databases such as MEDLINE/PubMed, CINAHL, Web of Science, Embase, Cochrane Library, and PsychInfo (Appendix I). The search strategy, including all identified keywords and index terms, will be adapted for each included database. A full search strategy for MEDLINE/PubMed is included in Appendix I. The reference lists of all included sources of evidence will be screened for additional relevant studies. We have worked and will continue to work with a medical librarian to continue to refine the search strategy in order to ensure that relevant and key articles are found.

Information Sources

The databases to be searched include MEDLINE/PubMed, CINAHL, Web of Science, Embase, Cochrane Library, and PsychInfo. Sources of unpublished studies/gray literature to be searched include Google, Web of Science, and Embase.

Study/Source of Evidence Selection

Following the search, all identified citations will be collated and uploaded into Mendeley and duplicates will be removed. Titles and abstracts will then be screened by three researchers for assessment against the inclusion criteria. Potentially relevant sources will be retrieved in full and their citation details imported into the JBI System for the Unified Management, Assessment and Review of Information (JBI SUMARI; JBI, Adelaide, Australia). The full text of selected citations will be assessed in detail against the inclusion criteria by two independent reviewers. Reasons for exclusion of sources of evidence at the full text review that do not meet the inclusion criteria will be recorded and reported in the scoping review. Any disagreements between the

1
2
3 reviewers at each stage of the selection process will be resolved through discussion with
4
5 additional reviewers. The results of the search and the study inclusion process will be reported in
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7 full in the final scoping review and presented in a Preferred Reporting Items for Systematic
8
9 Reviews and Meta-analyses extension for scoping review (PRISMA-ScR) flow diagram[26].
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12 **Data Extraction**

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14 Data will be extracted from papers included in the scoping review by four independent reviewers
15
16 using a data extraction tool developed by the reviewers. The extracted data will include specific
17
18 details about the author(s), year and country of publication, setting, population and sample size,
19
20 research design and methods, intervention type, outcome measures, and impact and results.
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24 A draft charting table is provided (see Appendix II). The data extraction tool will be pilot tested
25
26 by the two independent researchers by extracting data from three papers and comparing results.
27

28
29 The draft data extraction tool will be modified and revised as necessary during the process of
30
31 extracting data from each included evidence source. Modifications will be detailed in the scoping
32
33 review. Any disagreements between the reviewers will be resolved through discussion. If
34
35 appropriate, authors of papers will be contacted to request missing or additional data, where
36
37 required.
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39 **Patient and Public Involvement**

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41 There are several family and patient partners who will join us for meetings in which we will
42
43 discuss the data that have been extracted from the articles. The family partners are people who
44
45 have a family member with dementia and may act as the primary caregiver to the person living
46
47 with dementia, whereas the patient partners are people living with dementia. Prior to discussing
48
49 extracted data in meetings, the patient and family partners may review extracted data and several
50
51 full-text articles; the number of full-text articles will be determined by each individual partner.
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3 However, we anticipate that each person will review one to three articles. Each partner can
4 choose to be a named co-author in the scoping review paper, or remain anonymous. (See
5
6 acknowledgements of this paper for the full names of our patient and family partners who have
7
8 chosen to be identified.) The patient and family partners were recruited from various memory
9
10 disorder clinics.
11
12

13 14 **Ethics and Dissemination**

15
16 For this scoping review, data will be collected from publicly available articles. Thus, neither
17
18 informed consent nor research ethics approval is required. The findings will be disseminated to
19
20 health care practitioners and the public through a peer-reviewed publication and presentations at
21
22 conferences.
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25 26 **Data Analysis and Presentation**

27
28 The extracted data will be presented in a table to summarize the evidence. A narrative summary
29
30 will accompany the charted results and will describe the qualities of the literature on technology-
31
32 based group exercise interventions for people living with dementia. The categories that will be
33
34 used in the presentation of data include year of publication, author(s), country, setting,
35
36 population and sample size, research design and methods, intervention type, outcome measures,
37
38 and impact and results.
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49
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52 Celeste, and Dierdre Lacativa.
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Contributors

LH and JY conceived the idea. All authors helped to refine the research question and develop the protocol and methods. HL drafted the manuscript with support from JY, PR and LH, who made meaningful contributions. LH edited the final manuscript. All authors approved the final manuscript.

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Appendix I: Search Strategy

We have worked with and will continue to work with a medical librarian at the university to alter the search strategy to ensure that relevant articles are found.

We will follow the three-step approach methodology delineated by the Joanna Briggs Institute Scoping Review Guidelines.

Step 1: The preliminary search included two online databases relevant to the topic:

PubMed/MEDLINE and Embase.

Example Preliminary Embase Search:

#	Searches	Results
S1	Dementia or (Alzheimer disease)	193,282
S2	(web-based intervention) OR (exergaming) OR (exergame) OR (virtual reality) OR (technology-based intervention) OR telehealth OR telemedicine	46,382
S3	Exercise OR (physical activity)	509, 456
S4	S1 AND S2 AND S3	38

The initial search will be followed by an analysis of words contained in the titles and abstracts of retrieved papers, as well as index terms used to describe the articles.

Step 2: Using identified keywords and index terms, a second search will be undertaken across all selected databases: MEDLINE/PubMed, CINAHL, Web of Science, Embase, Cochrane Library, and PsychInfo.

Example PubMed Search:

#	Search: 7/9/21	Results
S1	(Dementia) OR (Alzheimer) OR (Cognitive impairment) OR (Neurocognitive disorder)	424,743 results

S2	(Online-based intervention) OR (web-based intervention) OR (internet-based intervention) OR (exergaming or exergame) OR (virtual reality) OR (technology-based intervention) OR telehealth OR (remote delivery) OR telemedicine	79,124 results
S3	Exercise OR (physical activity) OR (exercise intervention) OR (exercise therapy)	633,929 results
S4	S1 AND S2 AND S3	241

2a. Search terms and combinations in step 2:

Dementia terms	Technology terms	Exercise terms
Dementia	Online-based intervention	Exercise
Alzheimer	Web-based intervention	Physical activity
Cognitive impairment	Internet-based intervention	Exercise intervention
Neurocognitive disorder	Exergaming	Exercise therapy
	Exergame	
	Virtual reality	
	Technology-based	
	Telehealth	
	Telemedicine	
	Remote delivery	

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2
3 2b. Google, Web of Science, and Embase will be used to search grey literature. The Google,
4 Web of Science, and Embase searches will be performed using the following terms: (dementia
5
6 OR Alzheimer OR cognitive impairment OR neurocognitive disorder) AND (online OR web OR
7
8 internet OR exergame OR virtual reality OR technology-based OR technology-based OR
9
10 telehealth OR telemedicine OR remote delivery) AND (exercise OR physical activity OR
11
12 exercise intervention OR exercise therapy)
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18 Step 3: The reference lists of all included studies and articles will be searched for additional
19
20 relevant studies. Google Scholar will be used to find published articles and related studies.
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Appendix II: Data Extraction Instrument

Author, Year, Country	Aim	Population, Sample Size, setting	Research Design and Methods	Intervention Type	Outcome Measures	Impact and results

For peer review only

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	P.1 title
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	P.2 Abstract and article summary
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	P.3-5 Introduction
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	P. 5-7 Study objective, population, concepts, and context, review question
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	This article is the protocol for the scoping review
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	P. 7 inclusion criteria
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	P. 8-9 Type of studies, information sources, search strategy Supplementary file 1, a sample of literature search with Boolean operators and truncation
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Supplementary file 1
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	P. 9 Study selection
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any	P.10 Data extraction, supplementary file 2 – data extraction instrument



		processes for obtaining and confirming data from investigators.	
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	P. 11, Data analysis and presentation
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	NA. Quality appraisal will not be performed on studies in this scoping review.
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	To be conducted in the scoping review
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	To be conducted in the scoping review
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	To be conducted in the scoping review
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	N/A
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	To be conducted in the scoping review
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	To be conducted in the scoping review
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	To be conducted in the scoping review
Limitations	20	Discuss the limitations of the scoping review process.	P.3
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	To be conducted in the scoping review
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	P.12

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).



‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* ;169:467–473. doi: 10.7326/M18-0850

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BMJ Open

Technology-Based Group Exercise Interventions for People Living With Dementia or Mild Cognitive Impairment: A Scoping Review Protocol

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Manuscripts

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3 **Title: Technology-Based Group Exercise Interventions for People Living With Dementia or Mild**
4 **Cognitive Impairment: A Scoping Review Protocol**
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41 Declarations of interests: none.
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ABSTRACT

Introduction More than 50 million people worldwide are living with dementia in 2020, and this number is expected to double every 20 years. Physical exercise is a growing field in nonpharmacological interventions for dementia care. Due to public health measures during the COVID-19 pandemic, more people have considered adapting to technology-based exercise via digital devices. This scoping review will explore evidence relating to the use of technology-based group exercise by people with dementia or mild cognitive impairment.

Methods and analysis This review will follow the Joanna Briggs Institute scoping review methodology to review literature published between June and December 2021. This review is designed to identify existing types of technology-based group exercise interventions for people with dementia. The review will provide a synthesis of current evidence on the outcome and impacts of technology-based group exercise. The context of this review will include homes, assisted living facilities, and memory care services but exclude hospitals. The review will include a three-step search strategy: (a) identify keywords from MEDLINE and Embase, (b) search using the identified keywords in databases (MEDLINE/PubMed, CINAHL, Web of Science, Embase, Cochrane Library, and PsychInfo, and Google), and (c) review references from included studies to identify additional studies. Only studies in English will be included. Four researchers will independently assess titles and abstracts and then review the full text of the selected articles, applying the inclusion criteria. The extracted data will be presented in tables and summarized narratively.

Ethics and dissemination Scoping review data will be collected from publicly available articles; research ethics approval is not required. The findings will be disseminated to health care practitioners and the public through a peer-reviewed publication and conference presentations.

KEYWORDS: Dementia, telemedicine, world wide web technology, geriatric medicine.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This scoping review will follow the Joanna Briggs Institute Scoping Review Manual to ensure scientific rigour.
- Patients and family partners will be involved in the scoping review study.
- The review will be limited to literature published in English.
- Because the focus of this review is on technology-based group exercise for people with dementia or mild cognitive impairment living in the community, exercise programs provided by acute care services will not be captured.

INTRODUCTION

Dementia is a neurodegenerative condition characterized by progressive deterioration of cognitive function, often affecting memory, thinking, judgment, personality, and visuospatial skills, among many other possible deficits[1]. In addition to cognitive impairment, due to its progressive degenerative nature, dementia leads to physical decline in balance, gait, and movement coordination, behavioral and psychological symptoms of dementia (BPSD), and social disability[2,3]. Dementia can be categorized based on etiology. Alzheimer's disease (AD) is the most common type of dementia, followed by other types, such as vascular dementia, Lewy body dementia, frontotemporal dementia, and Parkinson's disease. Dementia is a widespread health issue, affecting more than 50 million people globally, with more than 10 million new cases every year[4,5]. Mild cognitive impairment (MCI) is noticeable decline in cognitive function that is not severe enough to require help with daily activities[6,7]. Although considered to be distinct from dementia, MCI is often a precursor to dementia[8]. It has been estimated that 10%-15% of people with MCI progress to AD[9]. Research on MCI can provide knowledge for preventing progression of MCI into dementia[10].

Although the number of people with dementia is increasing worldwide, no curative treatment is currently available and effective palliative treatments are lacking. Antipsychotic medications used to manage BPSD in people with dementia, in particular older adults, can cause adverse events such as oversedation, psychomotor impairment, Parkinsonian symptoms, stroke, or falls, all of which can contribute to admission to the emergency department or long-term care facilities and increased health care costs[11,12]. Evidence-based, safe, and effective nonpharmacologic treatments are needed to relieve dementia symptoms and/or delay progression of the severity of the disease. Group exercise programs, such as chair yoga and tai chi, have shown positive effects in managing dementia symptoms[13–16].

Meta-analyses have shown overall benefits of various types of physical exercise on physical function and BPSD in people with dementia[17–19]. However, people with dementia face challenges to participate in exercise groups due to restricted range of motion, declined cognition and balance, and risk of falls[2,14,15]. Major barriers to physical exercise in this population could include lack of accessible opportunities, transportation to community sites where exercise classes are offered, and limited support from caregivers[13,20,21]. People with dementia are more likely to experience social isolation and loneliness, which have been linked to increased depression, cardiovascular risk, and overall detrimental effects to quality of life[22,23]. Group exercise programs may not only help to improve mobility and function; they may support social engagement and reduce social isolation and loneliness. Given the rapid growth of technology use by older people, technology-based group exercise interventions offer opportunities for people with dementia to participate in exercise to manage dementia symptoms, improve social connections, and enhance their quality of life[24].

In this scoping review study, *technology-based exercise intervention* will refer to any exercise intervention in which technology is essential to the activity. Exergames, also known as interactive exercise-based video games or virtual reality exercise games, have been used as an acceptable intervention to increase physical activity in older adults[25,26]. In addition to exergames and virtual reality exercise games, recent technological advances have created the potential for an online exercise intervention with synchronous monitoring through a secure videoconferencing platform (e.g., Zoom,

WebEx) on a computer or tablet [24,27]. Remotely delivered exercise interventions via video conferencing have been found to be feasible for improving physical activity in persons with disabilities[24]. Group-based exercise interventions could increase physical activity and improve emotional well-being. Synchronous online group exercise could develop social connections via the Internet among people with dementia, who are often isolated from society[24].

With technology-based interventions, people with dementia and their caregivers can experience socialization without the need to go to a community center[24]. Several systematic reviews or meta-analyses have analyzed the effects of exergames[24] or virtual reality [26] in people with major cognitive neurocognitive disorder, mild cognitive impairment, or dementia[28–30]. However, a preliminary search of MEDLINE, the Cochrane Database of Systematic Reviews, and JBI Evidence Synthesis was conducted as of July 2021, and no current systematic review, meta-analysis or scoping review has been conducted on the topic of technology-based group interventions that included virtual reality, exergame, or other Internet-based intervention (synchronous or asynchronous) to support people with dementia. This gap will be addressed in this comprehensive review of the types of technology-based interventions across dementias and MCI and their effects. The format of the scoping review is specifically appropriate to mapping out the existing evidence and identifying gaps in knowledge on the topic of technology-based group interventions for people with dementia or MCI[31].

The main objective of the scoping review will be to understand and summarize the extent of evidence with respect to the existence of technology-based group exercise interventions for people with dementia or MCI and the outcome measures studied and reported in the literature.

Review Questions

1. What technology-based group exercise interventions exist for people with dementia or MCI?
2. What outcomes and impacts of technology-based group exercise interventions for people with dementia or MCI have been reported in the literature?

METHODS

The proposed scoping review will be conducted in accordance with the JBI methodology for scoping reviews[32].

Inclusion Criteria

Participants

We will include studies that focus on people with all types of dementia (e.g., AD, vascular dementia, Lewy body dementia, Parkinson's disease dementia, frontotemporal dementia) or MCI in people of all ages.

Concept

This review will focus on technology-based group exercise interventions for people with dementia. We will include studies that involved at least one group of people with dementia or MCI. A *group* is defined as any collection of two or more people, including participant-caregiver dyads.

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3 *Technology-based exercise* includes any form of exercise in which technology is integral to the execution
4 of the activity, such as interventions through video-sharing or online platforms, exergaming, and virtual
5 reality exercises. We will consider *exercise intervention* to include any sort of physical activity. Any
6 studies that focus solely on cognitive-based interventions will be excluded. Although MCI is considered
7 to be distinct from dementia, due to the relative difficulty of studying people with higher levels of
8 cognitive impairment, as well as the fact that MCI is often considered a precursor to dementia, studies
9 that focus on technology-based group exercise interventions for people with MCI will be included in this
10 review, as implications learned from MCI-focused studies could be relevant for populations with
11 dementia[8].
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14 **Context**

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16 We will include studies in which the intervention took place in homes, assisted living facilities, or
17 memory care facilities. We will not include studies in which interventions took place in a hospital or
18 research facility.
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21 **Types of Studies**

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23 This scoping review will consider both experimental and quasi-experimental study designs,
24 including randomized controlled trials, nonrandomized controlled trials, before-and-after studies and
25 interrupted time-series studies. In addition, analytical observational studies, including prospective and
26 retrospective cohort studies, case-control studies, and analytical cross-sectional studies will be
27 considered for inclusion. This review will also consider descriptive observational study designs, including
28 case series and descriptive cross-sectional studies. Qualitative studies and systematic reviews that meet
29 the inclusion criteria will be considered. Text and opinion papers will be considered. Protocols will not
30 be included. Only studies published in English will be included. There will be no limitation based on
31 publication date.
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34 **Search Strategy**

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36 The scoping review will follow the three-step search strategy recommended by the JBI
37 methodology[32]. The search strategy is designed to locate both published and unpublished studies. An
38 initial limited search of MEDLINE and CINAHL Embase will be undertaken to identify articles on the topic.
39 This preliminary search will use these selected keywords: (Dementia or (Alzheimer disease)) AND ((web-
40 based intervention) OR (exergaming) OR (exergame) OR (virtual reality) OR (technology-based
41 intervention) OR telehealth OR telemedicine) AND (Exercise OR (physical activity)). The text words
42 contained in the titles and abstracts of relevant articles and the index terms used to describe the articles
43 will be used to develop a full search strategy for selected databases such as MEDLINE/PubMed, CINAHL,
44 Web of Science, Embase, Cochrane Library, and PsychInfo (Appendix I). The search strategy, including all
45 identified keywords and index terms, will be adapted for each included database. A full search strategy
46 for MEDLINE/PubMed is included in Appendix I. The reference lists of all included sources of evidence
47 will be screened for additional relevant studies. We have worked and will continue to work with a
48 medical librarian to refine the search strategy in order to ensure that relevant and key articles are
49 found.
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Information Sources

The databases to be searched will be MEDLINE/PubMed, CINAHL, Web of Science, Embase, Cochrane Library, and PsychInfo. Sources of unpublished studies/gray literature to be searched will be Google, Web of Science, and Embase.

Study/Source of Evidence Selection

Following the search, all identified citations will be collated and uploaded into Mendeley and duplicates will be removed. Titles and abstracts will then be screened by four researchers for assessment against the inclusion criteria. Potentially relevant sources will be retrieved in full and their citation details imported into the JBI System for the Unified Management, Assessment and Review of Information (JBI SUMARI; JBI, Adelaide, Australia). The full text of selected citations will be assessed in detail against the inclusion criteria by two independent reviewers. Reasons for exclusion of sources of evidence at the full text review that do not meet the inclusion criteria will be recorded and reported in the scoping review. Any disagreements between the reviewers at each stage of the selection process will be resolved through discussion with additional reviewers. The results of the search and the study inclusion process will be reported in full in the final scoping review and presented in a Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping review (PRISMA-ScR) flow diagram[33].

Data Extraction

Data will be extracted from papers included in the scoping review by four independent reviewers using a data extraction tool developed by the reviewers. The extracted data will include specific details about the author(s), year and country of publication, setting, population and sample size, research design and methods, intervention type, outcome measures, and impact and results.

A draft charting table is provided (Appendix II). The data extraction tool will be pilot tested by the two independent researchers by extracting data from three papers and comparing results. The draft data extraction tool will be modified and revised as necessary during the process of extracting data from each included evidence source. Modifications will be detailed in the scoping review. Any disagreements between the reviewers will be resolved through discussion. If appropriate, authors of papers will be contacted to request missing or additional data, where required.

Patient and Public Involvement

Several family and patient partners will join us for meetings in which we will discuss the data that have been extracted from the articles. The *family partners* are people who have a family member with dementia and may act as the primary caregiver to the person with dementia, whereas the *patient partners* are people with dementia. Prior to discussing extracted data in meetings, the patient and family partners may review extracted data and several full-text articles; the number of full-text articles will be determined by each individual partner. We anticipate that each person will review one to three articles. Each partner can choose to be a named co-author in the scoping review paper or remain anonymous. (See acknowledgements of this paper for the full names of patient and family partners who

1
2
3 have chosen to be identified.) The patient and family partners were recruited from various memory
4 disorder clinics.
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6 **Ethics and Dissemination**

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8 For this scoping review, data will be collected from publicly available articles. Thus, neither
9 informed consent nor research ethics approval is required. The findings will be disseminated to health
10 care practitioners and the public through a peer-reviewed publication and presentations at conferences.
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12 **Data Analysis and Presentation**

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14 The extracted data will be presented in a table to summarize the evidence. A narrative summary
15 will accompany the charted results and will describe the qualities of the literature on technology-based
16 group exercise interventions for people with dementia. The categories that will be used in the
17 presentation of data are year of publication, author(s), country, setting, population and sample size,
18 research design and methods, intervention type, outcome measures, and impact and results.
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22
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26 Vincent Celeste, and David Call; family partners are Nate Riley, Diane Celeste, and Dierdre Lacativa.
27

28 **Contributors**

29
30 LH and JY conceived the idea. All authors helped to refine the research question and develop the
31 protocol and methods. HL drafted the manuscript with support from JY, PR, and LH, who made
32 meaningful contributions. LH edited the final manuscript. All authors approved the final manuscript.
33

34
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37
38 **Competing interests** None declared.

39
40 **Patient consent for publication** Not required.

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42 **Provenance and peer review** Not commissioned, externally peer reviewed.

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46 build on this work noncommercially, and license their derivative works on different terms, provided the
47 original work is properly cited, appropriate credit is given, any changes made indicated, and the use is
48 noncommercial. See <http://creativecommons.org/licenses/by-nc/4.0/>.
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Appendix I: Search Strategy

We have worked with and will continue to work with a medical librarian at the university to alter the search strategy to ensure that relevant articles are found.

We will follow the three-step approach methodology delineated by the Joanna Briggs Institute Scoping Review Guidelines.

Step 1: The preliminary search included two online databases relevant to the topic:

PubMed/MEDLINE and Embase.

Example Preliminary Embase Search:

#	Searches	Results
S1	Dementia or (Alzheimer disease)	193,282
S2	(web-based intervention) OR (exergaming) OR (exergame) OR (virtual reality) OR (technology-based intervention) OR telehealth OR telemedicine	46,382
S3	Exercise OR (physical activity)	509, 456
S4	S1 AND S2 AND S3	38

The initial search will be followed by an analysis of words contained in the titles and abstracts of retrieved papers, as well as index terms used to describe the articles.

Step 2: Using identified keywords and index terms, a second search will be undertaken across all selected databases: MEDLINE/PubMed, CINAHL, Web of Science, Embase, Cochrane Library, and PsychInfo.

Example PubMed Search:

#	Search: 7/9/21	Results
S1	(Dementia) OR (Alzheimer) OR (Cognitive impairment) OR (Neurocognitive disorder)	424,743 results

S2	(Online-based intervention) OR (web-based intervention) OR (internet-based intervention) OR (exergaming or exergame) OR (virtual reality) OR (technology-based intervention) OR telehealth OR (remote delivery) OR telemedicine	79,124 results
S3	Exercise OR (physical activity) OR (exercise intervention) OR (exercise therapy)	633,929 results
S4	S1 AND S2 AND S3	241

2a. Search terms and combinations in step 2:

Dementia terms	Technology terms	Exercise terms
Dementia	Online-based intervention	Exercise
Alzheimer	Web-based intervention	Physical activity
Cognitive impairment	Internet-based intervention	Exercise intervention
Neurocognitive disorder	Exergaming	Exercise therapy
	Exergame	
	Virtual reality	
	Technology-based	
	Telehealth	
	Telemedicine	
	Remote delivery	

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3 2b. Google, Web of Science, and Embase will be used to search grey literature. The Google,
4 Web of Science, and Embase searches will be performed using the following terms: (dementia
5 OR Alzheimer OR cognitive impairment OR neurocognitive disorder) AND (online OR web OR
6 internet OR exergame OR virtual reality OR technology-based OR technology-based OR
7 telehealth OR telemedicine OR remote delivery) AND (exercise OR physical activity OR
8 exercise intervention OR exercise therapy)
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12 Step 3: The reference lists of all included studies and articles will be searched for additional
13 relevant studies. Google Scholar will be used to find published articles and related studies.
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Appendix II: Data Extraction Instrument

Author, Year, Country	Aim	Population, Sample Size, setting	Research Design and Methods	Intervention Type	Outcome Measures	Impact and results

For peer review only

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	P.1 title
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	P.2 Abstract and article summary
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	P.3-5 Introduction
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	P. 5-7 Study objective, population, concepts, and context, review question
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	This article is the protocol for the scoping review
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	P. 7 inclusion criteria
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	P. 8-9 Type of studies, information sources, search strategy Supplementary file 1, a sample of literature search with Boolean operators and truncation
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Supplementary file 1
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	P. 9 Study selection
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any	P.10 Data extraction, supplementary file 2 – data extraction instrument



		processes for obtaining and confirming data from investigators.	
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	P. 11, Data analysis and presentation
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	NA. Quality appraisal will not be performed on studies in this scoping review.
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	To be conducted in the scoping review
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	To be conducted in the scoping review
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	To be conducted in the scoping review
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	N/A
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	To be conducted in the scoping review
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	To be conducted in the scoping review
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	To be conducted in the scoping review
Limitations	20	Discuss the limitations of the scoping review process.	P.3
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	To be conducted in the scoping review
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	P.12

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).



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3 ‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the
4 process of data extraction in a scoping review as data charting.
5 § The process of systematically examining research evidence to assess its validity, results, and relevance before
6 using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable
7 to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used
8 in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).
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11 *From:* Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-
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