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Facilitators and barriers to using virtual reality and augmented reality in aged care settings: A scoping review protocol

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ABSTRACT

Objective The objective of this scoping review is to provide an overview of current literature and studies on the facilitators and barriers of virtual reality (VR) and augmented reality (AR) among older adults in aged care settings.

Introduction Increasingly more studies are being conducted on the use of VR and AR in aged care settings. These technologies have the potential to increase wellbeing and quality of life, as well as decreasing loneliness and social isolation which is especially important during the COVID-19 pandemic. With the growing interest in using VR/AR in care settings among older adults, a comprehensive review of studies examining the factors and barriers of adopting VR/AR in these settings is needed. This scoping review will focus on best practices related to VR/AR in care settings among older adults.

Methods and analysis We will follow the Joanna Briggs Institute scoping review methodology. We will search the following databases: CINHAL, MEDLINE, PubMed, and PsycInfo. Additional articles will be handpicked from reference lists. Inclusion criteria includes articles that focuses on older adults using VR or AR in aged care settings. Our team (which includes patient and family partners, an academic nurse researcher, a clinical lead, and trainees) will be involved in the search, review, and analysis process.

Ethics and dissemination We will be collecting data from publicly available articles for this scoping review, so ethics approval is not required. By providing a comprehensive overview of the current evidence on the strategies, facilitators, and barriers of using VR/AR in aged care settings, findings will offer insights and recommendations for future research and practice to better implement VR/AR. The results of this scoping review will be shared through conference presentations and an open-access publication in a peer-reviewed journal.

Strengths and limitations

- A patient partner was involved in the preparation of this scoping review protocol, maximizing the clinical relevancy of this protocol. Patient and family partners will also be involved in conducting the full review.
- The review findings will provide insights and recommendations in adopting VR/AR technology in aged care settings which will be useful for future research and practice.
- This review will be timely because VR/AR have the potential to decrease loneliness and social isolation in care settings during the COVID-19 pandemic.
- Review will only include literature that was published in English.
- Strategies for implementing VR/AR outside of care settings will not be captured.

INTRODUCTION

Social isolation and loneliness

Social connection is a basic and essential human need, but the COVID-19 pandemic has brought about much social isolation and loneliness among residents living in care settings such as long-term care (LTC)[1]. Even prior to the pandemic, social isolation is a serious concern among these residents[2]. While there are many definitions of social isolation, it is generally referred to as a lack of social contacts and relationships[3] Loneliness is related to social isolation and is defined as a subjective feeling due to a lack of quantity and/or quality of ones' social network or relationships[4]. Both loneliness and social isolation can lead to many mental health issues, including depression and suicide[5], as well as an increase in certain types of health and social care utilisations[6]. Confinement and restrictions on visitations during the COVID-19 pandemic have increased residents' feelings of anxiety, isolation, and loneliness, creating new or exacerbating pre-existing physical and mental health concerns (e.g., depression, loneliness, cognitive decline, frailty, mobility issues)[7]. Therefore, it is more important than ever to develop and implement new ways to overcome loneliness and improve the wellbeing among residents in these care settings.

AR and VR Technology to decrease loneliness

Virtual reality (VR) and augmented reality (AR) technology has shown promise in enhancing residents' wellbeing and decreasing loneliness. Virtual reality has existed since the 1980s in various forms, but due to the advent of recent technologies (e.g., Microsoft HoloLens; Occulus Quest), the immersive VR/AR environment is now both portable and consumer-friendly, leading to different uses in care settings among residents. VR uses computer-simulated graphics in real time to allow users to experience an immersive digital environment, while AR is an enhanced version of the real physical world using computer graphics in real time[8]. A Canadian feasibility study found that it is safe and feasible for older adults with varying levels of cognitive and physical impairments to be exposed to VR, with reports of positive feedback and increased relaxation after usage[9]. Another VR program (Virtual Reality Forest) was found to improve pleasure and alertness among residents with dementia in an Australian care home[10]. In addition, AR has also been used to improve balance in older adults[11]. Finally, engaging in shared experiences through VR technology can decrease loneliness, social isolation, and depression among long-term care residents[12], which is especially important during the current COVID-19 pandemic. Overall, the use of VR/AR may be useful to meet psychosocial needs, increase pleasure, improve mental health and wellbeing of people living in care settings[10,13], and offers a possible way for residents in care settings to safely engage with others, incurring physical and mental health benefits.

Study objective

As discussed above, there is growing interest in using VR and AR among care settings; therefore, a comprehensive review that provides evidence on how best to adopt VR/AR across

settings is needed. Current research focuses on enhancing innovative designs and usability, and there is a lack of research probing into the preferences and requirements of older adults using VR/AR[14]. This research gap is noteworthy because understanding the facilitators and barriers (e.g., user needs and resources) is essential to ensure the readiness of adopting new interventions across multiple settings[15]. This scoping review is designed to review the facilitators and barriers of implementing VR/AR in care settings.

A preliminary search found a few reviews related to VR/AR and older adults, but none with the purpose on collating the facilitators and barriers of using VR/AR in care settings. For example, Appel et al.[16] conducted a scoping review on the current state of research using VR for people with dementia. Our review will be specific to care settings as we would like to know the facilitators and barriers of adopting VR/AR technology in these settings, which are different from home settings. We will also be more comprehensive in our review by including all older adults residing in care settings, since VR/AR can benefit people without dementia as well. Furthermore, Dermody et al.[17] conducted a systematic review on the role of VR among community-dwelling older adults. Their aim was to evaluate the effectiveness of VR. Finally, Carroll et al.[8] completed a scoping review to explore how VR/AR technology is being used with older adults and to examine whether consistent terminology of VR and AR is being used across studies. The purpose of our review differs from that of the above reviews in that we aim to determine the best practices of adopting VR/AR in care settings, and to identify barriers and facilitators. In our next study, we will be conducting an evaluation study where we will implement VR/AR technology to explore user experiences. The results of this scoping review will help inform strategies to implement VR/AR most effectively, as well as elucidate more specific research questions for future research.

Review questions

1. What are the facilitators and barriers to adopting group VR/AR in care settings for older adults?
2. What are the benefits and negative impacts of VR/AR for everyone involved (residents, families, staff members)?

METHODS

Our scoping review will be conducted using the Joanna Briggs Institute methodology[18]. A scoping review is useful for: identifying the conceptual boundaries of a topic, examining emerging evidence, and providing a broad overview of a topic; therefore, a scoping review is appropriate for the above review questions.

Inclusion criteria

This review will include articles that focus on the use of VR and/or AR in care settings (e.g., long-term care, assisted living, etc.) among older adults. See **online supplemental file 1** for more details on inclusion and exclusion criteria of articles.

A preliminary search by the first author (FTM) was conducted in collaboration with a university librarian from the University of British Columbia. The search was conducted in CINAHL. Keywords, Medical Subject Headings, index terms, titles, and abstracts were analyzed to identify search terms and keywords appropriate for the purposes of this scoping review. See **online supplemental file 2** for CINAHL search strategy.

In our full review, we will use the terms: ("older adult*" or geriatric* or elder* or aging or aged or senior* or "older people*") AND ("virtual realit*" or "augmented realit*") AND ("residential facilit*" or "nursing home*" or "long term care" or "long-term care" or "homes of the aged"). We will use those search terms in the following databases: CINHAL, MEDLINE, PubMed, and PsycInfo. We will search grey literature in Google Scholar.

A wide range of studies (e.g., randomized trials, descriptive studies) will be included, as well as user experience reports. Reference lists will be checked for any additional articles that meet our inclusion articles. No restrictions were set regarding the publication date. We will continue to work with a librarian in our full review to refine the search strategy and ensure that all key articles will be captured.

Study selection

We will use the reference management tool, Mendeley, to organize all references and articles selected for our review. Identified articles will be uploaded onto Mendeley, and duplicates will be removed. Two review team members will first screen articles' title and abstract for relevancy according to our eligibility criteria. All disputes will be resolved through a discussion with a third team member until consensus is reached. The full text of these articles will then be read by at least two researchers to confirm inclusion; reasons for exclusion will be recorded.

Data extraction

See **online supplemental file 3** for our data extraction instrument. Extracted data will include specific details about the article, facilitators and barriers to VR/AR technology, and other information relevant to our review objectives. Additional categories relevant to answering the review questions may be added as we review the articles. Extracted data will be conducted by two researchers, and any disagreement between the reviewers will be resolved through a discussion with an independent third reviewer.

Data synthesis

We will present the extracted data and results in a table, with the purpose of mapping the existing literature on the facilitators and barriers of VR and AR technology. A narrative summary will be used to accompany the tabled results, with themes to organize the results. We expect that both qualitative and quantitative data will be presented in our full review. We will use the PRISMA-ScR reporting guidelines to structure our full review.

Patient and public involvement

A patient partner (JM) was involved with preparing this scoping review protocol, including refining the research priorities and review questions. Involvement of a patient partner maximizes relevancy of this work to clinical care. Additional patient and family partners will continue to work with the review team to complete the scoping review. In particular, they will be actively engaged in the reading of the included articles and extracting of data, as well as being involved with data synthesis and analysis.

Ethics and dissemination

Research ethics approval is not required for scoping reviews since we extracted data from publicly available articles. This scoping review will be submitted for publication in an open-access journal, and results will be presented at conferences. We will also disseminate a 1-page infographic of our review findings to make findings accessible to a wide audience. For example, we will share findings through staff huddles and meetings with local care homes. Overall, we anticipate that the findings will be useful in providing evidence-based guidance to implement VR/AR in future practice and research.

Authors' contributions

FTM developed the research protocol and methods; she also drafted and edited the entire manuscript.

JM helped to refine the research questions and study methods and made important contributions to the editing of the manuscript.

LH is the primary investigator and contributed to the revising of the manuscript.

Funding statement

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Competing interests

None declared.

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Supplemental file 1: Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Articles that include users who are aged 65 or older	Articles with a focus on users who are less than 65 years old
Articles focused on virtual reality and/or augmented reality technology	Articles that are not focused on virtual reality and/or augmented reality technology
Articles with a focus on a healthcare setting with formal care provided by paid staff	Articles that focus on settings without formal care (e.g., home care)
Peer reviewed journal articles, full reports, case studies, user reports; grey literature	Only abstracts available
Publications in English	Non-English publications

Supplemental file 2: Preliminary search (CINAHL)

S1	(MH "Aged+") OR (MH "Geriatrics")
S2	TI ("older adult*" or elder* or geriatric* or aging or aged or senior* or "older people*") OR AB ("older adult*" or elder* or geriatric* or aging or aged or senior* or "older people*")
S3	S1 OR S2
S4	(MH "Residential Facilities+")
S5	TI ("residential facilit*" or "nursing home*" or "long term care" or "long-term care" or "homes of the aged") OR AB ("residential facilit*" or "nursing home*" or "long term care" or "long-term care" or "homes of the aged")
S6	S4 OR S5
S7	(MH "Virtual Reality+") OR (MH "Augmented Reality")
S8	TI ("virtual realit*" or "augmented realit*") OR AB ("virtual realit*" or "augmented realit*")
S9	S7 OR S8
S10	S3 AND S6 AND S9

Supplemental file 3: Data extraction instrument

Author, year	Country of study	Publication and study type	Study duration	Population/ Participants	Type of care setting	VR or AR program description	Facilitators	Barriers	Benefits	Negative impacts

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ABSTRACT

Objective The objective of this scoping review is to provide an overview of current literature on the facilitators and barriers of virtual reality (VR) and augmented reality (AR) among older adults in aged care settings, and the social implications of engaging in this technology.

Introduction Increasingly more studies are being conducted on the use of VR and AR in aged care settings. These technologies have the potential to decrease experiences of loneliness which is especially important during the COVID-19 pandemic. With the growing interest in using VR/AR in care settings among older adults, a comprehensive review of studies examining the facilitators and barriers of adopting VR/AR in these settings is needed. This scoping review will focus on facilitators and barriers related to VR/AR in care settings among older adults, as well as mapping the literature related to VR/AR and loneliness.

Methods and analysis We will follow the Joanna Briggs Institute scoping review methodology. We will search the following databases: CINHAL, Embase, Medline, PsycInfo, Scopus, and Web of Science. Additional articles will be handpicked from reference lists. Inclusion criteria includes articles that focuses on older adults using VR or AR in aged care settings. Our team (which includes patient and family partners, an academic nurse researcher, a clinical lead, and trainees) will be involved in the search, review, and analysis process.

Ethics and dissemination We will be collecting data from publicly available articles for this scoping review, so ethics approval is not required. By providing a comprehensive overview of the current evidence on the strategies, facilitators, and barriers of using VR/AR in aged care settings, findings will offer insights and recommendations for future research and practice to better implement VR/AR. The results of this scoping review will be shared through conference presentations and an open-access publication in a peer-reviewed journal.

Strengths and limitations

- This scoping review will examine the barriers and facilitators of adopting VR/AR in aged care settings, as well as map the literature on the potential benefits of VR/AR on decreasing loneliness.
- A patient partner was involved in the preparation of this scoping review protocol, maximizing the clinical relevancy of this protocol.
- This scoping review will follow the Joanna Briggs Institute methodological framework.
- Review will only include literature that was published in English, and only hand-picked grey literature will be included.
- Strategies for implementing VR/AR outside of care settings will not be captured.

INTRODUCTION

Social isolation and loneliness

Social connection is a basic and essential human need, but the COVID-19 pandemic has brought about much social isolation and loneliness among residents living in care settings such as long-term care (LTC)[1]. Even prior to the pandemic, social isolation is a serious concern among residents[2]. While there are many definitions of social isolation, it is generally referred to as a lack of social contacts and relationships[3] Loneliness is related to social isolation and is defined as a subjective feeling due to a lack of quantity and/or quality of ones' social network or relationships[4]. Both loneliness and social isolation can lead to many mental health issues, including depression and suicide[5], as well as an increase in certain types of health and social care utilisations[6]. Confinement and restrictions on visitations during the COVID-19 pandemic have increased residents' feelings of anxiety, isolation, and loneliness, creating new or exacerbating pre-existing physical and mental health concerns (e.g., depression, loneliness, cognitive decline, frailty, mobility issues)[7]. Therefore, it is more important than ever to develop and implement new ways to overcome loneliness and improve the wellbeing among residents in these care settings.

AR and VR Technology to decrease loneliness

Technology such as virtual reality (VR) and augmented reality (AR) has shown promise in enhancing residents' wellbeing and decreasing loneliness[8]. Virtual reality has existed since the 1980s in various forms, but due to the advent of recent technologies (e.g., Microsoft HoloLens; Oculus Quest), the immersive VR/AR environment is now both portable and consumer-friendly, leading to different uses in care settings among residents. VR uses computer-simulated graphics in real time to allow users to experience an immersive digital environment, while AR is an enhanced version of the real physical world using computer graphics in real time[9]. Users of VR and AR may wear hardware such as headsets, hand controllers, and/or wearable haptic devices, with the program being controlled by an external smartphone or computer. The primary benefit of VR/AR over other technologies (e.g., a flat screen TV, tablets) is the subjective experience of immersiveness, or "being there"[10].

A Canadian feasibility study found that it is safe and feasible for older adults with varying levels of cognitive and physical impairments to be exposed to VR, with reports of positive feedback and increased relaxation after usage[11]. Another VR program (Virtual Reality Forest) was found to improve pleasure and alertness among residents with dementia in an Australian care home[12]. In addition, AR has also been used to improve balance in older adults[13]. Finally, engaging in shared experiences through VR technology can decrease loneliness, social isolation, and depression among long-term care residents[14], which is especially important during the current COVID-19 pandemic. Overall, the use of VR/AR may be useful to meet psychosocial needs, increase pleasure, improve mental health and wellbeing of people living in care settings[12,15], and offers a possible way for residents in care settings to safely engage with others, incurring physical and mental health benefits.

Study objective

As outlined above, there is growing interest in using VR and AR among care settings especially to promote social engagement and decrease loneliness; therefore, a comprehensive review that provides evidence on how best to adopt VR/AR across settings is needed. Current research focuses on enhancing innovative designs and usability, and there is a lack of research probing into the preferences and requirements of older adults using VR/AR[16] and how this technology may decrease loneliness. This research gap is noteworthy because understanding the facilitators and barriers (e.g., user needs and resources) is essential to ensure the readiness of adopting new interventions across multiple settings[17]. This scoping review is designed to review the facilitators and barriers of implementing VR/AR in care settings, and the social implications of using VR/AR.

A preliminary search found a few reviews related to VR/AR and older adults, but none with the purpose on collating the facilitators and barriers of using VR/AR in care settings. For example, Appel et al.[18] conducted a scoping review on the current state of research using VR for people with dementia. Another systematic review identified studies exploring the use of VR in older adults[19]. Our review will be specific to care settings as we would like to know the facilitators and barriers of adopting VR/AR technology in these settings, which are different from home settings. We will also be more comprehensive in our review by including all older adults residing in care settings, since VR/AR can benefit people without dementia as well. Furthermore, Dermody et al.[20] conducted a systematic review on the role of VR among community-dwelling older adults. Their aim was to evaluate the effectiveness of VR. Finally, Carroll et al.[9] completed a scoping review to explore how VR/AR technology is being used with older adults and to examine whether consistent terminology of VR and AR is being used across studies. The purpose of our review differs from that of the above reviews in that we aim to determine the factors related to adopting VR/AR in care settings, and to identify barriers and facilitators. Additionally, we would like to explore the social implications of engaging in VR/AR in these settings. In our next study, we will be conducting an evaluation study to explore long-term care resident experiences of using VR/AR technology. As part of our efforts to implement VR/AR most effectively for our study, conducting this scoping review will inform strategies for adopting VR/AR in aged care settings, which remains a gap in previous reviews. Our scoping review will also elucidate more specific research questions for future research.

Review questions

1. What are the facilitators and barriers in adopting group VR/AR in care settings for older adults?
2. What is the current evidence on the impact of VR/AR on loneliness?

METHODS

Our scoping review will be conducted using the Joanna Briggs Institute methodology[21]. A scoping review is useful for: identifying the conceptual boundaries of a topic, examining

emerging evidence, and providing a broad overview of a topic[22,23]; therefore, a scoping review is appropriate for the above review questions. Our review will be conducted between March and June 2022.

Inclusion criteria

See **online supplemental file 1** for details on inclusion and exclusion criteria of articles.

Types of participants

This review will consider studies that include older adults aged 65 or older who are living in care settings. Articles that include residents along with care home staff and/or family will also be included.

Concepts

We will include studies that focus on the use of VR and/or AR. These systems need to produce an immersive experience for the users (e.g., creating a life-like environment through a head-mounted device and could be manipulated by the user).

Context

In terms of context, we will include studies that are situated in aged care settings such as (but not limited to) long-term care and assisted living settings.

Types of evidence sources

A wide range of studies (e.g., randomized trials, descriptive studies) will be included, as well as user experience reports.

Search strategy

We follow JBI's three-step search strategy:

1) Initial search

A preliminary search by the first author (FTM) was conducted in collaboration with a university librarian from the University of British Columbia. The search was conducted in CINAHL. Keywords, Medical Subject Headings, index terms, titles, and abstracts were analyzed to identify search terms and keywords appropriate for the purposes of this scoping review. See **online supplemental file 2** for our CINAHL search strategy.

2) Full search

In our full review, we will use the terms: ("older adult*" or geriatric* or elder* or aging or aged or senior* or "older people*") AND ("virtual realit*" or "augmented realit*") AND ("residential facilit*" or "nursing home*" or "long term care" or "long-term care" or "homes of the aged"). We will use those search terms in the following databases: CINHAL, Embase, Medline, PsycInfo,

Scopus, and Web of Science. Google will be searched for gray literature (e.g., student theses and dissertations from universities, and other articles that are not indexed in library databases) using phrases such as “virtual reality in aged care settings” OR “virtual reality in long-term care” OR “augmented reality in aged care settings” OR “augmented reality in long-term care”. No restrictions were set regarding the publication date. We will continue to work with a librarian in our full review to refine the search strategy and ensure that all key articles will be captured.

3) Reference list search

Reference lists will be checked for any additional articles that meet our inclusion articles.

Evidence selection

We will use the reference management tool, Mendeley, to organize all references and articles selected for our review. Identified articles will be uploaded onto Mendeley, and duplicates will be removed.

We will engage in pilot testing of the above search strategy, using the following steps:

1) A random sample of 5 titles/abstracts will be selected
2) The review team will screen these articles using the eligibility criteria
3) Team members will meet to discuss any discrepancies, adjusting the eligibility criteria and/or search strategy accordingly
4) The review team will start screening the remaining articles after at least 80% agreement is achieved

After pilot testing, two review team members will first screen the remaining articles’ titles and abstracts for relevancy according to our eligibility criteria. All disputes will be resolved through a discussion with a third team member until consensus is reached. The full text of these articles will then be read by at least two researchers to confirm inclusion; reasons for exclusion will be recorded.

Data extraction

See **online supplemental file 3** for our data extraction instrument. Extracted data will include specific details about the article, facilitators and barriers to VR/AR technology, and the impact of VR/AR on loneliness. Additional categories relevant to answering the review questions may be added as we review the articles. Extracted data will be conducted by two researchers, and any disagreement between the reviewers will be resolved through a discussion with an independent third reviewer.

Analysis of the evidence

We will present the extracted data and results in a table, with the purpose of mapping the existing literature on the facilitators and barriers of VR and AR technology, and the implications on loneliness.

Presentation of the results

A narrative summary will be used to accompany the tabled results, with themes to organize the results. We expect that both qualitative and quantitative data will be presented in our full review. We will use the PRISMA-ScR reporting guidelines[24] to structure our full review.

Patient and public involvement

A patient partner (JM) was involved with preparing this scoping review protocol, including refining the research priorities and review questions. Involvement of a patient partner maximizes relevancy of this work to clinical care. Additional patient and family partners will continue to work with the review team to complete the scoping review. In particular, they will be actively engaged in the reading of the included articles and extracting of data, as well as being involved with data synthesis and analysis.

Ethics and dissemination

Research ethics approval is not required for scoping reviews since we extracted data from publicly available articles. This scoping review will be submitted for publication in an open-access journal, and results will be presented at conferences. We will also disseminate a 1-page infographic of our review findings to make findings accessible to a wide audience. For example, we will share findings through staff huddles and meetings with local care homes. Overall, we anticipate that the findings will be useful in providing evidence-based guidance to implement VR/AR in future practice and research.

Authors' contributions

FTM developed the research protocol and methods; she also drafted and edited the entire manuscript.

JM helped to refine the research questions and study methods and made important contributions to the editing of the manuscript.

LH is the primary investigator and contributed to the revising of the manuscript.

Funding statement

This research is supported by Mitacs and VGH Foundation, grant number n/a.

Competing interests

None declared.

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Supplemental file 1: Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Articles that include users who are aged 65 or older	Articles with a focus on users who are less than 65 years old
Articles focused on immersive virtual reality and/or augmented reality technology	Articles that are not focused on virtual reality and/or augmented reality technology; non-immersive types of virtual reality and/or augmented reality will not be considered.
Articles with a focus on a healthcare setting with formal care provided by paid staff	Articles that focus on settings without formal care (e.g., home care)
Articles address at least one of the following areas of adopting virtual reality and/or augmented reality: barriers, facilitators, social implications (loneliness)	Articles that do not focus on any of the barriers, facilitators, or social implications (loneliness) of adopting virtual reality and/or augmented reality
Peer reviewed journal articles, full reports, case studies, user reports; grey literature	Only abstracts available
Publications in English	Non-English publications

Supplemental file 2: Preliminary search (CINAHL)

S1	(MH "Aged+") OR (MH "Geriatrics")
S2	TI ("older adult*" or elder* or geriatric* or aging or aged or senior* or "older people*") OR AB ("older adult*" or elder* or geriatric* or aging or aged or senior* or "older people*")
S3	S1 OR S2
S4	(MH "Residential Facilities+")
S5	TI ("residential facilit*" or "nursing home*" or "long term care" or "long-term care" or "homes of the aged") OR AB ("residential facilit*" or "nursing home*" or "long term care" or "long-term care" or "homes of the aged")
S6	S4 OR S5
S7	(MH "Virtual Reality+") OR (MH "Augmented Reality")
S8	TI ("virtual realit*" or "augmented realit*") OR AB ("virtual realit*" or "augmented realit*")
S9	S7 OR S8
S10	S3 AND S6 AND S9

Supplemental file 3: Data extraction instrument

Author, year	Country of study	Publication type	Study type	Study duration	Study purpose	Participants	Type of care setting	VR or AR program description	Facilitators	Barriers	Social implications (loneliness)

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.	
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.	
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.	
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.	
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.	
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.	
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.	
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	
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 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.	
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).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
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.	
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	
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.	
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	
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.	
Limitations	20	Discuss the limitations of the scoping review process.	
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.	
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.	

JBI = 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 (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

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Facilitators and barriers to using virtual reality and augmented reality and its impact on social engagement in aged care settings: A scoping review protocol

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Facilitators and barriers to using virtual reality and augmented reality and its impact on social engagement in aged care settings: A scoping review protocol

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ABSTRACT

Objective The objective of this scoping review is to provide an overview of current literature on the facilitators and barriers of virtual reality (VR) and augmented reality (AR) among older adults in aged care settings, and the impact of this technology on social engagement and/or loneliness.

Introduction Increasingly more studies are being conducted on the use of VR and AR in aged care settings. These technologies can decrease experiences of loneliness which is especially important during the COVID-19 pandemic. With the growing interest in using VR/AR in care settings among older adults, a comprehensive review of studies examining the facilitators and barriers of adopting VR/AR in these settings is needed. This scoping review will focus on facilitators and barriers related to VR/AR in care settings among older adults, as well as the impact on social engagement and/or loneliness.

Methods and analysis We will follow the Joanna Briggs Institute scoping review methodology. We will search the following databases: CINHAL, Embase, Medline, PsycInfo, Scopus, and Web of Science. Additional articles will be handpicked from reference lists of included articles. Inclusion criteria includes articles that focus on older adults using VR or AR in aged care settings. Our team (which includes patient and family partners, an academic nurse researcher, a clinical lead, and trainees) will be involved in the search, review, and analysis process.

Ethics and dissemination We will be collecting data from publicly available articles for this scoping review, so ethics approval is not required. By providing a comprehensive overview of the current evidence on the strategies, facilitators, and barriers of using VR/AR in aged care settings, findings will offer insights and recommendations for future research and practice to better implement VR/AR. The results of this scoping review will be shared through conference presentations and an open-access publication in a peer-reviewed journal.

Strengths and limitations

- This scoping review will examine the barriers and facilitators of adopting VR/AR in aged care settings, as well as map the literature on the potential benefits of VR/AR on decreasing loneliness.
- A patient partner was involved in the preparation of this scoping review protocol, maximizing the clinical relevancy of this protocol.
- This scoping review will follow the Joanna Briggs Institute methodological framework.
- Review will only include literature that was published in English, and only hand-picked grey literature will be included.
- Strategies for implementing VR/AR outside of care settings will not be captured.

INTRODUCTION

Social isolation and loneliness

Social connection is a basic and essential human need, but the COVID-19 pandemic has brought about much social isolation and loneliness among residents living in care settings such as long-term care (LTC)[1]. Even prior to the pandemic, social isolation is a serious concern among residents[2]. While there are many definitions of social isolation, it is generally referred to as a lack of social contacts and relationships[3] Loneliness is related to social isolation and is defined as a subjective feeling due to a lack of quantity and/or quality of ones' social network or relationships[4]. Both loneliness and social isolation can lead to many mental health issues, including depression and suicide[5], as well as an increase in certain types of health and social care utilisations[6]. Confinement and restrictions on visitations during the COVID-19 pandemic have increased residents' feelings of anxiety, isolation, and loneliness, creating new or exacerbating pre-existing physical and mental health concerns (e.g., depression, loneliness, cognitive decline, frailty, mobility issues)[7]. Therefore, it is more important than ever to develop and implement new ways to overcome loneliness and improve the wellbeing among residents in these care settings.

AR and VR Technology to decrease loneliness

Technology such as virtual reality (VR) and augmented reality (AR) has shown promise in enhancing residents' wellbeing and decreasing loneliness[8]. Virtual reality has existed since the 1980s in various forms, but due to the advent of recent technologies (e.g., Microsoft HoloLens; Oculus Quest), the immersive VR/AR environment is now both portable and consumer-friendly, leading to different uses in care settings among residents. VR uses computer-simulated graphics in real time to allow users to experience an immersive digital environment, while AR is an enhanced version of the real physical world using computer graphics in real time[9]. Users of VR and AR may wear hardware such as headsets, hand controllers, and/or wearable haptic devices, with the program being controlled by an external smartphone or computer. The primary benefit of VR/AR over other technologies (e.g., a flat screen TV, tablets) is the subjective experience of immersiveness, or "being there"[10].

A Canadian feasibility study found that it is safe and feasible for older adults with varying levels of cognitive and physical impairments to be exposed to VR, with reports of positive feedback and increased relaxation after usage[11]. Another VR program (Virtual Reality Forest) was found to improve pleasure and alertness among residents with dementia in an Australian care home[12]. In addition, AR has also been used to improve balance in older adults[13]. Finally, engaging in shared experiences through VR technology can decrease loneliness, social isolation, and depression among long-term care residents[14], which is especially important during the current COVID-19 pandemic. Overall, the use of VR/AR may be useful to meet psychosocial needs, increase pleasure, improve mental health and wellbeing of people living in care settings[12,15], and offers a possible way for residents in care settings to safely engage with others, incurring physical and mental health benefits.

Study objective

As outlined above, there is growing interest in using VR and AR among care settings especially to promote social engagement and decrease loneliness; therefore, a comprehensive review that provides evidence on how best to adopt VR/AR across settings is needed. Current research focuses on enhancing innovative designs and usability, and there is a lack of research probing into the preferences and requirements of older adults using VR/AR[16] and how this technology may decrease loneliness. This research gap is noteworthy because understanding the facilitators and barriers (e.g., user needs and resources) is essential to ensure the readiness of adopting new interventions across multiple settings[17]. This scoping review is designed to review the facilitators and barriers of implementing VR/AR in care settings, and the impact of this technology on social engagement and/or loneliness.

A preliminary search found a few reviews related to VR/AR and older adults, but none with the purpose on collating the facilitators and barriers of using VR/AR in care settings. For example, Appel et al.[18] conducted a scoping review on the current state of research using VR for people with dementia. Another systematic review identified studies exploring the use of VR in older adults[19]. Our review will be specific to care settings as we would like to know the facilitators and barriers of adopting VR/AR technology in these settings, which are different from home settings. We will also be more comprehensive in our review by including all older adults residing in care settings, since VR/AR can benefit people without dementia as well. Furthermore, Dermody et al.[20] conducted a systematic review on the role of VR among community-dwelling older adults. Their aim was to evaluate the effectiveness of VR. Finally, Carroll et al.[9] completed a scoping review to explore how VR/AR technology is being used with older adults and to examine whether consistent terminology of VR and AR is being used across studies. The purpose of our review differs from that of the above reviews in that we aim to determine the factors related to adopting VR/AR in care settings, and to identify barriers and facilitators. Additionally, we would like to explore the impact of VR/AR on social engagement and/or loneliness in these settings. In our next study, we will be conducting an evaluation study to explore long-term care resident experiences of using VR/AR technology. As part of our efforts to implement VR/AR most effectively for our study, conducting this scoping review will inform strategies for adopting VR/AR in aged care settings, which remains a gap in previous reviews. Our scoping review will also elucidate more specific research questions for future research.

Review questions

1. What are the facilitators and barriers in adopting group VR/AR in care settings for older adults?
2. What is the current evidence on the impact of VR/AR on social engagement and/or loneliness?

METHODS

Our scoping review will be conducted using the Joanna Briggs Institute methodology[21]. A scoping review is useful for: identifying the conceptual boundaries of a topic, examining emerging evidence, and providing a broad overview of a topic[22,23]; therefore, a scoping review is appropriate for the above review questions. Our review will be conducted between March and August 2022.

Inclusion criteria

See **online supplemental file 1** for details on inclusion and exclusion criteria of articles.

Types of participants

This review will consider studies that include older adults aged 65 or older who are living in care settings. Articles that include residents along with care home staff and/or family will also be included.

Concepts

We will include studies that focus on the use of VR and/or AR. These systems need to produce an immersive experience for the users (e.g., creating a life-like environment through a head-mounted device and could be manipulated by the user).

Articles will address at least one of the following areas of adopting VR/AR: barriers, facilitators, social engagement and/or loneliness. Barriers are defined as any factors (e.g., resources, practice culture, policies) that "impede the implementation of, or adherence" to the use of VR/AR in the practice setting[24,p5]. Conversely, facilitators are factors that promote "the implementation of, or adherence to" the technology[24,p5].

To meet the objective of articles addressing social engagement and/or loneliness, they would need to discuss how VR/AR enabled the user to interact and engage with others, or discuss peripherally-related issues such as impacting mood, feelings of isolation and anxiety, social visits and connections.

Finally, we will not include articles that were published more than 5 years ago, because VR/AR technology has evolved significantly in the last 5 years. We want to capture updated and current information on the facilitators, barriers, and social engagement impact of this technology.

Context

In terms of context, we will include studies that are situated in aged care settings such as (but not limited to) long-term care and assisted living settings.

Types of evidence sources

A wide range of studies (e.g., randomized trials, descriptive studies) will be included, as well as user experience reports.

Search strategy

We follow JBI's three-step search strategy:

1) Initial search

A preliminary search by the first author (FTM) was conducted in collaboration with a university librarian from the University of British Columbia. The search was conducted in CINAHL. Keywords, Medical Subject Headings, index terms, titles, and abstracts were analyzed to identify search terms and keywords appropriate for the purposes of this scoping review. See **online supplemental file 2** for our CINAHL search strategy.

2) Full search

In our full review, we will use the terms: ("older adult*" or geriatric* or elder* or aging or aged or senior* or "older people*") AND ("virtual realit*" or "augmented realit*") AND ("residential facilit*" or "nursing home*" or "long term care" or "long-term care" or "homes of the aged"). We will use those search terms in the following databases: CINHAL, Embase, Medline, PsycInfo, Scopus, and Web of Science. Google will be searched for gray literature (e.g., student theses and dissertations from universities, and other articles that are not indexed in library databases) using phrases such as "virtual reality in aged care settings" OR "virtual reality in long-term care" OR "augmented reality in aged care settings" OR "augmented reality in long-term care". No restrictions were set regarding the publication date. We will continue to work with a librarian in our full review to refine the search strategy and ensure that all key articles will be captured.

3) Reference list search

Reference lists will be checked for any additional articles that meet our inclusion articles.

Evidence selection

We will use the reference management tool, Mendeley, to organize all references and articles selected for our review. Identified articles will be uploaded onto Mendeley, and duplicates will be removed.

We will engage in pilot testing of the above search strategy, using the following steps:

1) A random sample of 15 titles/abstracts will be selected
2) The review team will screen these articles using the eligibility criteria
3) Team members will meet to discuss any discrepancies, adjusting the eligibility criteria and/or search strategy accordingly
4) The review team will start screening the remaining articles after at least 80% agreement is achieved

After pilot testing, two review team members will first screen the remaining articles' titles and abstracts for relevancy according to our eligibility criteria. All disputes will be resolved through a discussion with a third team member until consensus is reached. The full text of these articles will then be read by at least two researchers to confirm inclusion; reasons for exclusion will be recorded.

Data extraction

See **online supplemental file 3** for our data extraction instrument. Extracted data will include specific details about the article, facilitators and barriers to VR/AR technology, and the impact of VR/AR on loneliness. Additional categories relevant to answering the review questions may be added as we review the articles. Extracted data will be conducted by two researchers, and any disagreement between the reviewers will be resolved through a discussion with an independent third reviewer.

Analysis of the evidence

We will present the extracted data and results in a table, with the purpose of mapping the existing literature on the facilitators and barriers of VR and AR technology, and the impact of this technology on social engagement and/or loneliness.

Presentation of the results

A narrative summary will be used to accompany the tabled results, with themes to organize the results. We expect that both qualitative (e.g., how VR/AR impacts loneliness; the specific facilitators and barriers of adopting VR/AR) and quantitative data (e.g., number of mixed-method articles) will be presented in our full review. We will use the PRISMA-ScR reporting guidelines[25] to structure our full review.

Patient and public involvement

A patient partner (JM) was involved with preparing this scoping review protocol, including refining the research priorities and review questions. Involvement of a patient partner maximizes relevancy of this work to clinical care. Additional patient and family partners will continue to work with the review team to complete the scoping review. In particular, they will be actively engaged in the reading of the included articles and extracting of data, as well as being involved with data synthesis and analysis.

Ethics and dissemination

Research ethics approval is not required for scoping reviews since we extracted data from publicly available articles. This scoping review will be submitted for publication in an open-access journal, and results will be presented at conferences. We will also disseminate a 1-page infographic of our review findings to make findings accessible to a wide audience. For example, we will share findings through staff huddles and meetings with local care homes. Overall, we

anticipate that the findings will be useful in providing evidence-based guidance to implement VR/AR in future practice and research.

Authors' contributions

FTM developed the research protocol and methods; she also drafted and edited the entire manuscript.

JM helped to refine the research questions and study methods and made important contributions to the editing of the manuscript.

LH is the primary investigator and contributed to the revising of the manuscript.

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Competing interests

None declared.

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Supplemental file 1: Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Articles that include users who are aged 65 or older	Articles with a focus on users who are less than 65 years old
Articles focused on immersive virtual reality and/or augmented reality technology	Articles that are not focused on virtual reality and/or augmented reality technology; non-immersive types of virtual reality and/or augmented reality will not be considered.
Articles with a focus on a healthcare setting with formal care provided by paid staff	Articles that focus on settings without formal care (e.g., home care)
Articles address at least one of the following areas of adopting virtual reality and/or augmented reality: barriers, facilitators, impact on social engagement and/or loneliness	Articles that do not address at least one of the following areas of adopting virtual reality and/or augmented reality: barriers, facilitators, impact on social engagement and/or loneliness
Peer reviewed journal articles, full reports, case studies, user reports; grey literature	Only abstracts available
Publications in English	Non-English publications
Articles published within the last five years (2017-2022)	Articles published before 2017

Supplemental file 2: Preliminary search (CINAHL)

S1	(MH "Aged+") OR (MH "Geriatrics")
S2	TI ("older adult*" or elder* or geriatric* or aging or aged or senior* or "older people*") OR AB ("older adult*" or elder* or geriatric* or aging or aged or senior* or "older people*")
S3	S1 OR S2
S4	(MH "Residential Facilities+")
S5	TI ("residential facilit*" or "nursing home*" or "long term care" or "long-term care" or "homes of the aged") OR AB ("residential facilit*" or "nursing home*" or "long term care" or "long-term care" or "homes of the aged")
S6	S4 OR S5
S7	(MH "Virtual Reality+") OR (MH "Augmented Reality")
S8	TI ("virtual realit*" or "augmented realit*") OR AB ("virtual realit*" or "augmented realit*")
S9	S7 OR S8
S10	S3 AND S6 AND S9

Supplemental file 3: Data extraction instrument

Author, year	Country of study	Publication type	Study type	Study duration	Study purpose	Participants	Type of care setting	VR or AR program description	Facilitators	Barriers	Social engagement/loneliness

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.	
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.	
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.	
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.	
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.	
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.	
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.	
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	
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 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.	
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).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
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.	
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	
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.	
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	
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.	
Limitations	20	Discuss the limitations of the scoping review process.	
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.	
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.	

JBI = 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).

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