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REVIEW

Effectiveness of virtual and augmented reality-based interventions in training informal carers of people with dementia: a rapid review

Efectividad de las intervenciones basadas en realidad virtual y aumentada en la capacitación de cuidadores informales de personas con demencia: una revisión rápida

Tiago Branco[1], Lúcia Marques[2], Marta Andrade[3], Isabel Rabiais[4,5], João Tomás[4,6], Sandy Severino[4], Helena José[4,7], Luís Sousa[4,8]

[1]Algarve Local Health Unit, Intern Medicine Department. Faro, Portugal.
[2]Armed Forces Hospital, Medicine Department. Lisbon, Portugal.
[3]Ocidental Lisbon Local Health Unit, Surgery Department. Lisbon, Portugal.
[4]Atlântica School of Health, Atlântica University, Nursing Department. Barcarena, Portugal.
[5]Centre for Interdisciplinary Research in Health, Universidade Católica Portuguesa. Lisbon, Portugal.
[6]Life Quality Research Center (CIEQV). Santarém, Portugal.
[7]Health Sciences Research Unit: Nursing, Coimbra Nursing School. Coimbra, Portugal.
[8]Comprehensive Health Research Centre, Universidade de Évora. Évora, Portugal.

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Corresponding Author
Tiago Branco

ABSTRACT

Introduction: to enhance the understanding of dementia, the most effective approach is to provide a direct experience of the challenges faced by individuals with the condition. Caregivers should be able to perceive and experience the difficulties associated with dementia symptoms. This can be practically achieved through technologies such as virtual and augmented reality.
Objective: map out the effectiveness of interventions based on virtual and augmented reality in training informal caregivers of people with dementia, as reported in the literature, and identify the outcomes of this training.
Method: rapid Literature Review using the EBSCOhost platform in the following databases: CINAHL Complete, MEDLINE Complete, Nursing & Allied Health Collection: Comprehensive, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Cochrane Methodology Register, Library, Information Science & Technology Abstracts, MedicLatina and Cochrane Clinical. Accepting primary and secondary studies, published between January 1, 2019 and November 30, 2024. Cochrane guidelines were followed.
Results: this rapid review included seven studies.
Conclusions: the studies analysed provided consistent evidence that virtual reality-based interventions promote positive impacts on the attitudes, skills and empathy of informal caregivers of people with dementia.

Keywords: Augmented Reality; Virtual Reality; Caregivers; Dementia; Nursing

RESUMEN

Introducción: para mejorar la comprensión de la demencia, la forma más eficaz es proporcionar una experiencia directa de las dificultades por las que atraviesan las personas, es decir, los cuidadores deben ser capaces de sentir lo que las personas con demencia enfrentan cuando se enfrentan a los síntomas de la enfermedad. Esto se puede lograr de manera práctica utilizando tecnologías como la realidad virtual o aumentada.
Objetivo: mapear en la literatura la efectividad de las intervenciones basadas en realidad virtual y aumentada en la formación de cuidadores informales de personas con demencia e identificar los resultados de esta formación.
Método: revisión rápida de la literatura utilizando la plataforma EBSCOhost en las siguientes bases de datos: CINAHL Complete, MEDLINE Complete, Nursing & Allied Health Collection: Comprehensive, Registro Cochrane Central de Ensayos Controlados, Base de Datos Cochrane de Revisiones Sistemáticas, Registro Cochrane de Metodología, Biblioteca, Resúmenes de Ciencia y Tecnología de la Información, MedicLatina y Cochrane Clinical. Aceptar estudios primarios y secundarios, publicados entre el 1 de enero de 2019 y el 30 de noviembre de 2024. Se siguieron las guías Cochrane.
Resultados: esta revisión rápida incluyó siete estudios.

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Conclusiones: los estudios analizados proporcionaron evidencia consistente de que las intervenciones basadas en realidad virtual promueven impactos positivos en las actitudes, habilidades y empatía de los cuidadores informales de personas con demencia.

Palabras clave: Realidad Aumentada; Realidad Virtual; Cuidadores; Demencia; Enfermería.

INTRODUCTION

Dementia is a chronic syndrome that progresses over time and leads to a decline in cognitive function.[1] According to data from Alzheimer Europe, around 1,88 % of the Portuguese population would be diagnosed with dementia in Portugal in 2018.[2] The same study estimates that by 2050, this figure will rise to 3,82 % of the Portuguese population.[2] The most common symptoms of dementia are behavioral and psychological symptoms, which affect around 90 % of people with dementia and can occur for a variety of reasons.[3,4] The aging of the population and the increase in these associated syndromes, both worldwide and in Portugal, has increased the need for assistance for the elderly, whether by professionals or informal caregivers.[5]

The informal caregiver is defined as a person who provides care for a dependent person, without any remuneration for the service provided. These caregivers can be family members, friends, neighbors or other groups.[6] This role can become difficult, requiring significant changes in the life of the caregiver, causing high levels of anxiety, physical and psychological overload, resulting in a negative impact on the quality of life of both the caregiver and the person being cared for.[7,8] In the case of dementia, informal caregivers don't always understand that the symptoms are a natural process, which can lead to conflicts.[9,10]

Various face-to-face teaching programs have been provided for informal caregivers of people with dementia, using methods such as lecture, discussion, the question-and-answer model, the problem-solving model and skills training.[11] However, this type of intervention has its limitations, as it is unsustainable in the long term. In this sense, a variety of educational approaches based on immersive experience have been developed recently.[11]

According to Kirner and Siscoutto, virtual reality (VR) is a system that allows the user to visualize, move and interact with three-dimensional environments created virtually, in real time, using devices such as viewing helmets and sensory gloves, and/or gestures and voice commands.[12] The aim is for the user to have the feeling of being immersed in the virtual environment, using intuitive skills and knowledge to perform actions such as pointing, picking up, manipulating and interacting with objects in real time.[12]

Augmented reality (AR), in turn, is a system that enriches the real environment with virtual objects, using some technological device, working in real time and allowing users to interact with virtual elements integrated into the real environment, without requiring complete immersion in a virtual world or replacing physical space.[12] This technology uses interfaces that connect the real and virtual environments in a practical way, without relying on specific or advanced equipment.[12]

Today, VR and AR have a wide range of applications, including the health sector. In clinical practice, it has been an ally of professionals to promote health, prevent illness and contribute to the rehabilitation of clients, making care more accessible and interactive.[13] VR and AR can provide a more realistic learning experience for caregivers, better understanding the behaviors and attitudes of people with dementia, and thus adopting new strategies to care for the person with dementia.[1]

The aim of this rapid literature review is to map the effectiveness of interventions based on VR and AR in the training of informal caregivers of people with dementia and to identify the results in the training of informal caregivers of people with dementia.

METHOD

In order to obtain a synthesis of the existing evidence in a timely manner, a rapid literature review was conducted, based on the Cochrane recommendations. A rapid review is defined as "a type of evidence synthesis that gathers and summarizes information from different research studies to produce evidence (...), simplifying or omitting a variety of methods that should be clearly defined by the authors".[14]

This is a type of review that critically evaluates the existing evidence on a policy or practice, using the systematic review method, speeding up the process by limiting particular aspects.[15]

Cochrane outlines eight stages for this type of review, namely: definition of the research question, definition of eligibility criteria, search strategy, study selection, data extraction, risk of bias assessment, synthesis and other considerations.[14]

Setting the Research Question

The starting question was defined according to the PICO method: "What is the effectiveness of interventions based on VR and AR in empowering the informal caregiver of a person with dementia?"

Setting Eligibility Criteria

Based on the starting question and the PICO method, the inclusion and exclusion criteria were defined, following the Cochrane guidelines,[14] which are set out below:

- Population: informal caregivers, aged over 18, of people with dementia.
- Intervention: interventions based on virtual or augmented reality.
- Control: compared to a control group with an alternative educational intervention or no intervention at all.
- Outcome: changes in empathy, care competence and behavior, the informal caregiver's perception of the person with

dementia and other secondary changes associated with the type of intervention.

- Articles in English, accessible in full and published between January 2019 and November 2024.
- Primary and secondary studies of qualitative, quantitative or mixed origin with a level of evidence greater than or equal to 3.
- Limited use of gray literature.

Search

The research was preceded by an exploratory survey in which descriptors validated through Medline - Medical Subject Headings (MeSH) and other synonymous or free terms identified as necessary for the research were defined. The search strategy was carried out by TB and repeated and verified by LM and MA, in November 2024, using the Boolean search mode using the EBSCOHost Research search engine, in the databases: CINAHL Complete, MEDLINE Complete, Nursing & Allied Health Collection: Comprehensive, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Cochrane Methodology Register, Library, Information Science & Technology Abstracts, MedicLatina e Cochrane Clinical.

The Boolean equation used in the EBSCOHost search engine was: ("nurs*" AND ((MH "Virtual Reality") OR (MH "Virtual Reality Exposure Therapy") OR "Virtual Realities" OR (MH "Augmented Reality") OR "Augmented Realities" OR "Immersive technology" OR (MH "Simulation Training")) AND ((MH "Caregivers") OR "caregiver*" OR "informal caregivers" OR "spouse caregivers" OR "family caregivers" OR "care givers" OR "carers") AND ((MH "Dementia") OR "dement*" OR (MH "Dementia, Vascular") OR (MH "Alzheimer Disease") OR "Alzheimer*" OR "Alzheimer Syndrome")) NOT (Covid).

Study Selection

In the screening, all studies were extracted and stored in Mendeley® V1.19.8 (Mendeley Ltd., Elsevier, The Netherlands) where, together with the EBSCOHost search engine, duplicates were removed. The citations were then imported into the Rayyan QCRI program (Qatar Computing Research Institute (Data Analytics), Doha, Qatar).

To screen the selected studies by title and abstract, a pilot exercise was carried out and 20 titles and abstracts were evaluated by the three reviewers (T.B., L.M. and M.A.) to calibrate and test the selection process. Subsequently, 20 % of the abstracts were double-screened (T.B. and M.A.), with conflicts resolved. Finally, the remaining titles and abstracts were selected by two reviewers (T.B. and M.A.), and the third (L.M.) reviewed all the excluded studies, resolving any conflicts.

During the selection of the full studies, a pilot exercise was carried out using the same 5 studies among the whole team to calibrate and test the review method and application of the inclusion and exclusion criteria. Subsequently, the full studies were selected by 2 reviewers (T.B. and L.M.), and a third (M.A.) filtered the excluded studies, resolving conflicts. The study selection process is summarized in a flowchart adapted from the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA).[16]

Data Extraction

Data was then extracted following the Cochrane recommendations. Two reviewers (T.B. and L.M.) manually extracted the data from the selected studies into a table with the characteristics of the publication (authors, title, year of publication and journal).) into a table with the characteristics of the publication (authors, title, year of publication and journal), characteristics of the study (study design), characteristics of the population (sample size, country, demographic characteristics - age and gender, and type of informal caregivers), intervention (type of intervention, objective, duration , frequency and duration of sessions), main results (changes in empathy, care competence and the informal caregiver's behavior and perception of the person with dementia), and secondary results (secondary and less common changes associated with the type of intervention carried out, types of intervention carried out, facilitating and hindering factors). The accuracy and completeness of the data extraction was checked by a third reviewer (M.A.) for 10 % of the studies, and there were no significant errors, i.e. errors above 1 % of the records, so the remaining records were not checked.

Risk of Bias Assessment

After extracting the data, the risk of bias of the selected studies was assessed. The Joanna Brigs Institute's Critical Appraisal Grids, available at https://jbi.global/critical-appraisal-tools, were used to assess each study. This assessment was carried out by two reviewers (L.M. and M.A.) and checked by a third reviewer (T.B.).

Other Considerations

This review was carried out taking ethical and legal considerations into account. All the information in this review is the author's own work and all the citations listed throughout have been duly referenced. No participants were involved at any point, as this is a literature review.

The protocol for this rapid review was registered on the Open Science Framework platform https://osf.io/d7apq.

RESULTS

Study Selection

The database search strategy identified one hundred and five studies: Cochrane Central Register of Controlled Trials = 64, Medline Complete = 27, CINAHL Complete = 8, Nursing & Allied Health Collection = 5, e Library, information Science & Technology Abstracts = 1. No studies were obtained from the Open Access Scientific Repository. Nineteen studies were excluded in

a pre-screening, with the removal of duplicates, articles with a publication date prior to 2019 and that were not written in English. In the screening, the titles and abstracts of 86 studies were analyzed and after applying the inclusion and exclusion criteria, 16 studies were selected for full analysis. Nine studies were removed from the full analysis because they did not meet the inclusion and exclusion criteria, resulting in seven studies being selected for this rapid review. The results of the search are described in full and presented in a flowchart adapted from PRISMA in figure 1.

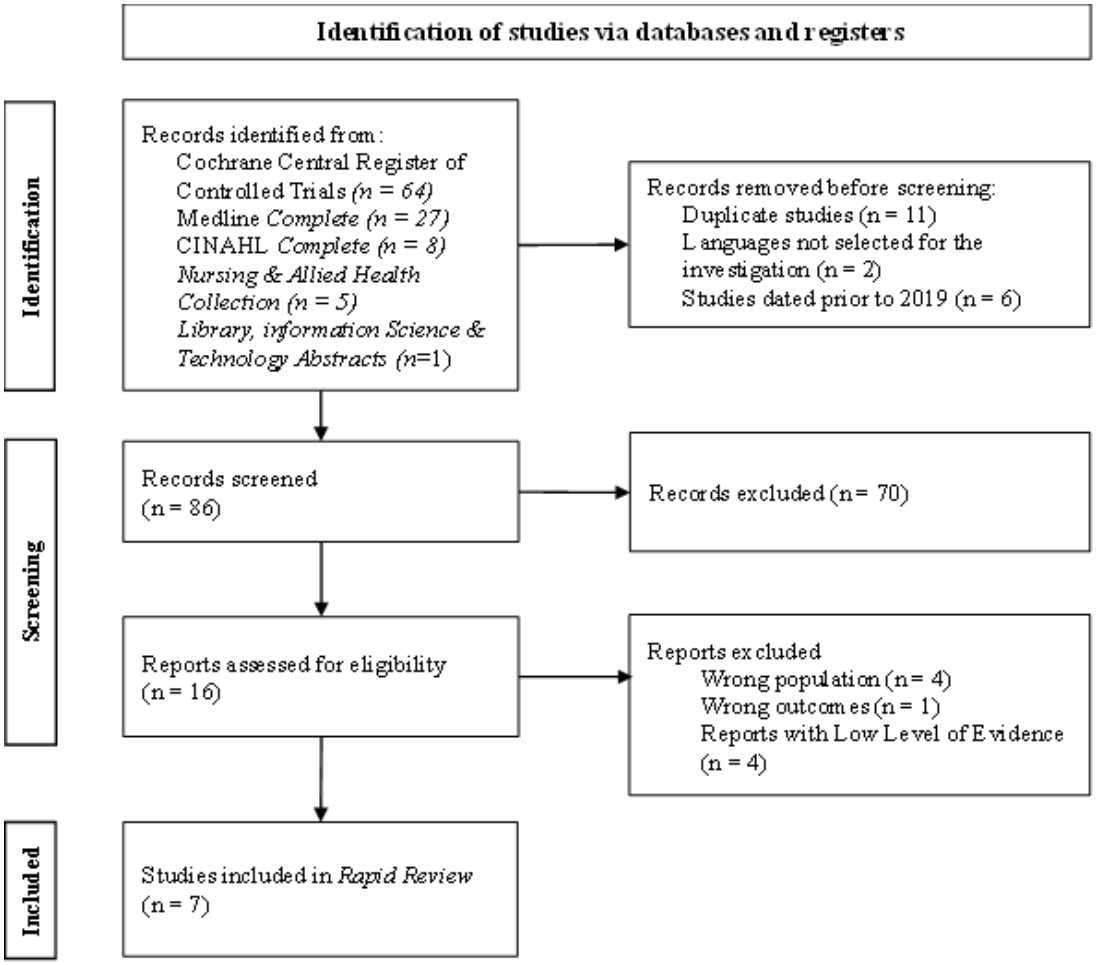

Figure 1. Flowchart adapted from PRISMA

Synthesis

The evidence found in the selected studies was summarized through descriptive means, using tables in the appendix to better organize the information, following the Cochrane guidelines.

First, a general characterization of the studies was carried out, with the authors, year of publication and country where the study was carried out, research design and level of evidence. They were then assessed for methodological quality and risk of bias. Finally, the main characteristics of the study are presented, such as the characteristics of the participants, the type of intervention carried out and the results obtained. The results identified in the selected studies were grouped together in order to respond to the objectives and starting question of this rapid review. Two groups were defined, relating to the main changes in the informal caregiver associated with interventions based on VR and AR. A final group was defined, associated with other results that were found in the selected studies that do not directly respond to the objectives of this review, but which were considered essential because they have a direct or indirect impact on the results obtained.

Data Extraction

This rapid review included seven studies.[1,4,17,18,19,20,21] All of the selected studies are recent, with two published in 2019,[18,21] another two in 2023[17,20] and the last three published in 2024.[1,4,19] Most of the studies selected are primary, three of which were conducted in South Korea,[4,18,20] one in Ireland[21] and one in the United States of America.[19] Two systematic literature reviews were also selected for study. A summary of the general characteristics of the seven studies selected is shown in table 1.

Regarding the level of evidence of the selected studies, two of them were qualitative with level of evidence 3;[18,21] one study is a Systematic review with meta-analysis with level of evidence 1.a;[17] two studies are mixed methods Quantitative Quasi-experimental with level of evidence 2.d and qualitative with level of evidence 3;[19,20] one study is a mixed-methods systematic literature review with level of evidence 1.b;[1] and one study is Quantitative Randomized Controlled with level of evidence 1.c.[4]

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Table 1. Identification of the selected studies

Study	Authors, Year and Country	Journal	Title	Study design (Level of evidence)	JBI score
E1	Slater et al., 2019, Irelanda[21]	International Journal of Older People Nursing	Virtual simulation training: Imaged experience of dementia	Exploratory study[3]	8/10 (80 %)
E2	Han et al., 2019, Coreia do Sul[18]	Dementia	Experiences of caregivers of people with dementia in a Korean dementia simulation program	Descriptive phenomenological study[3]	8/10 (80 %)
E3	Wang et al.,2023, China[17]	Journal of Nursing Management	Effectiveness of Virtual Reality on the Caregiving Competence and Empathy of Caregivers for Elderly with Chronic Diseases: A Systematic Review and Meta-Analysis	Systematic Review and Meta-Analysis (1.a)	10/11 (91 %)
E4	Cheon et al. 2023, Coreia do Sul[20]	CIN: Computers, Informatics, Nursing	Virtual Reality–Based Education Program for Managing Behavioral and Psychological Symptoms of Dementia	Mixed study: Qualitative (3) and Quasi-experimental study (2.d)	8/10 (80 %) 7/9 (78 %)
E5	Gómez-Morales et al. 2024, Estados Unidos da América[19]	Clinical Gerontologist	Through Alzheimer's Eyes: A Virtual Pilot Intervention for Family Caregivers of People with Dementia	Mixed study: Qualitative (3) and Quasi-experimental study (2.d)	8/10 (80 %) 8 /9 (89 %)
E6	Huang et al. 2024, China[1]	International Journal of Mental	Virtual reality-based simulation intervention for enhancing the empathy of informal caregivers of people with dementia: A mixed-methods systematic review	Mixed-methods systematic review	11/11 (100 %)
E7	Song et al. 2024, Coreia do Sul[4]	Geriatric Nursing	Effect of virtual-reality-based education program for managing behavioral and psychological symptoms of dementia: A randomized controlled trial	Randomized controlled trial (1.c)	10/13 (78 %)

Risk of Bias Assessment

The results of the reviewers' critical appraisal of the selected studies, shown in table 1, were obtained using the Joanna Briggs Institute (JBI) critical appraisal grids. Of these studies, only two had a quality percentage between 70 and 79 %,[4,20] three had a quality percentage between 80 and 89 % [18,19,21] and two had a quality percentage between 90 and 100 %.[1,17]

Only one study did not present a risk of bias as it met all the quality assessment criteria.[1] All the remaining studies are at risk of bias because they do not meet at least one of the quality assessment criteria defined by the JBI according to the study design. The criteria which are not present and which contribute to the risk of bias are Q6 and Q7 in qualitative studies, Q1 in systematic reviews, Q2 and Q7 in quasi-experimental studies and Q5, Q7 and Q9 in randomized controlled trials.

Synthesis

Of the five primary studies selected for the study, three had only informal caregivers in the sample,[4,19,20] the remaining two had formal and informal caregivers.[18,21] The sample size varied between 11 and 63 caregivers. Only one study had a control group (n = 30).[4] The average age of the participants in four of the five studies ranged from 54,1 to 64,1 years of age,[4,18,19,20] the last study only showed a median age range of 35 - 44 years.[21] Most of the caregivers who took part in the studies were female, with a percentage of 72,2 % to 100 %. The educational level of the participants was mostly secondary education or higher, representing around 55,6 % to 92,5 %. In studies with only informal caregivers, the rate drops to 55,6 % to 65 %.

The systematic reviews selected for the study included a total sample of 1090 caregivers, 541 of whom were informal caregivers in the E3 study[17] and 400 caregivers of whom 373 were informal caregivers in the E6 study.[1] The range of mean ages varied from 42 to 63,8 years in the E3 study[17] and from 43,4 to 63,7 years in the E6 study.[1] The ratio of female participants varied from 73,8 to 100 % in the E6 study.[1] The E3 study did not describe the percentage of female participants.[17]

The programs identified in the studies, with interventions based on VR and AR, were Virtual Dementia Tour ®,[1,17,21] Dementia Live™ and modified,[1,17,18] Second life: Virtual scene technology,[17] Into D'mentia,[1,17] VR-EduBPSD,[4,20] Through Alzheimer's Eyes[1,19] and Through the D'mentia Lens.[1] All the programs identified feature only VR-based interventions. A table summarizing the main findings of the selected studies has been drawn up and can be found in the topic Supplement.

The main results identified in the study were changes in the attitude of informal caregivers towards caring for the person with dementia, awareness of dementia and empathy. Changes in the attitude of informal caregivers to caring for the person with dementia was the most studied outcome, with the seven selected studies addressing outcomes after VR and AR interventions were carried out. [1,4,17–21] Awareness is addressed in six studies [1,4,18,19,20,21] and empathy in five studies.[1,17,18,19,21]

DISCUSSION

The aim of this rapid literature review was to understand the effectiveness of interventions based on VR and AR in training informal caregivers of people with dementia. The objectives were to map out, in the literature, the effectiveness of interventions based on VR and AR in the training of informal caregivers of people with dementia and to identify the results in the training of

informal caregivers of people with dementia using interventions based on VR and AR.

Given the high number of people diagnosed with dementia, it is important to define new strategies to enable their caregivers to be equipped with more knowledge in order to be able to care for people with dementia. To this end, interventions based on VR and AR were researched, identifying the results of these interventions in empowering the informal caregiver.

The studies reviewed provided consistent evidence that VR-based interventions have a positive impact on the attitudes, skills and empathy of informal caregivers of people with dementia. Although there is variability in study designs, target populations and methods, it is possible to identify patterns and limitations that help to understand the benefits and challenges associated with the use of these technologies.

The most consistent results of the studies found are the great acceptance and satisfaction of the participants in the various studies, as well as the increase in empathy of caregivers towards people with dementia, associated with a greater understanding of their experiences, a better understanding of the behaviors of people with dementia and even a change in their attitude towards them. The results of the studies analyzed, such as E1,[21] E2[18] and E3,[17] highlight significant improvements in levels of empathy among caregivers after participating in VR-based programs. This finding is in line with existing literature which suggests that immersive interventions are effective in stimulating empathy by providing simulated experiences of the difficulties experienced by people with dementia.[22,23]

Simulating situations that present cognitive and emotional challenges seems to help caregivers understand the emotions and behaviors of the people they care for, confirming that empathy can be improved when caregivers experience first-person perspectives.[24] However, studies such as E5[19] point to a contradiction between the results obtained quantitatively and qualitatively regarding empathy. Study E5[19] also mentions that quantitative effects on empathy may be limited, suggesting that methodology and measurement instruments play a crucial role in assessing this construct. The results of studies E3[17] and E6[1] highlight that VR offers unique benefits compared to traditional methods such as written material or lectures. Despite this, the effects on empathy and competence may be comparable to other approaches, depending on the study design and target audience. The E3(17) study found that participants who underwent VR-based interventions and participants in the control group who underwent other types of educational interventions showed the same level of empathy, so combining VR with traditional methods can maximize the benefits.

Caregiver competence was also an outstanding result, since through the interventions developed, namely skills training for managing dementia symptoms, participants reported an improvement in practical skills, with the acquisition of coping strategies and communication training to better deal with the behavioral and psychological symptoms of dementia.[1,4,17,20]

Programs such as VR-EduBPSD[4,20] and Dementia Live™[18] show evidence of increased awareness and competence of caregivers in managing behavioral and psychological symptoms of dementia. These findings corroborate the literature, which suggests that VR is a valuable tool for empowering caregivers by combining practical and immersive education.[25]

On the other hand, E6[1] points out that the benefits in skills can vary depending on the design of the program and the level of interactivity. The comparison between programs, such as Into D'mentia and Dementia Live™, illustrates that the effectiveness of VR can depend on the organization of the program and the complexity of the content.[17] The Dementia Live™ program promotes an empowerment session with skills and competencies training that results in an increase in care competence as indicated by the existing literature.[26,27] On the other hand, the Into D'mentia program only realistically simulates the experience, without resorting to practical skills training, only promoting a better understanding of the caregiver about dementia and thereby increasing empathy.[22,28]

Other reported results show high levels of satisfaction and sense of presence in VR programs.[4,20] Previous studies highlight that immersion is one of the main factors that differentiate VR from other educational methods, as it creates a deeper emotional connection and a more meaningful learning experience.[29]

However, some limitations, such as nausea and discomfort, were mentioned.[4,20] These problems are consistent with the literature, which points to the need for technical improvements and personalized adaptations to avoid barriers to the use of technology.[30]

Although VR programs have been shown to be effective, studies have reported gaps in the literature on the long-term impact of interventions and their applicability in different cultural contexts.[19,21] Suggest that studies be carried out to assess the long-term impact of VR-based interventions on the maintenance of gains from the intervention.[21] Studies such as E2[18] and E4[20] suggest that cultural adaptations can increase the effectiveness of interventions.

In the E4 study[20] it was found that the participants, despite their advanced age, carried out the program without difficulty, contrary to what the existing literature says, linking ageing with increased difficulties in using technology.[31] Despite this, they found that the participants requested a prior introduction to the use of VR.[19]

One of the limitations noted by the E4 study[20] was the restriction of the behavioral and psychological symptoms of dementia addressed in the program. The author states that there is a broad spectrum of symptoms associated with dementia that could not be addressed due to the costs and technical restrictions of the programs.[20] The authors also reported the speech of a participant who already had a degree in higher education and had extensive experience in other dementia education programs, and who stated a preference for other teaching methods. The author recommends creating new content, including a wider range of dementia symptoms and segmenting the target population taking into account the level of experience in education programs.[20] On the other hand, in the E5 study, it was found that participants preferred weekly sessions focusing on just one piece of content, as they found it difficult to assimilate all the information.[19] E4 define that VR sessions should last long enough to bring about behavioral changes, highlighting the importance of practicing at home to reinforce the acquisition of skills.[20] This is in line with the existing literature, which states that during the acquisition of skills, behavioral change does not happen immediately.[32] Some studies have found that longer programs, such as the REACH II and Community REACH studies, which lasted around 6 months with 12 sessions, were more effective in behavioral change.[33,34]

As this is a rapid review, this study has limitations to consider in the analysis, since the research was restricted to articles in English, which limited the results obtained and may have conditioned the conclusions drawn. Likewise, the exclusion of studies that did not have full text reduced the number of articles available for analysis.

In this review, no studies were identified that evaluated the effectiveness of programs describing AR-based interventions. There is little evidence to support the use of AR compared to the use of VR.[34] This tool is a recent technology and has a high margin of progression similar to VR, however it offers different advantages, such as being able to be used in any closed or open environment since it involves reality with virtual objects, promoting the feeling of presence of the participant in the experience, while VR is entirely created virtually.[11,35] In this sense, we consider it to be an asset to carry out future studies that include AR.

Some of the studies selected included formal caregivers in the sample, but they did not distinguish between the results obtained by formal caregivers and informal caregivers, presenting the results in general. That said, this study was unable to assess with certainty the effectiveness of this VR-based intervention for informal caregivers of people with dementia. Another limitation was the inclusion in the study of a systematic review that included studies whose sample included informal caregivers of people with other types of chronic illness, in addition to dementia, which could have altered the results of this review.

CONCLUSIONS

A particularly relevant aspect of VR and AR interventions is their flexibility and capacity for personalization, allowing them to be adjusted to the specific realities and challenges faced by caregivers. This adaptability contributes to increased accessibility and greater adherence to training programs, especially in contexts where access to traditional methods is limited.

Although the existing evidence indicates that VR and AR technologies have a transformative potential in empowering informal caregivers, it is essential that future research adopts more robust methodological designs, including randomized clinical trials, longitudinal studies and complementary qualitative evaluations, to assess the long-term impact of these technologies on both the quality of care provided and the well-being of caregivers and people with dementia. This stronger evidence base could consolidate VR and AR as an integral part of training programs, expanding the possibilities of offering more humanized, effective and sustainable care for people with dementia and their caregivers.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Tiago Branco, Lúcia Marques, Marta Andrade.
Data curation: Tiago Branco.
Formal analysis: Tiago Branco, Lúcia Marques, Marta Andrade.
Research: Tiago Branco, Lúcia Marques, Marta Andrade.
Methodology: Tiago Branco, Lúcia Marques, Marta Andrade.
Project management: Tiago Branco, Lúcia Marques, Marta Andrade.
Resources: Tiago Branco, Lúcia Marques, Marta Andrade.
Software: Tiago Branco.
Supervision: Isabel Rabiais, João Tomás, Helena José, Luís Sousa.
Validation: Sandy Severino, Luís Sousa.
Display: Tiago Branco.
Drafting - original draft: Tiago Branco.
Writing - proofreading and editing: Isabel Rabiais, Sandy Severino, Helena José, Luís Sousa.

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ANNEXES

Supplement 1. Summary of article data

Study	Objective	Sample	Intervention and Methods	Results / Conclusions
E1	To investigate the impact of the Virtual Dementia Tour ® experience on the empathy of health and social care staff and informal caregivers.	Sample: n=18 Informal caregivers (n=4) Gender: 83,3 % female Age: 25,54 years (72,2 %).	The participants in this study took part in the Virtual Dementia Tour ® simulation program. This program seeks to simulate the symptoms of dementia at a moderate level. This program uses headsets, glasses and gloves to recreate the physical and cognitive symptoms of dementia, providing participants with an "inside view" to help them better understand what it is like to live with dementia. It also promotes reflection by allowing observation of other participants and discussion between groups. Interviews were conducted 4 to 6 weeks after taking part in the Virtual Dementia Tour ® program.	The results indicate a positive impact on all the elements of empathy (cognitive, moral, emotional and behavioral), resulting in an empathic understanding that had an impact on the caregivers' behavioral and communicational responses in the relationship with the person being cared for. Feelings such as fear, anxiety, disorientation, isolation and helplessness were widely reported as results relating to the emotional impact; however, as the training progressed, anxiety changed to feelings of frustration, stress and boredom, which were attributed to the inability to master simple tasks and/or the lack of ability to rely on their everyday senses. Regarding moral impact, some participants felt that they needed to review their practice to ensure that they adopted a person-centered approach, ensuring that they focused on the person and not the condition. Other participants mentioned the need to reflect on the care they had provided in the past and to feel shame and guilt about the way they had previously cared for a client with dementia, with some participants recommending the need to provide psychological support to trainees. With regard to cognitive involvement, the program helped participants to become aware of other manifestations of dementia, in addition to memory impairment. In this sense, the participants understood why some people with dementia have problems related to comprehension, judgment, thinking and language, as well as adopting behavioral and psychological responses such as feeling aggressive and agitated. The results also indicated behavioral responses among participants with reports of feeling more confident to care, being more empathetic and viewing client care holistically, and leading to self-remodeled behavior change. That said, there was an improvement in empathy and awareness where participants reported a greater understanding of the daily difficulties and behaviors associated with dementia.
E2	Exploring the experiences of caregivers of people with dementia who participated in a Korean dementia simulation program.	Sample: n=28 Informal caregivers of people with dementia (n=16) Gender: 89,3 % female Average age: 54,1 years Level of education: 89,3 % of participants had secondary education or higher	The participants in this study took part in the modified Dementia Live™ program. This program lasts around 30 to 40 minutes and is carried out in groups of up to four participants, using specially designed headphones with MP3 players, glasses and gloves that mimic the sensory, perceptual or cognitive changes associated with dementia. Each participant is given 5 daily tasks. While performing the tasks, the participants' behavior is observed and notes are taken by the observers. After 7 minutes of each experience, the participants are taken to a room where they discuss the experience and their reactions during the experience as a group, associate their behaviors with the behaviors of people with dementia and discuss changes to care strategies for people with dementia. Finally, semi-structured interviews were conducted.	Three main results emerged from this study: empathy; care strategies and greater awareness. The results indicate greater empathy on the part of caregivers towards people with dementia. This increase in empathy was associated with a greater understanding of the world from the perspective of the person with dementia, the relationship of the emotions felt during the program with the potential emotions of the person with dementia and the similarity of the behaviors experienced during the simulation program with the way people with dementia behave in their daily lives. In terms of care strategies, the results indicate that the program positively affected caregivers' strategies for caring for the person with dementia, through the adoption and improvement of strategies to reduce negative feelings associated with the care dyad, and the discovery of the emotional and social benefits of these strategies for the relationship with the person being cared for. Finally, the results indicate that taking part in the program increased participants' awareness. Understanding the perspectives, emotions and behaviors of the person with dementia allowed caregivers to become more aware of the attention and affection they provide to the person with dementia. The study also reports a greater awareness among caregivers of the possible changes associated with their own aging processes and risk of dementia.

E3	Review the application and effectiveness of VR as an intervention, both for stimulating empathy in caregivers and for improving competence in caring for patients with chronic illnesses.	Sample: n=9 Randomized controlled (n=4) Non-randomized (n=5) Studies of caregivers of people with dementia (n=5) Studies that included only informal caregivers (n=5) Total sample: n=1090 Size of experimental group: n=[6-145] Control group size: n=[3-82] Average age: 42-63,8 years	The experimental groups took part in programs Interactive multimedia computer training program on CD-ROM drive Second life: virtual scene technology program Into D'mentia program Dementia Live™ program and modified programs Virtual Dementia Tour™ program Control group: Use of educational videos Video-based educational lectures Face-to-face or telephone role-play Teaching Other types of simulation	The results found that the participation of caregivers in VR programs increased their empathy towards the person being cared for, however they did not find significant sizes of the effect of the programs on empathy compared to the control group who undertook other educational approaches. However, in the comparison between the Dementia Live™ program and the Into D'mentia program, there was a greater effect on empathy in the Into D'mentia program, while the result on caregiver competence was better in the Dementia Live™ program. With regard to caregiver competence, the study indicates that VR-based interventions can improve the competence of caregivers of people with chronic illness compared to other types of interventions. To have this competence, the caregiver must have knowledge about the person they are caring for, the skills to act when the person needs them and attitudes that promote a good relationship with the person being cared for.
E4	Develop and evaluate the feasibility of a VR-based educational program for family caregivers to improve their proficiency in managing the behavioral and psychological symptoms of dementia.	1R test Informal caregivers of people with dementia (n=11) Gender: 81,8 % female Average age: 64 years. 2R test Informal caregivers of people with dementia (n=9)	The study was carried out in 2 phases: program development and feasibility testing. The program development phase consisted of content development, scenario development, program learning design and program production. The program, called VR-EduBPSD, is divided into 2 types. Type 1 consists of demonstrating content aimed at promoting an empathetic understanding of people with dementia through an experience from a first-person perspective, while type 2 focuses on interactions between caregivers and the person with dementia, using a communication	The results show a change in the participants' attitudes, associated with understanding the person living with dementia, and the acquisition of coping strategies by them to manage the behavioral and psychological symptoms of the person with dementia, after the communication training, using the VERA strategy (Validation, Emotion, Reassurance, Activity). The caregivers reported that they understood the position of people with dementia and their relatives by experiencing the first-person point of view of people with dementia through VR and that the communication training helped them to understand bad practices and adopt new strategies. Most of the participants expressed their commitment to better understanding the person they care for and changing their behavior after completing this program. This study found that satisfaction with the program was high in both phases. This study used a questionnaire with a Likert-type scale, assessing the usefulness of the program, ease of use and satisfaction. At the same time, the participants qualitatively rated their satisfaction as high, and reported
		Gender: 100 % female Average age: 59,89 years Level of education: Secondary school or higher (n=5) Participation in a specific dementia education program: n=5	Strategy, VERA, to train effective communication methods in symptom management. After developing the program, the feasibility test was carried out. This test was conducted in two rounds, 1R-test and 2R-test. The 1R-test included 3 type 1 episodes and 2 type 2 episodes and the 2R-Test included 4 type 2 episodes. Each test was carried out in 60 minutes, including an interview at the end of each test.	An increase in satisfaction after the 2R test because they felt more immersed and comfortable carrying out the test. In addition, they reported greater immersion than other educational interventions due to the feeling of presence. The majority of participants completed the program without experiencing any negative effects; only one person dropped out due to illness associated with the use of VR. The majority of participants would recommend the program to family members of people in the early stages of dementia, but some would also recommend it to long-term caregivers or the general population.

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E5	To assess the feasibility and acceptability of a psychoeducational skills development intervention delivered virtually to caregivers of people with Alzheimer's disease or other similar dementias, and to examine patterns of change among the main outcomes targeted by the intervention.	Informal caregivers of people with Alzheimer's disease or other similar dementias (n=20) Gender: 80 % female Average age: 64,1 years Level of education: 65 % Higher education or more	The Through Alzheimer's Eyes program was held. This program consisted of four weekly 90-minute group sessions, combined with four individual coaching sessions, all conducted via Zoom. The components of the intervention covered topics aimed at reducing caregivers' stress and discomfort, including a VR experience to help them understand dementia.	At a quantitative level, they found changes in empathy, since they did not show significant effect sizes in the empathic concern subdomains of the Interpersonal Reactivity Index. However, on a qualitative level, they found an increase in the caregivers' understanding of dementia and their environment, resulting in a change in attitude, with more empathy, and in the way they care for them. The study showed statistically significant improvements in terms of the caregiver's preparedness to care for the person with dementia and communication with the person with dementia. These results showed an increase in the informal caregivers' confidence in their abilities after the intervention, and with this they felt prepared to care for themselves and the person with dementia and overcome daily obstacles. This study also showed improvements, although not statistically significant, in the caregiver's ability to understand their negative emotions and act on them, to respond to disruptive behaviors of the person with dementia and to solve problems, in satisfaction with social support and in the reduction of negative feelings such as anger, depression, resentment or tension associated with the relationship with the person with dementia. One of the limitations identified by the study participants was time, and they recommended reducing the number of topics per session.
E6	To provide professionals and researchers with insights into the development and/or adoption of VR-based simulation interventions to increase empathy in informal caregivers of people with dementia.	Sample: n=7 Quantitative studies (n=3) Qualitative studies (n=4) Total sample: Caregivers (n=400) Informal family caregivers (n=340) Other types of informal caregivers (n=33) Average age: 43,4-63,7 years Gender: 73,8-100 % female	The studies included in this systematic review included the following VR-based simulation programs: -Dementia Live™ -Virtual Dementia Tour™ -Into D'mentia This program includes performing small tasks inside a portable simulation booth using a vest with speakers and microphones, a simulator and VR goggles to simulate the experience of symptoms associated with dementia. -Through the D'mentia Lens This program includes watching a 13-minute simulation video with a VR headset, half-day group training and three 20-minute online courses.	In terms of quantitative results, there was an increase in levels of empathy and in the adoption of coping strategies and in the sense of competence of informal caregivers who took part in VR programs compared to those who did not. A more person-centered attitude was also detected among informal caregivers after the simulated VR-based intervention, although it was not significant. There were also lower levels of knowledge about dementia compared to the control group. There were no significant changes in the dyadic relationship compared to the control group. The qualitative results indicate that the caregivers perceived the changes in sensation and perception, the negative emotions associated with daily difficulties and the behaviors of people with dementia, allowing for an understanding of the frustrations. Another finding was the improvement in the ability to think from the perspective of the person with dementia, resulting in changes in attitude and behavior. In other words, the adoption of a gentler, more client-like attitude and more appropriate behavior towards the person with dementia.
E7	To evaluate the effectiveness of the VR-EduBPSD program in increasing the competence of informal caregivers in managing the behavioral and psychological symptoms of dementia.	Informal caregivers of people with dementia (n=63) Experimental group: n=33 Control group: n=30. Gender: 81 % female Average age: 68,44 years Level of education: 57,1 % secondary education or higher	The experimental group took part in the VR-EduBPSD program, which included immersive scenarios that simulated everyday situations with clients with behavioral and psychological symptoms of dementia, providing practical problem-solving strategies. The control group was provided with didactic material with content analogous to that experienced by the experimental group. This program took place over 6 weeks, with the first week containing type 1 experiences of empathic understanding of the person with dementia, and the second week containing type 2 experiences of interaction with the person with dementia. At the end of each experience, both groups were interviewed and a final follow-up interview was carried out one month after the type 2 experience.	The results of this study indicate a significant improvement after the program and compared to the control group in the following parameters: awareness of the behavioral and psychological symptoms of dementia, increased caregiver skills in symptom management, adoption of attitudes centered on the person with dementia, introspection to improve care, ability to take care of one's own mind and body and self-efficacy of caregivers in dealing with the challenges of daily life. There was also an improvement in the dyadic relationship between the informal caregiver and the person with dementia. No significant relationship was detected with self-efficacy in self-care, on the scale of attitude towards dementia and for the ability to control behavior. The study indicates that satisfaction, a sense of presence and immersion were high. The nausea questionnaire associated with the VR device showed reduced results.