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LITERATURE REVIEW: THE INFLUENCE OF VIRTUAL GAMES ON COGNITION IN THE ELDERLY

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INTRODUCTION

The growth of the elderly population is a significant global phenomenon. According to the United Nations (2017), the number of people aged 60 and over is projected to double by 2050, from approximately 1 billion in 2017 to 2 billion. This increase represents a considerable challenge for public health and social care policies, given that older people have a wide range of physical and cognitive capacities, with aging experiences that vary considerably depending on environmental factors, lifestyle and multimorbidity. This calls for innovative strategies to ensure healthy ageing and a better quality of life for this population.

One of the problems most faced by the elderly population is the loss of cognition, which is a set of mental processes that involve the acquisition, organization, storage and use of knowledge. This includes functions such as perception, where we interpret sensory information; attention, which allows us to focus on specific stimuli; memory, which involves storing and retrieving past information; thinking, which covers reasoning and problem-solving; language, which is the ability to understand and use verbal and written communication; and learning, the process of acquiring new skills and knowledge.

These processes are fundamental to understanding the world around us, making decisions and interacting with others. often associated with diseases such as Alzheimer's, dementia, neurodegenerative diseases and stroke. It is estimated that the number of people living with dementia will increase from 57.4 million in 2019 to 152.8 million by 2050 (Nichols et al., 2022). This cognitive decline can lead to a loss of independence and have a profound impact on the mental health of older people, often resulting in depression due to the loss of autonomy and leading to feelings of worthlessness, frustration and low self-esteem, creating an environment prone to the development of depressive symptoms due to a greater need for long-term care. In recent years, research has focused on interventions that slow cognitive decline and improve the mental health of older people (Vaportzis et al., 2019). These interventions include cognitive activities, physical exercise, a balanced diet and, more recently, the use of digital technologies and games.

In parallel, we have seen an increase in the use of game elements in non-leisure contexts, a practice known as gamification (Jonna Koivisto & Aqdas Malik 2021). Games are known for their ability to engage and motivate users, and there is growing interest in exploiting these benefits to help improve the cognitive health of older people. Gamification refers to the use of game design elements in non-game contexts, such as education, training and health, to increase user engagement and motivation (Deterding et al., 2011). Research indicates that games can provide various cognitive and emotional benefits, making them a promising tool for health interventions aimed at the elderly population.

The benefits of digital games for the elderly include improved memory, attention, processing speed and problem-solving skills. Games that involve cognitive challenges can help keep the brain active and engaged, slowing cognitive decline. In addition, games that promote physical activity can help improve mobility, balance and strength, reducing the risk of falls and promoting overall physical health.

In addition to the cognitive and physical benefits, digital games can offer emotional and psychological benefits for the elderly. Playing games can be a fun and enjoyable activity that provides a sense of accomplishment and satisfaction. Games that involve goals and challenges can help improve players' self-esteem and confidence. In addition, games

that allow for social interaction can help build and strengthen social connections, providing a sense of belonging and social support.

Technology is increasingly present in our lives, and this includes the field of health, such as telemedicine, wearables, artificial intelligence, robotics and 3D printing. Shattering the stigma that games are just for entertainment, just as technology has been of great help in the area of health, in recent years, digital games have been studied as a potential tool to promote improvements in health, particularly with regard to cognition in the elderly.

Although gamification is often seen as more attractive to young people, due to their familiarity with digital technologies (Betts et al., 2019; Bittner & Shipper, 2014; Malik et al., 2019; Thiel et al., 2016), research shows that older people also play and enjoy games (De Schutter, 2011; Hall et al., 2012), 2012), but they are neglected by the current generation because they are not as knowledgeable about new games and their platforms, resulting in a sense of exclusion and lack of belonging among the elderly.The elderly's lack of familiarity with digital technologies creates a significant barrier to their participation in digital games. This gap in knowledge and experience with modern games can make them feel less confident and less motivated to explore these activities, limiting their opportunities to benefit from the potential positive effects of digital games on health and well-being.

However, the implementation of digital games and gamification for the elderly must take into account their specific needs and limitations. It is important that games are designed in an accessible and intuitive way, with interfaces that are easy to use and do not require advanced technological skills. In addition, games should be adapted to accommodate possible physical and sensory limitations, such as vision, hearing or mobility problems.

With digital generations getting older, it is important to explore how playful interactions can benefit the elderly (Raban & Brynin, 2006). Generations that have grown up with digital technologies are now entering old age, and these people are more familiar and comfortable with using technological devices. This offers a unique opportunity to develop and implement digital games and other interactive technologies that can benefit the health and well-being of the elderly.

In the current systematic review, we examined the existing literature on gamification aimed at older adults, focusing on playful interventions adapted for this age group. We analyzed the objectives and outcomes of these interventions, as well as the types of gamification applied and the results achieved. This analysis offers valuable insights into how gamification can be optimized to promote a better quality of life for older people, highlighting the importance of developing personalized and effective approaches for this audience. The review contributes to a deeper understanding of the potential and challenges associated with implementing game elements in improving the quality of life of older adults

METHODOLOGY

ELIGIBILITY CRITERIA

The detailed eligibility criteria are shown in Table 1. Studies published in English, freely available, investigating the influence of virtual games on cognition in the elderly were included. According to the most recent United Nations definition (2024), older people are those aged 60 or over, the criterion adopted to include participants in the studies. These studies could be carried out in any context, such as hospitals, communities, or in any country.

The types of study included were: clinical trials, meta-analyses, randomized controlled trials, analyses, systematic reviews, books and documents, as long as they were published between 2014 and 2024. The interventions analyzed could include immersive platforms, such as virtual reality, or non-immersive platforms, such as games on monitors. Examples of games analyzed include Big Brain Academy, Crossword Puzzles, and Dr. Kawashima's Brain Training.

SEARCH STRATEGY

To carry out this review, scientific articles were searched in the PubMed, Scielo and Google Scholar databases, using the keywords "elderly", "games", and "cognition". The selection of studies included publications between 2014 and 2024, focusing on research that analyzed the impact of virtual games on the cognition of people aged 60 and over. The inclusion criteria prioritized studies with controlled samples and rigorous quantitative methods, ensuring the quality and relevance of the data analyzed.

After removing the duplicates, three independent reviewers screened the potential studies by analyzing the title and abstract, and assessed the full texts based on the eligibility criteria, as detailed in Table 1. When disagreements arose over the inclusion of a study, the reviewers discussed these discrepancies until a consensus was reached. All controversial studies were discussed between the three reviewers until a unanimous agreement was reached.

DATA EXTRACTION

A data extraction form was developed to collect the following information: year of publication, country of the study, context of the study (such as hospital or community setting), study design, characteristics of the participants (such as age and cognitive status), platform of the games used, specific details of the intervention (duration, frequency, type of game), results obtained and main findings. Three authors carried out the data extraction independently, ensuring the integrity of the process. A fourth author then reviewed the extracted data for accuracy. Any discrepancies found were discussed between the four authors until a consensus was reached, ensuring the consistency and reliability of the data.

QUALITY ASSESSMENT

The quality of the included studies was independently assessed by three authors. The assessment covered the appropriateness of the study objectives, the methodology employed, the participant recruitment process, data collection and analysis, the reflexivity of the researchers, ethical considerations, and the rigor of the findings presented. Any discrepancies in the assessments were discussed between the three authors until a consensus was reached. Although no studies were excluded on the basis of the quality assessment, given that the topic is relatively new, this assessment was essential to critically analyze the existing studies on the impact of virtual games on cognition in the elderly. In addition, the results of this analysis provide a solid basis for guiding future research in this field, highlighting areas that need greater rigor or further investigation.

Criteria	Inclusion Criteria	Exclusion Criteria
Population	Older adults (≥ 60 years), including healthy seniors and those with illnesses.	People under the age of 60.
Interest/Context	- Studies on the influence of virtual games on cognition in the elderly. - Interventions using immersive platforms (such as virtual reality) or non-immersive platforms (such as monitors). - Real-time interaction with the virtual environment changing in response to the participants' actions.	- Studies that do not deal with virtual games. - Studies that do not include intervention with virtual games.
Context	Any environment, such as a home, clinic or activity center for the elderly.	Not applicable.
Study design	- Clinical trials. - Meta-analysis. - Randomized controlled trials. - Analyses and systematic reviews.	- Studies that are not clinical trials or that do not relate to the topic. - Non-experimental studies without quantitative data.
Type of Publication	- Peer-reviewed articles with full texts available. - Relevant books and documents on the impact of virtual games on cognition in the elderly.	- Gray literature, such as dissertations and theses. - Conference abstracts and test protocols.
Language	English and Portuguese	Not applicable
Publication Date	Publications between 2014 and 2024	Publications outside the specified period.

Table 1

SYNTHESIS METHODS

To synthesize the evidence from the included studies, a narrative synthesis approach was adopted. This methodology allowed for a comprehensive integration of the findings, considering the heterogeneity of the studies in terms of design, intervention and results. The extracted data was organized into thematic categories, such as type of game, platform used, participant characteristics and cognitive outcomes. Common trends and differences between the studies were identified and compared. The narrative synthesis also included a critical assessment of the methodological limitations of the studies, considering aspects such as sample size, internal and external validity, and possible biases. Recommendations based on the findings were presented for future interventions and research into the impact of virtual games on cognition in the elderly.

RESULTS

The review included nine studies that investigated the effects of cognitive interventions with digital games on the cognition of healthy elderly people. The interventions ranged from simple games on monitors to more complex immersive platforms such as virtual reality. The main cognitive outcomes analyzed included working memory, attention, processing speed and logical reasoning.

Of the nine studies analyzed, six reported significant improvements in participants' cognition. For example, the study by Lee et al. (2019) demonstrated notable advances in working memory and processing speed after using digital games. These results suggest that digital games can act as an effective cognitive stimulus, especially when adapted to engage different mental functions. Another study, conducted by Iizuka et al. (2020), observed improvements in visual working memory and highlighted the importance of social interaction in face-to-face board games, suggesting that the social dimension of the game can amplify its cognitive benefits.

However, three studies did not find significant improvements. Bozoki et al. (2018) reported that cognitive gains were limited, possibly due to the variation in time dedicated to the game and the reluctance of participants to progress to more challenging levels, highlighting the need to adapt interventions to the preferences and limitations of the elderly. In other studies, the lack of significant results was attributed to the heterogeneity of the samples and the diversity of interventions, suggesting that the effectiveness of digital games can be influenced by factors such as the type of game, the frequency of use and the context in which they are applied.

These results indicate that although the majority of studies have shown improvements in cognition in older people following the use of digital games, the effectiveness of interventions can vary significantly. Factors such as the complexity of the games, the level of challenge and the support offered during the intervention seem to play a crucial role in determining the results. It is therefore essential that future research explores these aspects in greater depth, seeking to identify the ideal conditions for maximizing the effectiveness of interventions.

DISCUSSION

Overall, the majority of studies showed that interventions with digital games improved working memory and processing speed. However, the review also highlighted the limited number of studies focusing on healthy older people and using serious games as an intervention, suggesting a gap in research on the effects of these games on psychosocial variables and the quality of life of older people.

In addition, the review highlighted the need to consider the physical and sensory limitations of the elderly when developing and implementing digital games. Games that require fine motor skills or have complex interfaces can represent significant barriers for this population, limiting their potential for engagement and, consequently, their benefits. It is therefore essential that games are designed with a user-centered approach, taking into account the needs and preferences of the elderly.

Another relevant question is the long-term sustainability of cognitive benefits. Few of the studies included in the review evaluated the effects of the interventions after the end of the training period, and the available results suggest that the gains may not be maintained without continued engagement. This raises the question of how to integrate digital games sustainably into the daily routines of older people, potentially as part of long-term care programs.

The authors unanimously recognized that the search carried out may not have captured all the relevant articles, indicating the need for new systematic reviews with different search terms. Thus, the results showed that half of the studies reviewed showed significant cognitive improvements, while the other half did not observe these benefits, pointing to the need for more research to better understand the conditions that influence the effectiveness of digital games on cognition in the elderly.

Finally, this study showed that the majority of studies found improvements in cognition in older people after using digital games, especially in working memory and processing speed. However, not all studies showed significant benefits, suggesting that the effectiveness of games may depend on factors such as the type of game, the involvement of the participants, and the context of use. Differences in results may reflect the diversity of samples and interventions. The limitation of studies focused on healthy older adults and the use of digital games highlights the need for more research to better understand how these tools influence cognition and to optimize cognitive training programs.

CONCLUSION

This systematic review revealed that intervention with digital games has the potential to benefit older people's cognition, with a particular focus on improvements in working memory and processing speed. Although most of the studies analyzed showed positive effects, the effectiveness of digital games can vary significantly, depending on factors such as the type of game, the intensity of the intervention and the context of use. Therefore, the results suggest that digital games can be a useful tool for slowing cognitive decline and improving quality of life in the elderly. However, it is important to note that not all studies reported significant improvements, which indicates that the effectiveness of digital games may not be uniform for all individuals and conditions. This suggests that the success of digital games may depend on several factors, such as the type of game, the frequency of use and the context in which they are applied.

In addition, the review highlighted the lack of studies focused exclusively on healthy older people and the need for more research to better understand how play interventions can influence psychosocial variables and quality of life. The variation in results also suggests that personalization of digital games and interventions may be crucial to maximizing cognitive benefits. Therefore, for digital games to become a truly effective tool in promoting cognitive health in the elderly, more research will need to be carried out and programs adjusted to the particularities of each person. With a more personalized approach and a better understanding of the conditions that influence results, we will be able to make the most of the benefits that these games can offer.

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