**Smart Ageing and Gerontology Project**

**The Attitudes Towards Serious Games Among Caregivers of People with Dementia**

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**Abstract**

**Background:** With the increasing global aging trend, the problems brought about by aging are gradually revealed. People with dementia require more meticulous care from caregivers due to cognitive decline and poor physical condition with aging. Nevertheless, it is indeed a tedious and workload-intensive task for caregivers. Caregivers of older people with dementia are. This high-pressure living environment over a long time has a tremendous negative impact on caregivers of older people with dementia, and they are prone to psychological problems like depression and anxiety. The invention of increasingly intelligent products, such as serious games, can be used in healthcare, often acting as medical aids. Serious games can improve the care skills of caregivers of people with dementia and reduce the psychological stress levels of caregivers.

**Objective:** Identify feedback on attitudinal issues and the use of serious games (through gamification or video games) by caregivers of people with dementia.

Methods: To synthesize caregivers' feelings about serious games, we used four databases (Embase, PubMed, Cochrane, and Web of Science databases) to conduct a systematic review. We searched both quantitative and qualitative studies. Eight articles were included in this study, consisting of 5 qualitative studies and three quantitative studies.

**Result:** A total of eight studies met the search criteria, seven related to carers' experiences of using serious games after using a shot, serious games, on caregivers. Recent studies have reported caregivers' attitudes after using serious games, including their opinions on the design of serious games and their experience of using them. The average age of most people involved in the study was over 50. Furthermore, the beneficiaries of serious games are mainly dementia patients and their caregivers. Regarding the experience of using serious games, most of them pay attention to whether games can improve the efficiency of nursing work.

**Conclusion:** In the face of significant psychological problems for caregivers, exploring more effective intervention methods can help caregivers have more space to choose intervention methods that suit them. With the advancement of technology, more electronic applications suitable for caregivers can be developed to carry out treatment and prevention through procedures at their fingertips after work.

*Key words*: dementia, caregiver, serious games, elderly, systematic review

**Introduction**

With the global aging trend, the number of Dementia patients is gradually increasing. Today, the number of Dementia patients worldwide has reached 50 million. By the middle of this century, the number of Dementia patients worldwide will reach 150 million (Gustavsson et al.,2023).

However, caregivers of dementia patients are also under tremendous psychological pressure while bearing the pressure of nursing work. Because dementia patients need long-term from caregivers. Moreover, because the symptoms physical conditions of each dementia patient are different, caregivers have already experienced tremendous psychological pressure during the long-term work process (MaTeresa González-Salvador et al., 1999). In the Innes' (2012) study, the prevalence of sleep disturbance and depression among Alzheimer's caregivers was as high as 68 percent and 55 percent, respectively. Therefore, targeted interventions for caregivers with dementia and alleviating the psychological problems of caregivers are essential in health care. Many research designs have also been proposed in the current study to help caregivers reduce stress and improve work efficiency. The current interventions for caregivers of dementia are divided into drug intervention and psychosocial intervention (Mittelman et al., 2008). Family caregivers of people with dementia (often called invisible second patients) are the key figures in whether people with dementia can achieve a good quality of life. The impact of being a family caregiver, while sometimes positive, is usually primarily negative, with high rates of burden and psychological morbidity, as well as social isolation, physical ill-health, and financial hardship. Caregivers are vulnerable to negative influences can be identified, as well as factors that can reduce or exacerbate burdens and stress. Unlike professional caregivers, informal caregivers have no professional nursing training and suffer from a care-work-life imbalance in their daily lives.

Carers face many barriers in balancing caring with other demands, including childcare, professional and interpersonal relationships. They are at increased risk of financial burden, stress, depression, and other health complications. Research has shown that the impact on carers is varied and complex, and many other factors may exacerbate or improve carers' reactions and feelings about their role. Many studies report that caring for someone with dementia is more stressful than caring for someone with a physical disability (Brodaty & Donkin, 2022). A meta-analysis in one study found that family caregivers with dementia are significantly more stressed and experience more severe depressive symptoms and physical problems than non-dementia family caregivers. The situation may be more severe in developing countries where formal services and benefits for patients and caregivers are lacking. Dementia caregivers are at risk of cardiovascular disease, particularly hypertension, mediated by chronic inflammatory responses and sympathetic hyperactivation (Sallim et al.,2015). Another meta-analysis found that the overall prevalence of elevated symptoms of depression and anxiety was 34% and 44%, respectively (Joling et al.,2015). A longitudinal study found that for caregivers who did not have these conditions at baseline, the prevalence of major depression and anxiety disorders was 37% and 55% over two years intervals; comorbidities were found in up to 60% of caregivers with depression or anxiety disorders (Joling et al.,2015). This is reason enough for mental health professionals to be concerned (Cheng,2017). One study of face-to-face interviews with 50 older women caring for their husbands with dementia at home showed that frustration was associated with more distress (Motenko,1989). When caring for a person with dementia, the frustration of disrupting life plans is most significant at the onset of symptoms. It decreases as daily life progresses, despite the need to provide more care. Nevertheless, the quality of care is more critical to the caregiver's well-being than the quantity of care provided (Motenko,1989). Therefore, in the question of how to help caregivers improve their mental health in nursing work, it may be possible to focus on helping caregivers increase work efficiency.

With the advancement of technology, there are more interventions for caregivers of dementia, such as video-based games, VR games, and non-pharmaceutical interventions for A.R. games. Serious or applied game is designed for purposes other than pure entertainment. This "serious game" is commonly used in strategic military training, educational dissemination of knowledge, learning complex scientific knowledge, and video games in multiple social domains such as healthcare delivery (Alvarez et al., 2012). Serious games are used in healthcare for rehabilitation training and as an auxiliary medical tool. Serious games have been used for many purposes. For example, they can be used to initially grade patients' diseases, educate the population about related diseases through games, and help people perform rehabilitation training through game mechanisms (Manera et al., 2017). In the past two decades, many serious games have been developed in electronic medicine, such as using V.R. technology to help surgeons perform surgical training and practice cardiopulmonary resuscitation (CPR) for patients. They carry out nursing care (Watters et al., 2006). The gamification model for caregivers has been explored and focused on in some ways. Serious games aim to improve one of the appropriate tools for formal and informal caregivers of patients with dementia (Wiloth et al., 2017). iDO game evoked positive emotions and attitudes in future caregivers of people with dementia, indicating that they were in a more relaxed state and less fearful when completing the caregiving process (Maskeliūnas et al.,2019). Serious games are designed to improve an individual's knowledge, skills, or attitudes in the 'real' world. Serious games for medical or health-related purposes are growing rapidly in number and type of application. They are more effective than traditional neuropsychological interventions in improving the cognitive abilities of older people. An essential application of serious games is the training of medical and nursing staff. Serious games have improved medical students' understanding of geriatric principles (Dietlein et al.,2019). Therefore, serious games can help medical practitioners or informal caregivers to learn. It can also provide information technology support and services for healthcare in the context of a number of different diseases.

Caregiving stress is evident in formal and informal caregivers of people with dementia (AdA & NAC, 2004; Schulz & Beach, 1999). These stresses include physical, psychological, and financial stress (Selfe et al., 2012). According to new research, iSupport Virtual Assistants (VA) can alleviate the mental health of carers of people with dementia, Serious Game cCBT package is effective in treating the psychological problems of carers of people with dementia, Serious Game Make a Cup of Tea can improve the quality of life of family carers of people with dementia, and video games can improve the well-being of professional carers. Exergames Go&Grow can relieve the psychological stress of caregivers and video games can improve the well-being of professional caregivers. A new serious game, the iSupport Virtual Assistant (VA), improves caregivers' mental health and well-being by developing the skills and resilience of caregivers of dementia patients (PLWD) to manage different stressors (Nguyen et al., 2021). Similarly, the Serious Game cCBT package effectively accessed mental health difficulty treatment for formal and informal caregivers of people with dementia (Hales & Fossey,2018). Additionally, Serious Game Make a Cup of Tea has improved the quality of life among family caregivers of pre- and early-stage dementia patients (Liu,2019). Second, a study showed that the Exergames Go&Grow could alleviate high stress experienced by caregivers of people with dementia (Lin et al., 2020). Finally, studies have shown that video games can support the daily life of patients and caregivers, reduce caregivers' stress, and improve their health status (Unbehaun et al., 2018). In summary, serious games can be an intervention for caregivers of people with dementia.

Serious games can be used to assess the acceptability and effectiveness of an indicator, decision-making, which is essential in care delivery. Serious games that develop creativity and thinking skills can be used to teach nursing staff creative methods to provide better person-centered, highly skilled care outcomes. A study of professional, serious games in nursing education has shown that various essential competencies, including procedural development, health assessment, communication, and clinical reasoning skills, can be improved (Johnsen et al., 2018). Dialogue and other types of simulation in games can also be used to illustrate cross-cultural cross-communication issues (Davis, & Knight, 2018). Serious games can also enhance virtual training, such as clinical virtual simulations(Williams-Bell et al.,2015). They can be used as a teaching method to complement real-life alternatives and for contextual awareness, situational thinking, and model improvement, for example, in dementia care. Significant differences in the appearance of competence have been found between people who play simulation games and those who have received traditional life support exercises (Maskeliunas et al.,2022). Therefore, in modern times, there are serious games available for people with dementia and their caregivers.

Historically, systematic reviews have focused on artificial intelligence (A.I.) interventions for people with dementia, with little reference to caregivers, including review of the literature on artificial intelligence interventions for patients with dementia (Mohammed,2019), and Literature Review on the Design of Smart Homes for People with Dementia (Raei, & Bouchachia,2016). Dementia Games: Literature Review of Dementia-Related Serious Games (McCallum, & Boletsis,2013). To date, a systematic review of the literature on artificial intelligence (A.I.) interventions for caregivers of patients with dementia is lacking (Xie et al., 2020). Although caregivers of dementia patients increasingly use game-based interventions, the requirements for caregivers are different for patients with dementia at various stages. In addition, the limited capacity of informal caregivers must be considered. We therefore conducted a systematic review of attitudes towards serious games among caregivers of people with dementia. Feedback from caregivers on the effectiveness of using serious games and suggestions and comments on the use of serious games have tremendous practical value for developing serious games at a later stage. And since there is no review literature on feedback and recommendations for serious play interventions from caregivers of people with dementia, this systematic review fills a gap in the field.

Just as serious games can be used to assist people in all areas of society at present, there is still a need for more systematic research to help the development of serious games. This is because dementia caregivers are often faced with the complex progression of dementia in their care, and informal caregivers lack specialist skills due to a lack of training. This results in caregivers often experiencing difficulties in communicating, low caregiving skills, and reduced self-efficacy when caring for people with dementia. There is therefore a need to provide an assistive technology for carers of people with dementia and to investigate their attitudes and feelings when using it. Understanding the impact of games on caregiver interventions is crucial. Lay carers of people with dementia are family members or people who are not professionally trained in caring for people with dementia. These groups face various problems such as the need for a medical foundation, nursing skills, time, communication skills and an inability to empathies with the patient. Therefore, a systematic review of the nature of the literature on play interventions for caregivers of people with dementia was carried out. A qualitative analysis of the literature included in the study was carried out.

The purpose of this study was to explore how to improve the caring ability of dementia caregivers and improve the physical health of dementia caregivers through a systematic review of relevant literature. It can also increase the well-being of carers of people with dementia and ultimately reduce public pressure on society as a whole. Traditional stereotypical thinking has always only considered people with dementia as a group. A staggering number of carers of people with dementia also suffer from physical and mental stress. They are either professional medical caregivers or non-professional family companions. They face many problems, such as difficulties in communicating with patients, lack of responsiveness to their work, and lack of patient cooperation. We hope this new therapeutic intervention, Serious Games, can significantly help professional and non-specialist caregivers in caring for patients with dementia who face difficulties in caregiving and communication.

**Research Methodology**

**Methods**

A systematic review study was conducted using the PRISMA (Preferred Reporting Project for Systematic Evaluation and Meta-Analysis) guidelines. The review was based on a February 2023 search of Embase, PubMed, Cochrane, and Web of Science databases. There are no restrictions on the year of publication.

**Search strategy**

References are made to the following databases: EMBASE (Ovid), PubMed, Cochrane, and Web of Science. Grey literature was also consulted, but no relevant research was found. The grid terms used in the search strategy are '(game OR gamification OR virtual reality OR video games OR exergaming OR experimental) AND (dementia OR delirium OR cognitive dysfunction OR Alzheimer disease) AND (caregivers OR nurses). ' The study was conducted in February 2023 under the PICO (Population, Intervention, Comparison, Outcomes) strategy. Explore the following questions: What are the attitudes of carers of people with dementia towards the use of serious games?

**Inclusion and exclusion criteria**

Articles meeting the following criteria were included:

1. The purpose is to analyze the impact of different serious games on caregivers' or caregivers' perceptions of serious games.

2. These articles need to include a survey of caregivers and analyze the impact of serious games on caregivers.

3. The sample included both informal and formal caregivers who cared for at least one older person with dementia.

4. Serious games are designed for medical care, need to be operated on electronic devices, and need to be operated by users in the form of games.

5. The methods are qualitative analysis and quantitative analysis.

The following types of study were excluded:

1. A language other than English.

2. Papers that offered a review of any sort, meta-analyses, theoretical papers, notes from conferences, proposals, and any other form of literature review.

3. Research not related to health care factors, but games for entertainment.

4. Papers for which no or only abstracts are available.

5. Only focus on older people with dementia, not caregiver populations.

**Data extraction and presentation**

Two independent reviewers selected studies following the following procedure: First, the title and abstract of the study were screened according to the inclusion criteria, and then the full text was screened. Two authors (Peng-An Chen and Xue-Ting Yuan) independently reviewed the abstract and title using Endnote software. Any doubts between the two authors about fulfilling these criteria could be resolved through a discussion between Peng-An Chen, Yidan Yuan and Xue-Ting Yuan.

Next, full-text articles were assessed by Xue-Ting Yuan and Yidan Yuan to evaluate whether the included studies met the inclusion criteria. We emailed the corresponding author twice to obtain the requested article if an article was unavailable. The language requirement for our setting was English. After selecting eligible articles, the three authors (Peng-An Chen, Xue-Ting Yuan, and Yidan Yuan) extracted the required items separately according to the extraction format designed for the process. Any discrepancies or disagreements in the data extraction were resolved through discussion between Peng-An Chen, Xue-Ting Yuan, and Yidan Yuan until a consensus was reached. We tabulated the results based on the options selected to systematically summarize the effects of the application of serious games in each piece of literature studied. Based on the terms of reference for the systematic scoping review, the eight pieces of literature and the above data were categorized to map the current evidence.

**Result**

**Search Results**

The first part is identification (Figure 1). Four hundred eighty-eight articles were selected from four databases. Thirty-six of them were excluded before screening due to record duplication.

The second part is screening. We screened 452 articles by title, 58 of which were excluded because they contained conference articles, literature reviews, or systematic reviews. The remaining papers(n=182) were excluded because they did not involve people caring for people with dementia.

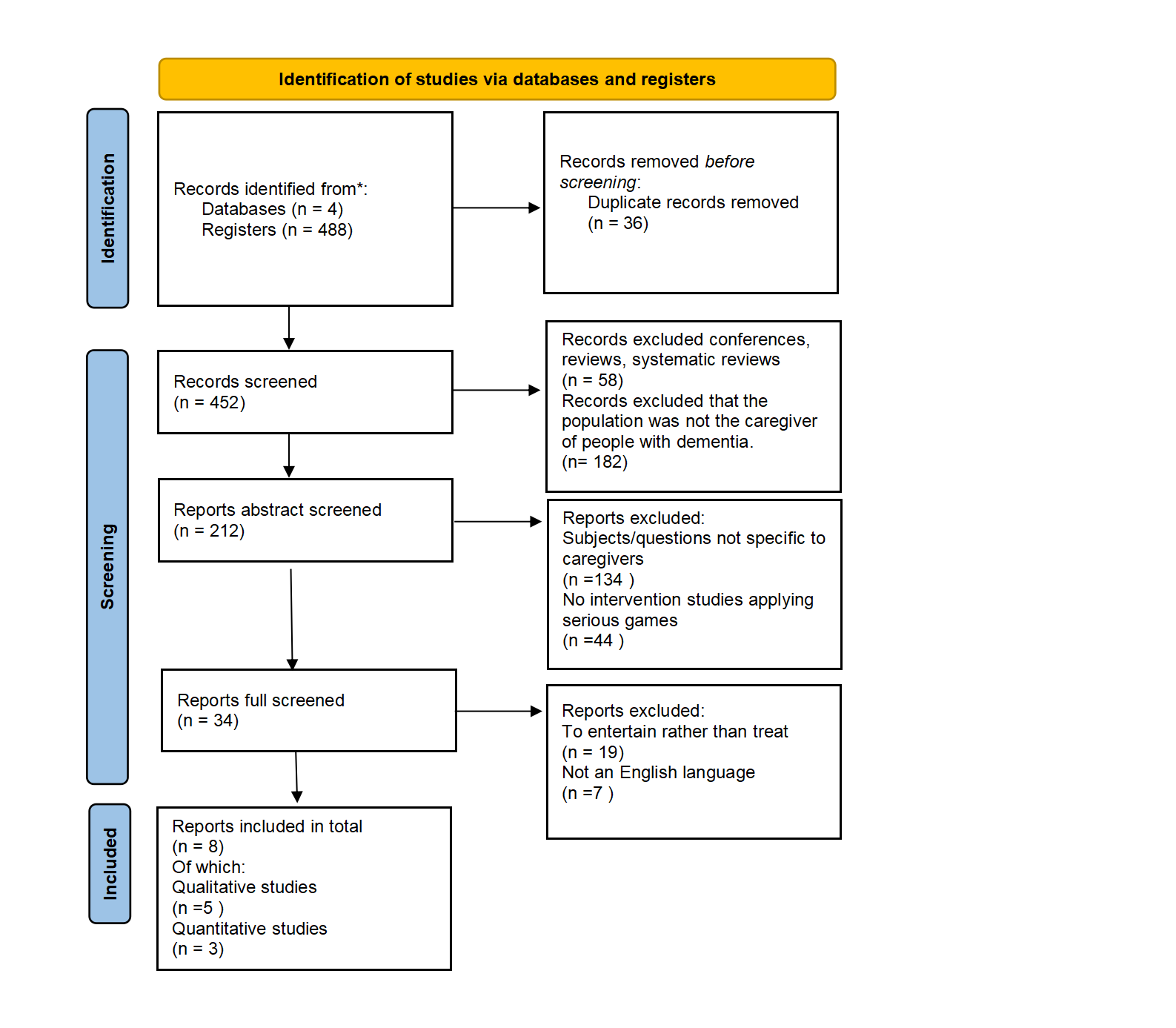
The third part was to screen abstracts(n=212), 134 of which were excluded because the subjects and questions were not specific to caregivers. The remaining 44 were excluded because the intervention study did not use serious games.

The fourth part was to sift through the full text of articles(n=34), 19 of which were excluded because serious games were used for entertainment rather than therapy. The other seven were excluded because the literature needed to be in English.

In our screening process, a third reviewer is asked to make the final decision if the reviewer disagrees. A total of eight studies were included in the analysis, three of which were quantitative and the remaining five were qualitative (Table 1).

**Figure 1**

*Diagram of search strategy.*



**Table 1**

*Association of serious games with caregiver attitudes*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Title | Year | Ref. | Collect data from caregiver | Focous on the dementia | Use serious games | Data collection | Number of the caregiver | Age of caregivers | Experiment duration |
| A Usability Analysis on the Development of Caregiver Assessment Using Serious Gaming Technology (CAST) Version 2.0: A Research Update | 2021 | Jennifer et al., 2021 | Yes | Yes | CAST | Semi-structured interviews | n=10 | Average Age 59 | 10 minutes |
| Human Factors and Requirements of People with Mild Cognitive Impairment, their Caregivers and Healthcare Professionals for eHealth Systems with Wearable Trackers | 2020 | Stavropoulos et al., 2020 | Yes | Yes | Mobile Health (mHealth) apps | Questionnaire (close-ended, open-ended, multiple choice, and Likert scale questions) | n=33 | HCPs (Average Age 34.05); caregivers (Average Age 52.53) | 1 month |
| Notes of memories Fostering social interaction, activity and reminiscence through an interactive music exergame developed for people with dementia and their caregivers | 2020 | Unbehaun et al., 2020 | Yes | Yes | A music-based exergame | Semi-structured interview | n=7 | unclear | 4 months |
| SafeHome: A Serious Game to Promote Safe Environments for Persons Living with Dementia | 2020 | Appel et al., 2020 | Yes | Yes | SafeHome | Questionnaire and semi-structured focus groups | n=13 | unclear | 45 minutes |
| Social Technology Appropriation in Dementia: Investigating the Role of Caregivers in engaging People with Dementia with a Videogame-based Training System | 2020 | Unbehaun et al., 2020 | Yes | Yes | Videogame-based training system | Interview | n=25 | Aged between 34 and 97; Average Age 66.4 | 4 months |
| Use and Adoption of an Assisted Cognition System to Support Therapies for People with Dementia | 2016 | Navarro et al., 2016 | Yes | Yes | Assisted cognition system AnswerPad and AnswerBoard | Scale assessment | n=3 | Average Age 51 | 16 weeks |
| Effects of Exergaming on Cognitive and Social Functioning of People with Dementia: A Randomized Controlled Trial | 2020 | van Santen et al., 2020 | Yes | Yes | Exergaming | Structured questionnaires | n=65 | Exegame group (Average Age 65); Control group (Average Age 67) | 9 months |
| Serious Game iDO: Towards Better Education inDementia Care | 2019 | Maskeliūnas et al., 2019 | Yes | Yes | The iDO serious game | Scale assessment | n=48 | Age between 26 and 71 | 4 months |

**Table 2**

*Associations between the use of serious games and caregivers in included studies.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Title | Development time | User | Experience time | Beneficiary | Content | Theory |
| A Usability Analysis on the Development of Caregiver Assessment Using Serious Gaming Technology (CAST) Version 2.0: A Research Update | 2020 | Caregivers and patients | 5 to 15 minutes | Patients and caregivers | Creat Reminder/Word Scramble/Questionnaire | ICT |
| Human Factors and Requirements of People with Mild Cognitive Impairment, their Caregivers and Healthcare Professionals for eHealth Systems with Wearable Trackers | 2020 | Caregivers and patients | 3 to 6 months | Patientscaregivers and HCPs | mHealth and brain games | Implement passive apps which target in assessment and monitor apps/ICT |
| Notes of memories Fostering social interaction, activity and reminiscence through an interactive music exergame developed for people with dementia and their caregivers | 2020 | Caregivers and patients | 60 minutes | Patients and caregivers | A music-based exergame | ICT |
| SafeHome: A Serious Game to Promote Safe Environments for Persons Living with Dementia | 2020 | Caregivers and patients | 180 minutes | Patients and caregivers | Game elements and feedback(2D) | 3D and 2D |
| Social Technology Appropriation in Dementia: Investigating the Role of Caregivers in engaging People with Dementia with a Videogame-based Training System | 2020 | Caregivers and patients | 20-25 minutes | Patients and caregivers | Strength and movement,coordination,balance | ICT/ Videogame-based training system |
| Use and Adoption of an Assisted Cognition System to Support Therapies for People with Dementia | 2016 | Caregivers and patients | 30 minutes | Patients and caregivers | Intervention with Traditional Artifacts Intervention Support with AaIS | AT/ AnswerPad and AnswerBoard |
| Effects of Exergaming on Cognitive and Social Functioning of People with Dementia: A Randomized Controlled Trial | 2020 | Dementia patient and informal caregivers | 60 mintues | Patients and caregivers | Interactive cycling using a stationary bicycle | ICT |
| Serious Game iDO: Towards Better Education inDementia Care | 2019 | Dementia patients and formal and informal caregivers | 20 minutes | Patients and caregivers | iDO caregivers’ behavior improvement model, design of game mechanics | ICT |

**Characteristics of the Studies in the Review**

***Age***

Most studies reported (5 studies) the mean age of the carers participating in the study, most of whom were over 50 years old (Jennifer et al., 2021; Stavropoulos et al., 2020; Unbehaun et al., 2020; Navarro et al. al., 2016; van Santen et al., 2020). The average age of participants was not reported in other studies (Unbehaun et al., 2020; Appel et al., 2020). Because in this systematic review, the scope of the definition of caregiver was defined as informal caregiver and formal caregiver. Therefore, in the study, the minimum age range for the caregivers participating in the study was 26 years old.

***Data collection***

A total of three studies used interviews to collect data, most of which used semi-structured interviews (Jennifer et al., 2021; Unbehaun et al., 2020; Appel et al., 2020). Three studies used questionnaires to collect data (Stavropoulos et al., 2020; Appel et al., 2020). In addition, two studies collected research data by means of scale measurement (Navarro et al., 2016; Maskeliūnas et al., 2019).

***Number of carers participating.***

The number of caregivers involved in the studies varied. The study with the largest number of caregivers was 48, and the smallest was only three (Maskeliūnas et al., 2019; Navarro et al., 2016). Therefore, the sample size in the eight included studies was small, and it was difficult to extract diverse information in the studies.

***Experiment duration***

Six studies had a study duration of one month or more (Stavropoulos et al., 2020; Unbehaun et al., 2020; Unbehaun et al., 2020; Navarro et al., 2016; van Santen et al., 2020; Maskeliūnas et al., 2019). The shortest experiment length collects attitudes toward serious gaming after 10 minutes of use (Jennifer et al., 2021).

***Paper publication time***

Six studies were published in or after 2020 (Jennifer et al., 2021; Stavropoulos et al., 2020; Unbehaun et al., 2020; Appel et al., 2020; Unbehaun et al., 2020; van Santen et al., 2020). However, the time gap between the two other publications could be more outstanding.

**Outcomes**

Table 1 summarizes the research methods and subjects used in the eight included studies. Serious games can help ease the caregiver's burden in their work. Therefore, caregivers' feelings about using serious games mostly revolve around whether serious games can help caregivers improve the quality of nursing work. According to the research, the caregivers put forward their feelings of use around three points of use experience. They are: (1) Improve efficiency. (2) Reduce the burden. (3) Increase health. The following is an analysis of caregivers' attitudes toward serious games in the study included through these three keywords.

***Improve efficiency.***

Because of the busy work burden of caregivers, caregivers should pay special attention to whether a serious game can help their work efficiency when using serious games. First, reminders became the most popular feature in serious games. In two articles, caregivers responded positively to reminders in serious games (Jennifer et al., 2021; Stavropoulos et al., 2020). In the Jennifer et al. (2021) study, all participants approved of the reminder function in serious games, and in Stavropoulos et al. (2020) study, more than half of the participants said that having medication reminders in serious games helped caregivers better with their tasks. Because caregivers are faced with long hours of multi-tasking, most caregivers need to juggle nursing and daily life tasks. As a result, caregivers expressed great approval and support for the reminder feature in serious games. Secondly, the length of use may affect the caregiver's experience of use. Dementia patients need care and help from caregivers for a long time, so a serious game that can be played quickly for caregivers can improve the quality of their work while improving their work efficiency. In two articles, caregivers used interviews to express suggestions about the length of play in serious games (Jennifer et al., 2021; Unbehaun et al., 2020). In the interview, the caregivers hope that serious games can be integrated into the nursing process so that serious games can be conveniently used in daily life. When serious games appear in the daily life of the caregivers as daily objects, they can help the caregivers recover in a brief time so that the caregivers can get relaxation in the short free time.

***Reduce the burden.***

Caregivers tend to have a substantial work burden in the busy work content. Moreover, due to the condition of dementia patients, they may distrust and refuse to listen to the nursing staff, which can also exert intense pressure on the mental state of the nursing staff. In two articles, caregivers' attitudes after using serious games are shown by testing their psychological burden before and after using serious games. In the included study by van Santen et al. (2020), serious games can improve caregivers' positive experiences during the nursing process. In the performance of the playgroup, caregivers' distress showed a slight decline after intervention and three months after intervention. Jennifer et al. (2021) also proved that using serious games could effectively reduce caregivers' burden in the long run. Even in the two articles, the sample size still needs to be bigger, and the results are not significantly reduced. But the overall value also provides a more positive scientific basis for future research.

***Increase health.***

Caregivers are often faced with heavy work burdens, and under work pressure, caregivers may suffer from severe mental and physical diseases. Given this phenomenon, a lot of serious games have been played, and gamification has been carried out for this purpose, hoping to reduce caregivers' psychological and physical burdens through gamification interaction. Thus, improving the health of caregivers. In the research of Appel et al. (2020), it is proposed explicitly that the reward mechanism should be increased in the setting of serious games, and the motivation and satisfaction of caregivers to participate in games should be improved through specific reward and punishment systems. Another study also mentioned reward mechanisms to help caregivers become more actively engaged with the game (Jennifer et al., 2021). In addition, caregivers can get positive feedback while playing games, which can improve their enjoyment in the process of using games and reduce their boredom in day-to-day work.

The first of the eight studies included was published in 2016. In this systematic review, the scope of the definition of caregivers is defined as informal caregivers and formal caregivers. Thus, the age range of caregivers in the eight studies was relatively wide. Nevertheless, the average age of caregivers from the eight studies was mainly older than 50. In the eight studies included, there was a small sample size. In addition, most survey methods are based on interviews and questionnaires, resulting in a small sample size and insufficient information extraction of small props. Nor was there an incredibly detailed description of the race and country of the participants in the eight studies. It was also mentioned in two studies that serious games did not significantly relieve or improve caregivers, who could not effectively improve the quality of life and relieve the mental pressure brought by nursing after using element games (van Santen et al., 2020; Unbehaun et al., 2020). This study also suggested that only 18% of HCPS and 27% of caregivers were willing to use serious games long-term (Stavropoulos et al., 2020). Another study also reported that caregivers and dementia patients were less motivated to use the number game (Unbehaun et al., 2020). In the eight studies, caregivers surveyed reported positive attitudes toward serious games. Only two studies showed that serious games had a slight improvement for caregivers.

In Table 1,we analyze the associations with caregivers in the eight included studies, and from that, we analyze the general profile of study participation. Table 2 summarizes and analyzes the serious games used in each study.

Table 2 shows the association of serious games used in the included studies with caregivers. The design of serious games can determine how caregivers feel about their experience during work. Therefore, based on the research included, the analysis can focus on five aspects of serious game design: development time, users of the game, game experience time, beneficiaries of the game, and the theory of the game.

***Development time***

The attitude of caregivers towards serious games, especially for caregivers of people with dementia, is a new research direction. Therefore, all eight papers have a game development time of around 2020.

As this timeframe falls during the global pandemic of New Coronary Pneumonia, healthcare is becoming increasingly challenging. One article clearly shows New Coronary Pneumonia's impact on caregivers (Jennifer et al., 2021). In Jennifer et al. (2021) study, it is mentioned that in this environment, there is a greater risk of isolation and stress for caregivers, which further complicates their ability to receive treatment and service assessments. In addition, the new coronary pneumonia outbreak exacerbated caregiver isolation, leading to the timely development of a home assessment tool.

***Game users***

The most serious game users of the eight papers were dementia patients and their caregivers. There are six papers where the game users are caregivers (Jennifer et al.,2021; Stavropoulos et al., 2020; Unbehaun et al., 2020; Appel et al., 2020; Unbehaun et al., 2020; Navarro et al., 2016) and patients and the remaining one paper where the user is a dementia patient and informal caregivers (van Santen et al., 2020), and the other one was for dementia patients and formal and informal caregivers. However, in Maskeliūnas et al. (2019) study, it was explicitly suggested that users of serious gaming make formal caregivers and informal caregivers, and he lumped both categories of people together. The definition of caregivers was also mentioned in another study, which focused on informal caregivers' perceptions of the experience of exergaming (Van Santen et al., 2020).

***Experience time***

Due to the heavy workload of caregivers, caregivers should pay special attention to whether it may affect work efficiency when using serious games. The duration of game use emerged as a significant factor in whether caregivers used serious games. From the included literature, it is found that there are four papers with game time within 30 minutes and a total of four papers with game time greater than 30 minutes. In two articles, caregivers experienced short periods of serious play (Jennifer et al., 2021; Maskeliūnas et al., 2019). Jennifer et al. (2021) showed that caregivers spent 5-15 minutes each in the game, while in Maskeliūnas et al. (2019) Learning, Serious Games 20 minutes per session.

***Beneficiary***

The most serious game beneficiaries of the eight papers are dementia patients and their caregivers. For game beneficiaries, seven papers had Patients and caregivers as beneficiaries, and the remaining one had Patients, caregivers, and HCPs as the game's beneficiaries. However, in Stavro Poulos et al. (2020) study, it is proposed explicitly that the beneficiaries of serious gaming are healthcare professionals and their patients. Their needs in terms of mHealth apps were explored through a constructive survey questionnaire.

***Theory***

The final analysis is the theory of serious game applications, and most of the eight studies used information and communication technology for the theory of serious games. Four papers used only information and communication technology for the theory of games. Of the rest, one used Implement passive apps which target assessment and monitor apps and information and communication technology; one used 3D and 2D; one used information and communication technology and Videogame-based training system; one paper used Assistive Technology and Answer Pad and Answer Board. However, in Maskeliūnas et al. (2019) study, it is specifically suggested that the theory of serious game applications is 2D and 3D technology. This technology enables the communication between healthcare professionals and user interface (UX/UI) designers to achieve a better sense of the gaming experience.

**Discussion**

From the research, caregivers generally support using serious games and propose improvement measures for setting serious games for reference. In the current era of widespread use of smart devices, people can carry out various activities through serious games to enrich, improve, and improve individuals' quality of life and medical conditions. When the world is facing the problem of population aging, serious games are undoubtedly a key to reducing the medical burden for the aging society and improving the quality of old-age care for human beings and the world. In the field of elderly care, we should pay attention not only to the quality of life of the older person but also to the quality of life and mental health of the caregivers who have cared for the older person for a long time. Therefore, exploring caregivers' views on serious games can have a specific impact on the future development of serious games and the development of the elderly care industry. We systematically reviewed attitudes towards using serious games among carers of people with dementia, identifying eight studies. The eight studies varied in terms of the serious games used and how they were used.

**Caregiver attitudes toward serious games.**

Even today, the popularity of smart devices has brought much convenience to nursing work. However, serious gaming or smart devices are a significant challenge for many. First, caregivers' acceptance of serious play is influenced by several factors. We found that the mean age of informal caregivers in the included studies was predominantly over 50. Older users present a specific challenge for serious gaming setups.

On the one hand, gamification can help older users better acquire knowledge and reduce the tedious experience of acquiring knowledge. On the other hand, the setting of gamification may also affect the age of more significant users, bringing difficulty in understanding the meaning and operation of the game. A literature survey found that older person has specific barriers to learning and acquiring information technology, and some older adults have relatively low intentions to use smart devices or learn innovative technology (Niehaves & Plattfaut, 2014; Raban & Brynin, 2006). Because informal caregivers of people with dementia generally consist of family partners or children. Informal caregivers (partners) who are similar in age to people with dementia often face difficulties with unhealthy physical conditions or cognitive decline. In using emerging electronic devices, the older adult needs more confidence in using and processing technology due to the complex operation process, thus reducing the chances of older adults being exposed to related technological products (Karavidas et al., 2005).

Moreover, according to the research, it is also pointed out that much health-related software currently only focuses on the young people's market and is biased towards young people regarding content and form (Martinho, 2020). Even in the modern world of intelligent devices, serious games for caregivers of people with dementia can benefit economically and educationally underserved populations. However, most of the eight included studies required participants to have an internet-connected computer or a clear monitor at home or in a daycare center. Equipment limitations mean certain financial and educational limitations to using serious games for medical purposes. However, the research also found that many caregivers were keen to provide pre-use training during serious games. Providing prior training can help caregivers reduce the strangeness of using serious games. At the same time, it can also improve the experience of caregivers after using serious games.

Furthermore, it is also mentioned that in serious games, it is necessary to provide users with pre-use training (Unbehaun et al., 2020). Studies have shown that providing thorough training for the elderly can help them elderly improve their motivation to learn new technologies (Kubeck, 1999; Morris, 1994). Some studies currently provide workshops for older adults to learn innovative technology in many communities (Bradley & Poppen, 2003; Lam & Lee, 2005). Learning information technology, on the one hand, can help informal caregivers adopt serious games more smoothly. On the other hand, it can help caregivers use more information technology in daily life or the Internet for learning. Caregivers' attitudes toward serious games, therefore, depend on multiple factors. Various factors should be considered when designing serious games to attract caregivers to use serious games for healthcare functions.

In short, the gamification setting can allow people of more ages to learn and progress through games. With the aggravation of the aging trend, patients with dementia also need more attention. They have increased public understanding and awareness of people with dementia through a serious game that a wide range of age groups can use. At the same time, it can also reduce the knowledge barriers caregivers of dementia patients encounter in nursing work. Some informal caregivers do not have the experience of preparing to learn nursing knowledge during the nursing process, and they also lack relevant knowledge about drugs or nutrition. A serious game for the public can help informal caregivers receive relevant education and learning opportunities daily.

**Factors Influencing Caregiver Attitudes to Serious games Use.**

A variety of factors influence caregivers' attitudes toward the use of serious play. From the included studies, we found that the main feeling of most caregivers about serious games is whether this kind of serious play can improve their work efficiency in nursing work. Therefore, when game designers design related serious games, serious games cannot only have a single function of relaxation or relaxation. The design of serious games must include related assistive technologies to help caregivers reduce the burden of nursing work: burden and stress. Furthermore, the user can more quickly and conveniently acquire knowledge, experience, and satisfaction from the game's results through the game. We found that many smart devices or systems can help caregivers reduce stress, but how they exist and behave is not in the form of gamification. The study by Madara Marasinghe (2016) found that Assistive technology can help caregivers reduce their burden. Even though technology cannot wholly replace manual labor hours, it can increase the efficiency of nursing work and save nursing staff through the assistance of technology. More time and energy. It is also proposed that the application designed for caregivers is not limited to helping caregivers obtain correct information in many aspects and needs to pay attention to the emotional needs of caregivers (Sala-González et al., 2021). Therefore, when designing and discussing the purpose of serious games with caregivers, more attention should be paid to caregivers' work and spiritual needs. However, only one of the eight included studies looked at the effect of serious games on the caregiver's condition. The focus of the remaining seven studies was caregivers' improvement in handling and use of serious games. Research on the former may shed light on the effects of serious games on caregivers. The latter study may illustrate where caregivers are more likely to expect serious games to be continuously improved to suit the caregivers' work needs. In fact, for serious games, we should pay attention to the relationship between the two and discuss the two-way influence between serious games and caregivers. This allows for a more diverse design and development of serious games and research to understand the practical difficulties that caregivers face in nursing work. Therefore, when using serious games, caregivers can evaluate the functions of serious games and the benefits obtained after using elemental games. This evaluation also affects caregivers' attitudes after using serious games.

**Serious Game for Caregivers**

While we reviewed serious games that caregivers of people with dementia can use, there are currently more serious games aimed at people with dementia only. Serious games used in only two studies in our study were directed to caregivers alone. There are already many smart devices available for caregivers to use. However, most smart devices are designed to assist caregivers in nursing. Most smart assistive devices can provide practical and valuable assistance to caregivers in monitoring patients and predicting patient activities, thereby reducing the workload of caregivers. Some ICT technologies can help caregivers broaden the scope of social interaction or help caregivers learn related knowledge. A survey showed that more than 80% of caregivers use technology of teleassistance applications (Martínez-Alcalá CI et al., 2016).

Moreover, the general technical concern is to improve the quality of the daily life of caregivers. A literature review also suggested that using ICT technology in Europe can reduce the pressure caused by the geographical environment and labor shortage of nursing staff (Lucero et al., 2019). Moreover, since many chronically ill patients require long-term care, the range of practical applications and designs for intelligent technology is also more comprehensive. The use of smart devices in nursing work also covers all aspects of nursing work. Whether providing social support for nursing staff, helping nursing staff and patients improve opportunities to participate in social activities, or helping nursing staff detect and predict the future development of patients' illnesses, these intelligent technologies can significantly improve self-care in nursing work. Efficacy and work enhance work experience (Barrera-Ortiz et al., 2011; Genovese et al., 2018). Although the serious games used in most of the studies in our review were not designed for caregivers alone, it is precisely because the most crucial aspect of serious games for caregivers is that it is connected to the caregiver's nursing work, so the needs of both parties must be considered when designing related games.

All in all, according to the above-mentioned, caregivers' attitude towards serious games depends on different factors in the use process and affects the caregivers. The factors of attitude are composed of many aspects for the use of serious games. Therefore, when designing serious games that can be applied to caregivers of dementia patients, the corresponding scope of application should be clearly defined. On the one hand, when serious games are only intended for caregivers, caregivers should be considered in the design process. In design research, personal caregivers should be actively involved in product research and development, and caregivers should be able to use them generally during life. On the other hand, when serious games need to be geared toward caregivers and the people, they care for. In the design process, users' needs should be widely considered in a human-centered manner.

The enthusiasm for the development of different serious games is generally shown in our research. Easy to use in healthcare settings, in the community, and at home, following the continuous development of serious games for caregivers.

**The advantages of information and communication technology**

Based on the frequency of information and communication technology in game theory in eight papers, it appears that serious games, especially video games (video games with physical activity), have also recently gained some attention. These studies have shown that they improve fitness, persistence, and balance regardless of age (Larsen et al., 2013). Video games that combine physical, cognitive, and socio-emotional goals have the potential to further support people with dementia by promoting social interaction and collaborative activities that help to alleviate the depression, anxiety, and stress commonly associated with dementia.

**The widespread use of ICT**

Based on the frequency of ICT in game theory in the eight papers, serious games, especially video games (video games with physical activity), have also received some attention recently. It is clear from the research that ICT technologies have a wide range of applications in serious games and that ICT technologies can help serious games to be better designed, for example, by improving health, persistence, and balance, regardless of age (Larsen et al., 2013). Video games that combine physical, cognitive, and socio-emotional goals have the potential to further support people with dementia by facilitating social interaction and collaborative activities that help to reduce the depression, anxiety, and stress that are often associated with dementia. In the included studies, caregivers have also reported increased communication with people with dementia or expanded opportunities to communicate with others during serious games (Unbehaun et al., 2020). With the help of ICT technology, there are more possibilities for developing serious play and more design options for serious play formats.

**ICT technology for serious gaming support**

In the David Unbehaun et al. (2020) study, although research on ICT-based music activities suggests that these activities have individual and group benefits for disabled people and their care networks, few studies have examined the role of ICT, music, and music-related activities in their daily lives over time (Fang et al., 2017). With the lack of technology, there is a particular focus on the (movement) play of music for people with dementia and their caregivers. Therefore, there is a need for more research to investigate how information and communication technology-based musical activities can be integrated with other physical and cognitive activities. Physical and cognitive activities include dance, physical exercise, and video games (Fang et al., 2017). This implies empirical and design-oriented research that can identify and support the needs and expectations of people with dementia and their caregivers by closely examining the social impact of personal and information and communication technology interventions over a more extended period (Meiland et al., 2017). This highlights the need for more focused research in human-computer interaction, which can inform the ongoing development of information and communication technology-based systems. Examples include information and communication technology and music-based superpower games for people with dementia and their caregivers.

**Attitudes of people with dementia toward information and communication technology**

In Rytis Maskeliunas et al. (2019) Research, active and assisted living solutions can positively impact the health and quality of life of older people. ICTs can provide the following care tasks for people with depression and chronic illnesses, limitations in daily activities, chronic diseases, risk of falls, dementia, depression, social isolation, and poor medication management. It is because dementia is incurable, medication only treats the symptoms and not the cause, that caregivers may face difficulties in caring for people with dementia who are progressively unable to communicate with them or even wander away due to poor caregiving. New information and communication technologies are thought to improve communication skills and reduce stress. New ICT-based technologies are thought to improve communication skills and reduce stress for people with dementia and caregivers. Creating emotional engagement, determination, and total immersion in virtual reality situations can distract caregivers and relieve caregiving stress and help to increase the effectiveness of professional caregiver training. Learning games have been used successfully to enhance knowledge acquisition in different areas while supporting, to a lesser extent, the maintenance of work productivity and the acquisition of new knowledge, social skills, and behavior change and allowing educators to use this ICT interface to envisage new and innovative teaching methods. For example, healthcare practitioners explore new treatments and medical procedures that reduce people's risk. Many informal carers lack the appropriate knowledge of care or knowledge of dementia. This can, therefore, also lead to delays and increased workload for people with dementia. Convenient learning games can make dementia-related knowledge more accessible to carers or the public. Studies have shown that older people who use computers have an 8.5-year reduced risk of being diagnosed with dementia (Almeida et al., 2012). This would allow practitioners to gain new competencies in assessment, detection, review, and observation and recognize how these affects them in everyday real-life situations (Pront et al., 2018). Simulating real-life situations can be used to train practitioners to respond to dynamically changing events, thereby improving the quality of their performance. In medical practice, it can even save the life of the person being cared for.

**Application of ICT-based IDO serious games**

We found that serious games are increasingly used in health (Bardelli et al.,2022). Such games help to improve the daily management of neuropsychiatric symptoms (NPS) and, ultimately, the psychological state and satisfaction of people with dementia and caregivers (Radue et al.,2019); thus, iDO serious games with the application of information and communication technologies are targeted at caregivers of people with dementia, rather than at people with dementia themselves. In this context, virtual games related to practice simulation have become a measure of best teaching practice, improving the parameters of caregivers' expertise and self-satisfaction. Expertise and self-satisfaction of caregivers (Fairén et al., 2020), while more common games are directly targeted at people with dementia. (Memory games and cognitive skills development). The resulting advantages and corresponding advantages of best care practices can improve motivation, decision-making, and financial value (Pront et al., 2018). Much serious play-related research, specifically on dementia (Zheng et al., 2017), does not focus on dementia caregivers. Serious games evolved from a combination of traditional e-learning and gamification. Serious games using applied information and communication technologies can be used as different independent training solutions for doctors, formal and informal caregivers, and people with dementia. As a different stand-alone training solution for doctors, formal and informal caregivers, and people with dementia. For people with dementia, usability evaluation studies have shown that completing a serious game can serve as a different independent training solution for doctors, formal and informal caregivers, and people with dementia.

The iDO applied information and communication technology model of education, based on the game concept, comes from best practices in e-health gamification (Sardi et al.,2017) and demonstrates that short-term engagement can be generated through extrinsic rewards alone. For a serious game to reach its full potential, that game must consider e-health. The core experience and psychological effects of the game mechanics. This idea was applied to a behavioral model of rehabilitation by Wiemeyer et al. (2011). including physiological, psychological, social, and sensory-motor factors, one of the apparent advantages being that gaming interventions have advantages if they are developed and assessed according to individual prerequisites. This is confirmed by the flowchart scheme of Elaachak et al. (2016), which describes the most effective approach. They argue that the most effective serious game environments tend to be those that resemble the natural environment so that learners can more easily envisage different solutions (for nursing, but also iDO games applying information and communication technology); for each correct decision, the player is awarded a set of points. The player is awarded the points needed to reach the goal for each correct decision. This game provides players with the ability to analyze and assess situations, as well as the ability to develop them.

 We also found that in René F. Navarro et al. (2016) study, information and communication technology could help occupational therapists collect assessment data, implement interventions, and monitor responses to treatment. However, research has mainly evaluated low-cost and standard assistive technologies, such as process kits, automatic reminder dispensing, and environmental aids. There is limited evidence on the use and impact of treatments. Most studies are based on qualitative research to understand the perceptions of stakeholders involved in caring for people with disabilities. Perceptions of stakeholders caring for people with disabilities on the potential and limitations of computing-based Information and communication technologies. For example, findings from an interview-based study with occupational therapists highlighted the benefits of multimedia-based Information and communication technologies to support the temporal orientation of people with dementia if the technology is adapted to their needs and abilities, which was related to the acceptance of the technology.

Similarly, semi-structured interviews with family caregivers and occupational therapists identified a range of needs and ideas for possible solutions, for example, virtual caregivers and occupational therapists. Possible solutions, such as virtual companions, to promote social welfare and to enable people with disabilities to perform tasks that are difficult for them through robotics. On the other hand, the survey results applied to art therapists specializing in treating people with dementia were used to inform the design of the Engineer. The survey findings of art therapists treating people with dementia were used to inform the design of a participatory platform for artistic development so that art therapists could select themes and tools for artistic creation. (Radue et al.,2019)

**The integration of mHealth apps and information and communication technology**

In the Ioulietta Lazarou et al. (2021) study, information and communication technology advances focus on developing innovative solutions to improve functional and cognitive capabilities and increase safety and autonomy while compensating further decline of people with dementia. Several applications, including brain games, are exciting to healthcare professionals, given that they have proved very beneficial for people with dementia (Zygouris et al., 2015). Additionally, medication reminders and global positioning system (GPS) trackers for people with dementia are essential for caregivers and patients since they provide safety to the second ones (Faucounau et al., 2009). In general, mobile Health (mHealth) apps and information and communication technology can ameliorate the cognitive and functional decline of people with dementia by implementing passive apps which target assessment and monitoring or interactive apps such as brain games and reminders (Docking et al., 2018). The mHealth apps and information and communication technology can provide insightful information about patients' health status, send reminders for patients' daily medication or physical activity, allow caregivers and patients to set alarms in case of emergency, and provide meaningful disorder-specific feedback to healthcare professionals. At the same time facilitates communication between patients and healthcare professionals (Lencioni et al.,2009).

In addition, the mHealth app and ICT interventions in the form of brain games can improve diagnostic accuracy by assessing real-time cognitive function while allowing healthcare professionals to compare their results with other evidence-based biomarkers in the dementia population and the preclinical phase (e.g., mild cognitive impairment, MCI) Professionals (Choi et al., 2019 2010). Meanwhile, puzzle games have constituted a non-pharmacological intervention for nearly a decade to enhance patients' cognitive and motor function and coordination. In contrast to traditional intervention models, in which caregivers need to assist people with dementia with functional training manually, serious games are certainly an efficient alternative to help caregivers reduce their workload. In addition, mHealth applications and ICT are available to most people as they are often affordable, can be easily installed on the patient's mobile phone, and can be easily integrated with electronic health records (Tachakra et al., 2003). For caregivers, mobile phones can also facilitate the scheduling of caregiving tasks for people with dementia, as well as provide real-time information on the progress of the patient's condition. However, the acceptance of mHealth applications by the older population, and more specifically by people with dementia, remains challenging. At the same time, research into more desirable characteristics and requirements constitutes an important topic in ICT and clinical research (Betiga et al., 2020). Recent research studies have found that although many older people have positive attitudes toward adopting mHealth apps and ICT, the use of technologies such as mobile phones and computers by older people remains low (Fischer et al., 2014).

Nevertheless, much research has been done investigating various aspects of health-related technologies, focusing on preferable features and traits that the elders would like to be incorporated in the suggested mHealth apps and information and communication technology (Stucki et al.,2014). The elders' attitudes toward different kinds of technologies ranging from brain games, intelligent home systems, remote monitoring, and assistive technology to general information they would like to receive, have also been explored (Stavropoulos et al.,2020). Given that the elderly need to be more specific before acting, they are usually among the last to adopt a product, service, or innovative idea (Hawley-Hague et al.,2014). In addition, older adults tend to have relatively negative views toward information and communication technology and show less interest in using various new technologies (Xue et al.,2012). It has been shown that the computer-using experience, perceived ease of use, perceived usefulness, self-attitude toward new technology, and socialization agents could increase the acceptance of information and communication technology (Miah et al.,2019). Therefore, the abovementioned research studies have paved the way to explore features of high importance for the end-users to increase patients' engagement and empowerment in self-monitoring of their health and provide seamless access to healthcare services to healthcare professionals and caregivers.

Even in the modern world, where smart devices are ubiquitous, serious games aimed at caregivers of dementia patients can benefit more people in economically and educationally underdeveloped areas. However, in most of the eight studies included, participants had to be satisfied with having an Internet-connected computer or a transparent screen in a home or daycare center. This means serious games have economic and educational limitations for medical purposes. Nevertheless, in our research, we show enthusiasm for the development of different serious games. After the development of serious games for caregivers, they can be easily used in medical settings, communities, and families.

All in all, through our research, we found that the composition of serious games has different theoretical foundations, but this also proves that serious games have more possibilities for development and can also meet the needs of a more diverse group of people. Even among caregivers in our study, attitudes toward serious play were optimistic. However, our research also revealed that serious gamers need more standardized measurement methods and careful design thinking.

**Future**

***Simplifying the use of serious games***

The above systematic review study found that serious games have some positive intervention effects on caregivers of dementia patients. For example, it reduces the psychological stress of caregivers of dementia patients and improves the caregiving skills of caregivers. In terms of future directions, the purpose of our study is that the summarized literature review can positively affect the broader society as a whole. The systematic review taught us that the experimental intervention population is 50 years old and above. Currently, most caregivers for people with dementia are still homebound, mostly partners or relatives of people with dementia. These older people need to be cared for and looked after. They are limited by age, poor learning ability, poor adaptability, and lack of professional caregiving knowledge.

Caregivers of people with dementia (non-professionals) are not only faced with caring for people with dementia but may also be faced with their own work. Under double pressure, non-professional caregivers of dementia patients are more likely to be anxious and depressed. This vicious circle not only puts a great deal of psychological pressure on the caregivers of people with dementia but also leads to a reduction in the effectiveness of caregivers in caring for this group of people. Some studies have shown that improving the care skills of caregivers of people with dementia and increasing the efficiency of caregivers of people with dementia (Brodaty, & Donkin, 2022). Stress levels of caregivers can be significantly reduced. Serious games can be used in the home, where serious games and home water fountains can be used together to ease the workload of family caregivers while guiding dementia patients to help themselves to water (Eichhorn et al., 2019). The development of serious games is still in its infancy and primarily used in medical institutions, with relatively few applications in the home. In the future, more serious games can be combined with household items. This would be a great help to people with dementia, both in terms of living and in terms of healthcare. It would be a tremendous positive intervention for the group of family carers of people with dementia, both physically and psychologically.

***Serious games combined with home products.***

Moreover, currently, the world is in an environment of coexistence with COVID-19, where medical stress is much higher than in the original environment. Moreover, people with dementia are in permanent need of care. Resources for professional caregivers in the healthcare environment may less allocated to the dementia patient population. This is when the general medical environment requires even more technical and technological support. The literature on serious games as an intervention for caregivers of people with dementia is mainly within the last five years. This suggests that the development of serious games is still in its infancy and that there is a long way to go.

Furthermore, this high-tech product goes a long way to alleviating the pressure on the healthcare environment. The way forward, as serious gaming technology continues to advance, applicability should become more and more widespread to non-medical professionals. In previous studies, we have usually only considered the dementia population as a group, considering the pressure that people living with dementia can place on society, families, healthcare, and government finances. However, in subsequent research, more attention should be paid to the group of caregivers and substantial help should be provided to them.

***Serious games expand their popularity****.*

Data analysis predicts that the number of people with dementia worldwide may reach 150 million by the middle of this century (Gustavsson et al.,2023). This means the associated need for caregivers can be far greater than the 150 million. Caregivers of people with dementia are in chronic neglect and may face a lack of family care and social support. In particular, non-professional family caregivers may face the dual stress of caregiving and daily work. Some studies have shown that family caregivers of people with dementia also face difficulties communicating with their patients, feeling undervalued for their work, and not receiving feedback for their emotional commitment (Fortinsky et al., 2016). This shows that caregivers of dementia patients need social support and high-tech support in the overall context. Improve the function of serious games and increase the market penetration of serious games. Serious games for healthcare can greatly help the ageing world process when they are available in more homes. The purpose of our study in the future, serious games should enhance skills of use and simplify the use of the game, which caregivers can easily use. It has been suggested in the literature that improving the caregiver's caregiving skills is beneficial in reducing the caregiver's psychological stress levels (Clegg et al., 2001). In turn, it can enhance the quality of care for dementia caregivers, improve the physical quality of caregivers of dementia patients, enhance the well-being of dementia caregivers, and reduce the psychological stress of dementia caregivers.

***Serious games reduce pressure on society as a whole****.*

Dementia undoubtedly brings indelible pressure on the environment from security, economy, and government financial expenditure, which can fall on every young person. Improving the nursing skills of the caregivers of Alzheimer's patients and enhancing the well-being index of the caregivers can reduce the pressure of social retirement and ease the financial pressure of social retirement. Family caregivers are significantly more likely to suffer from hypertension and depression in families with people with dementia than in ordinary families (Cheng,2017). The time of people with dementia cannot be spent entirely on the patient, who has his or her work, social and rest time. However, the lack of medical expertise and the absence of assistive care tools dramatically increase the stress of caring for this group. It has been suggested that advances in information technology can improve the quality of health care and the quality of health care, thereby reducing the pressure on society to provide medical care and treatment (Holden et al., 2010).

A more diverse development of serious play could be facilitated by studying the attitudes of caregivers of people with dementia following serious play. Through this research, it can be concluded that in the field of serious games, there are many developments, possibilities, and development opportunities. At the same time, it also shows that the elderly care industry not only needs to take care of the mental and health problems of older adults but also needs to help groups closely related to older adults to provide corresponding medical support and services. When these serious games can widely serve multiple types of people, they can adequately reduce the social pressure on older adults, provide a more comfortable and healthy living environment for older adults, and provide caregivers with a more efficient way of life and work.

**Limitations**

In a systematic review, some relevant literature is always missing, and articles must be included. We have also taken a sample of a large group of people to study. The weakness of our study is that the sample needs to be sufficiently representative. We searched for keywords without the additional qualifiers of age and region before caregivers, or there were relevant databases that we should have included in our search. In our study, we made several iterations of the search string. We searched four databases (Embase, PubMed, Cochrane, and Web of Science) which covered serious games interventions for caregivers of dementia patients (PLWD) and some other studies. This study could have been added to the database by adding other key search terms and adding some relevant literature. We ended up with only eight valid articles included in the study, three in quantitative studies and five in qualitative studies.

Moreover, only one of the three articles in the quantitative study was a controlled variable experimental study, so we could not do a Meta-analysis. Without an objective quantitative analysis, we could only do a qualitative analysis of the valid eight articles. This can contain more or less subjective elements. Furthermore, the qualitative analysis generally focuses on rich, contextualized data. Qualitative analysis is more comprehensive, which means that the results of our study, and the conclusions we draw from the results, can appear more ambiguous than in a purely quantitative study. A quantitative study can represent the numerical relationship between caregivers and serious games for people with dementia through data. Qualitative studies, on the other hand, contain a large number of uncontrolled parameters, so our study should be seen as a preliminary qualitative study designed to pose research questions for the quantitative studies that may arise later.

**Conclusions**

In this article, we summarize the attitudes of caregivers of people with dementia towards serious games from eight included studies and suggest that caregivers of people with dementia, in general, are optimistic about serious games' enthusiastic attitude. In our research, we also discussed technical requirements related to serious games. It is precisely because of the variety of technologies that constitute serious games; this shows that serious games can show different effects through different technologies. Moreover, using experience can help developers of serious games lock in suitable technologies faster by collecting caregivers' attitudes and feelings after using serious games to carry out new designs and develop serious games. These studies found caregivers' thoughts and suggestions after using serious games. From the idea of caring, we can understand that in the process of serious game design, designers and developers should pay attention to which aspect of use, experience, and needs of caregivers during use, and also, through systematic analysis, discover improvements that serious games can make in the future. The literature review at the end thus highlights the current positively oriented design and use of serious games to support caregivers of people with dementia. In the development and design of serious games, some innovative settings have the potential to help people with dementia, and their caregivers, improve their abilities in nursing work.

However, for these serious games to be well received by caregivers and widely used, they must be redesigned for complex factors. In the current world of development, aging has become the content that every country must pay attention to and pay attention to when developing. In the process of aging, the first thing people pay attention to is the elderly group. However, there are many caregivers in the elderly group. As an indispensable and easily overlooked part of the aging process, they play a vital role in the development of aging. Although the current serious games focus more on the physical rehabilitation of older adults or the promotion of cognitive abilities, some smart devices and software focus on the caregiver market. Serious games, as a system or facility that can play an auxiliary role in multiple fields of work, can be applied to the needs of different types of people. Because of the population's complex needs, the design of serious games must consider the development of dementia patients, the complexity of the work of nursing staff, the sustainable use of software applications, and ethical considerations.

These eight papers show that ICT-centric games account for the vast majority of serious games designed for caregivers of people with dementia. This is because of the widespread use of ICT technologies in the current information technology market. This shows the importance of information and communication technology to health services. ICT is the core technical field of the new concept formed by the fusion of information technology and communication technology, and the fields where ICT technology can be used are extensive. In daily life, ICT technology can help humans in all aspects of life. Information and communication technology has the characteristics of high penetration, high efficiency, and high added value. These characteristics make the development of ICT closely related to the medical and health service industry. It also provides powerful technical support for serious game settings. In the design of serious games, ICT technology can help serious games become more intelligent. The specific situation of the user can be judged through simple instructions. ICT technology can also simplify the information transmission process, allowing serious games to connect hospitals, families, or nursing homes. A further innovation of serious games can be promoted through ICT technology, and the care model of caregivers can also be highly efficient.

Also, from the research, we found that with the widespread use of serious games and the continuous innovation of technology. The use of serious games is also constantly iteratively updated. Serious games have evolved from being interactive only through screens to be able to be used through wearable devices combined with AR and VR technologies. It is also shown in this study that people can use serious games in more scenarios in the future. This can significantly benefit caregivers to use it in their spare time, thereby helping caregivers improve work efficiency. Although the current serious games are not only aimed at caregivers, it is also found in the research that more serious games are developed and designed to adopt caregivers' attitudes.

To sum up, with the continuous development of technology, caregivers can use serious games in more environmental conditions to improve the quality of work and life of caregivers.

As the aging population rises, so does the dementia population, and there is a broad market for caregivers of people with dementia. Smart assistive devices can help caregivers ease the burden of nursing work. For example, helping caregivers monitor the whereabouts of dementia patients or helping predict and judge the cognitive ability of dementia patients. At the same time, the use experience of caregivers can also promote the development and innovation of intelligent auxiliary facilities. Therefore, during the development of serious games, collecting caregivers' attitudes towards the use of serious games can help serious games continue to innovate. Serious games for caregivers of people with dementia are yet to be developed and designed. There is also a lack of standardized measures of serious games to examine the effectiveness of serious games for caregivers. Future research can also focus on improving caregivers' physical and psychological conditions through serious games.

Moreover, before the serious games that serve the medical field widely enter the software market and the public eye, it is necessary to conduct more extensive research on serious games and increase the number of people participating. The economics, effectiveness, and experience of serious games can be compared with traditional interventions, resulting in more cost-effective interventions for the caregiver population. Finally, the authors recommend the widespread international promotion of serious games, further collaboration between people with dementia and caregivers, research on the effectiveness of more standardized and precise quantification of serious game development, and creation of a broad-based care system. Serious game service for caregivers to improve caregiver efficiency and reduce caregiver burden in care work.

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