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Mobile applications for individuals living with dementia and their caregivers. Dementia prevention

Aplikacje mobilne dla ludzi żyjących z demencją i ich opiekunów. Prewencja demencji

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Abstract

The increasing global aging population and the rising incidence of dementia create urgent demands for medical professionals. Innovation in medical technology is driving novel approaches to facilitate early diagnosis, rehabilitation, treatment, and care. Researchers worldwide are increasingly exploring the potential of mobile applications to support effective cognitive training for older adults and individuals living with dementia. Cognitively stimulating activities have consistently demonstrated a positive influence on cognitive functions such as processing speed, memory, reasoning, and verbal abilities. These activities are among the non-pharmacological approaches recommended for dementia care. Consequently, engaging in cognitively stimulating activities could benefit older adults by decreasing the risk of developing neurodegenerative conditions or helping to halt the progression of mild cognitive impairment in some individuals. The increasing use of mobile devices across all demographics, including 61% of adults aged 65+ according to a 2022 Pew Research Center study in the United States (Faverio, 2023), makes mobile platforms a promising vehicle to expand access, ease, and usability in cognitive training. This review aims to summarise findings from scientific literature on existing mobile applications designed to promote cognitive training and their potential to support cognition in older adults. The review presents examples of commercially available mobile games for cognitive training and exercise, discussing their potential advantages and disadvantages in usability for cognitive stimulation therapy in older adults.

Keywords: dementia, cognitive training, mHealth, mobile apps

Streszczenie

Starzenie się społeczeństwa oraz rosnąca liczba zachorowań na demencję na całym świecie sygnalizują pilne zapotrzebowanie na specjalistów medycyny. Innowacje w technologii medycznej napędzają nowatorskie podejścia mające na celu ułatwienie wczesnej diagnozy, rehabilitacji, leczenia i opieki. Badacze na całym świecie są coraz bardziej zainteresowani użyciem aplikacji mobilnych do skutecznego wspomagania treningu poznawczego osób starszych i osób z chorobami otępiennymi. Aktywności stymulujące poznawczo wykazały pozytywny wpływ na funkcje poznawcze, takie jak szybkość przetwarzania, pamięć, rozumowanie czy funkcje werbalne, i są jedną z zalecanych niefarmakologicznych interwencji w przypadku demencji. W rezultacie zaangażowanie w aktywności stymulujące poznawczo może przynieść korzyści osobom starszym poprzez zmniejszenie ryzyka rozwoju chorób neurodegeneracyjnych lub pomóc w zatrzymaniu postępu łagodnych zaburzeń poznawczych u niektórych osób. Rosnąca powszechność korzystania z urządzeń mobilnych we wszystkich grupach demograficznych – w tym 61% osób dorosłych powyżej 65. roku życia (dane według badania Pew Research Center z 2022 roku w Stanach Zjednoczonych) – sprawia, że platformy mobilne są obiecującym narzędziem do poszerzenia dostępu, łatwości i użyteczności w treningu poznawczym. Niniejsza praca przeglądowa została przygotowana w celu podsumowania wniosków z literatury naukowej analizującej istniejące aplikacje mobilne opracowane w celu promowania treningu poznawczego, które mogłyby być ewentualnie dostosowane do rozszerzenia funkcji poznawczych wśród osób starszych. Praca przeglądowa przedstawia przykłady dostępnych komercyjnie gier mobilnych zaprojektowanych do treningu poznawczego i ćwiczeń oraz omawia ich potencjalne zalety i wady pod względem użyteczności w terapii stymulującej poznawczo dla osób starszych.

Słowa kluczowe: choroba otępienna, trening poznawczy, mHealth, aplikacje mobilne

INTRODUCTION

Increasing life expectancy and societal aging in recent decades have brought new challenges to the world of medicine. As age is one of the major risk factors for developing neurodegenerative disorders (Ferreira-Brito et al., 2021), we are seeing a growing number of older adults living with dementia resulting from conditions like Alzheimer's disease (AD) and other neurodegenerative disorders. The Alzheimer Europe Foundation reports that 7,853,705 people in the European Union are living with various types of dementia. Researchers estimate that the number of individuals affected by dementia will nearly double by 2050 (Alzheimer Europe, 2023).

The problem is serious, as dementia impacts most areas of an individual's life. The condition causes progressive loss of cognitive functions, such as memory and spatial orientation (Saragih et al., 2022). Due to a lack of appropriate and universal support and care, coupled with widespread ignorance and stigma in societies, the quality of life for people living with dementia (PLWD) decreases, which often contributes to the additional problem of depression (Kivipelto et al., 2018).

Generally, the main potentially modifiable risk factors for cognitive impairments include lower education, hypertension, hearing impairment, smoking, obesity, depression, physical inactivity, diabetes, low social contact, excessive alcohol consumption, traumatic brain injury, and air pollution (Livingston et al., 2020). Some researchers suggest that the risk of developing dementia could be decreased by engaging in intellectually demanding activities (Bauer and Andringa, 2020). Cognitive training techniques involve exercises targeting verbal learning and memory, non-verbal memory, working memory, and attention. Enhancing memory may help reduce the risk of amnesia, one of the most acute issues related to many dementia-related diseases. Training the mind brings additional benefits for older adults, including a boost in mood, improvement in well-being, and delaying the onset of depression (Kivipelto et al., 2018). It is worth noting that there are three main forms of cognitive interventions: cognitive stimulation, cognitive training, and cognitive rehabilitation. Mobile applications can be used in each of these forms in different ways, e.g. in rehabilitation, with the content individually designed by the trainer.

Access to digital technologies has become widespread, and many older adults are now familiar with computers, smartphones, tablets, and other digital devices. Based on current trends, it is safe to assume that the number of older individuals accessing and using digital electronic devices will continue to rise in the future (Faverio, 2023). In 2015, for the first time in world history, the number of mobile devices exceeded the global population, reaching over 7.3 billion mobile phones (Linares-Del Rey et al., 2019). This presents a significant opportunity for medical professionals to utilise these technological achievements to support patients living with neurodegenerative conditions and help prevent individuals from vulnerable groups from developing dementia.

MATERIALS AND METHODS

PubMed search

The electronic databases PubMed and Google Scholar were searched. Only these two databases were selected for their accessibility and coverage of the most relevant journals and search engines. The key search terms were: "neurodegenerative + apps" and/or "neurodegenerative + mobile apps", "serious games dementia", "puzzle application for Alzheimer's", "cognitive training dementia", "Parkinson + mobile apps", "dementia + apps", "mild cognitive impairment + apps". Filters were applied to exclude abstracts. The publication date range was limited to the past ten years, up to 2023. No particular language was set.

The aims of this review include:

1. assessing the availability of mobile applications for individuals living with neurodegenerative disorders;
2. evaluating available mobile apps designed for early diagnosis and/or prevention of neurodegenerative conditions;
3. identifying the extent to which the use of these technologies improves cognitive function;
4. appraising improvements in the well-being of PLWD and caregivers following the use of such technologies.

Inclusion criteria:

1. use of technology in the context of neurodegenerative disorders;
2. comparison of existing mobile applications to determine their target populations (i.e. AD, Parkinson's disease, healthy adults) and their impact on multiple domains of cognition and well-being;
3. apps designed for individuals with and without dementia/neurodegenerative conditions but with the primary goal of promoting brain health or offsetting dementia.

Exclusion criteria:

1. cognitive training designed for individuals without dementia and/or without the goal of promoting brain health or offsetting dementia;
2. cognitive training but without incorporating technology.

No restrictions for the age, sex, or ethnicity of participants using the mentioned technologies were set. Also, no specific type of device was exclusively selected for the review.

Google Play Store and Apple App Store search

To expand the knowledge about the availability and quality of existing mobile apps offering cognitive training targeting diverse populations, an additional search of the two predominant mobile application stores was performed. The Google Play Store (for Android), the Apple App Store (for iOS), and Google (for reviews and rankings) were

searched. The search terms used were "cognitive training apps", "cognitive training apps Alzheimer's', "Alzheimer's games", "Alzheimer's puzzle", "Parkinson app" and "app for Alzheimer's/dementia".

RESULTS

In total, 30 articles and online sources were identified and synthesised in this narrative review to align with the aims of the study.

Search results

Preventing dementia

It is well-established that brain changes, especially structural changes, support cognitive improvements resulting from cognitive training (Chen et al., 2021). For example, using apps like CogniFit by older adults, or even by individuals of any age, can help protect against the onset of dementia associated with syndromes like AD (Shatil et al. 2013). The likelihood of developing dementia can be decreased by engaging in intellectually demanding exercises. The CogniFit app helps train memory, emotions, concentration, processing speed, problem-solving, and other cognitive skills by offering daily training composed of a few simple games. The positive influence of certain games on the cognitive condition has been proven by researchers, and CogniFit is one of the scientifically validated apps. In 2013, Shatil conducted a randomised, controlled trial with older adults and concluded that using the app improves verbal and non-verbal skills, enhances brain plasticity, and even supports coordination. Interestingly, Gigler et al. (2013) found that CogniFit could also be useful for patients with mild cognitive impairment.

Many programmes supporting cognitive functions are based on classic logic games, such as jigsaw puzzles, sequencing tasks, identifying differences or similarities, and solving mathematical riddles. One such app is NeuroNation. Initially, it performs a test to measure the user's cognitive efficiency by checking their memory, processing speed, attention, and reasoning. Afterwards, the app compares the results with other users in the same age group and provides feedback highlighting fields in which the user's performance could be improved. The software then designs customised training plans for the user (Maggio et al., 2024).

Different apps require varying amounts of time to see the results. Some suggest as little as 15 minutes of training, 3–5 times per week, while others claim that the best results come from hour-long sessions conducted 7 times a week. For example, a study using the board game "GO" as a cognitive intervention, conducted once a week for 15 weeks, showed potential improvements in cognitive functions among nursing home residents (Iizuka et al., 2018). Another study claimed that 1–3 hours of training a week for 3–4 months was necessary to improve cognitive functions. It was also found that combining physical and cognitive exercises might be even more effective, as elderly people who cycled along a virtual bike path achieved better results than those on traditional stationary cycling (Anderson-Hanley, 2018).

The main disadvantage of existing apps is that their free versions usually do not offer full access to training programmes. An advantage of most available apps is that they track user progress over at least several days, even without registration.

Early diagnosis

In a short period of time, mobile health (mHealth) has grown rapidly in terms of assisting individuals living with chronic disorders (Yousaf et al., 2020). The COVID-19 pandemic further transformed mHealth apps and telemedicine into essential tools for healthcare infrastructure. The pandemic underscored their importance, as many older adults avoided in-person medical visits due to fear of infection.

Early diagnosis was the guiding idea behind the app MOBICOG. It asks users to perform three activities: clock drawing, word recall, and word recognition. After completing these tasks, the app displays an assessment based on user performance (Yousaf et al., 2020). The app can screen for dementia with 99.53% accuracy (Thabtah et al., 2020). Another example is BrainTest®, based on the Self-Administered Gerocognitive Exam (SAGE), which can detect cognitive impairment with a sensitivity and specificity of 71% and 90%, respectively (Sokolov et al., 2020). While mHealth may not yet be sufficient to replace traditional methods, its ongoing development and the impact of the pandemic have highlighted the growing demand for such solutions.

Slowing down the progression of dementia

Studies confirm that serious games improve cognitive function and reduce depression in PLWD, but future research should aim to determine and evaluate their long-term effect (Saragih et al., 2022). These games also offer a valid, feasible, and acceptable method for collecting health-related patient data (Rosenblum et al., 2021). However, like all mHealth processes, this topic requires further study.

One app specifically designed for PLWD is Alzheimer's Speed of Processing, which has been downloaded over 10,000 times. According to its description on the Google App Store, research from the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) study, covered by "The Washington Post" and "The New Yorker", shows that this type of cognitive training has positive effects for PLWD. Due to its specific target audience and limited popularity, only two reviews including this app have been published. Neither of them focuses on its effectiveness (Muchagata and Ferreira, 2019; Yousaf et al., 2019).

Most studies report better effects of cognitive training for individuals with mild dementia, calling it a promising option to slow cognitive decline (Robert et al., 2020). The relationship between mobile devices and healthcare is still in its early stages, leaving many paths to explore. Now is the right time to further develop and integrate mHealth

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technologies into the routine assessment and care of PLWD. Overall, the literature supports the view that even though there is no curative treatment for dementia, cognitive training helps delay or slow the progression or onset of these conditions and their mild forms (Robert et al., 2020). Non-pharmacological treatment may indeed improve the quality of life for patients (Appel et al., 2021), but most studies have been conducted in nursing homes, and some uncertainty remains (Zucchella et al., 2018). Also, due to issues with visual acuity or hearing, older adults with advanced dementia can struggle with using mobile devices.

Helping families and caregivers of PLWD

Some of the mentioned apps were designed mainly to help relatives and caregivers of PLWD communicate with patients. By improving cognitive functions, especially memory, these apps make life easier for their relatives by reducing the number of situations where the elderly person does not recognise their family members.

One of the newer games helping caregivers of PLWD is Memory Lane Games. A clinical trial conducted in December 2022 showed that most users caring for someone with dementia felt more relaxed and happier as a result of using this app. Overall, 42% claimed that the app helped them communicate with the person with dementia, and 52% thought the patients' communication had improved (Memory Lane Games, 2022).

Further research could confirm that improving cognitive functions in PLWD using mobile devices helps caregivers communicate more effectively and feel less stressed. Unfortunately, there are only a few apps tailored to meet the needs and functional competencies of PLWD and their caregivers (Tak, 2021). Most apps lack comprehensive features to support caregivers, forcing users to rely on multiple mHealth apps to satisfy all their needs, which may discourage continued use (Kim et al., 2021).

Other potentially useful apps

Preventing dementia

Some applications, such as Witty Words, provide language tasks that involve creating words from given letters. This type of game can be helpful for seniors experiencing issues with verbal functions. Epperly et al. (2017) showed improved cognition and self-reported quality of life and well-being in individuals with mild to moderate AD, with no effect on functional status, mood, or behaviour after cognitive training with word games. Witty Words evaluates correct spelling, word meanings, and usage. Additionally, it offers two game modes: single-player and multiplayer. The latter mode gives users more motivation to train by involving them in competition, which can help maintain consistent practice.

Early diagnosis

The Mindset app was created during the COVID-19 pandemic to provide early diagnosis of dementia for patients whose contact with doctors was restricted due to ongoing international quarantine measures (Stop Barierom, 2022). The idea behind the app was to run reliable tests by having potential patients solve tasks and answer questions, with results professionally analysed for cognitive functions. Further development and popularity of this method could improve traditional tests, such as the clock-drawing test.

Slowing down the progression of dementia

According to their website, AcTo Dementia is a group of university researchers that provides recommendations for mobile apps for PLWD through an evidence-based review process. One recommended app, Let's Create! Pottery, helps upgrade concentration and calm patients (AcTo Dementia, 2024). The app is useful, as many people often quit training when they fail to see immediate effects, which is common with cognitive training apps.

Oya: Alzheimer Games, Match, specifically designed for individuals with AD, is a simplified matching game that helps slow the progression of AD by keeping short-term memory active. It offers 50 levels, from simple to complex, and has been downloaded over 100,000 times on the Google App Store. No scientific reviews are available due to its unpopularity.

Another app, AmuseIT, is designed primarily for tablet screens due to their larger size compared to smartphones. It aims to stimulate the minds of PLWD using a dementia-friendly interface. Users are obliged to pay $3.49 to purchase AmuseIT, and has been downloaded only over 100 times on the Google App Store. The app promotes conversation by offering over 1,000 simple quiz questions with a strong visual component (Munteanu et al., 2022).

Helping families and caregivers of PLWD

MOJO – Moments of Joy is an app designed for PLWD that includes a timeline of images of family and friends over the years to help elderly individuals recognise them today, as reported on multiple UK business sites (e.g. "London Business Magazine" or Express.co.uk). Features like a digital album of people and places from the person's life, medication reminders, and personal checklists make caregivers' lives easier. This app has been downloaded over 500 times on the Google App Store.

DISCUSSION

Modern technologies are becoming more accessible and increasingly used in healthcare. Mobile devices are among the most common and low-cost options (Yousaf et al., 2020). mHealth has become a popular, cross-functional field, attracting global scientific interest in testing available applications for their medical efficacy. Mobile apps for cognitive function training can be categorised into four main purposes:

1. preventing dementia;
2. early diagnosis;

3. slowing down the progression of dementia;
4. helping families and caregivers of afflicted individuals.

These programmes have many advantages: they are widespread, accessible at any time and place, and require little time per day. Their costs are usually low, and some are even free. Serious game applications are both entertaining and intellectually demanding, making patients feel relaxed and stimulated while training their minds. Many of the applications described have proven effectiveness in enhancing cognitive functions, so they could be recommended by healthcare professionals (Gigler et al., 2013; Stahil, 2013).

The main disadvantages of mobile apps include the need for proficiency in operating high-tech devices, regular use over extended periods, and continuous progress monitoring. Many apps also require Internet access, potentially causing problems in areas with poor Internet availability or while traveling (by train, plane, abroad etc.). Online activity may also increase exposure to Internet fraud, such as phishing, data theft, and financial extortion. Additionally, many apps are paid and require online payment for subscriptions, which can be difficult for seniors unfamiliar with online shopping, further increasing the risk of financial fraud. People with memory impairment may forget to complete their daily training, requiring reminders that could cause additional issues. Another limitation is the language of the interface, as some apps are available only in a limited number of languages and may be accessible only on Android or iOS devices.

Given these factors, mobile applications are not a perfect or universal solution for maintaining physical health or supervising PLWD, but they hold significant potential. It is important to emphasise that despite their advantages, no mobile applications can substitute medical diagnosis and professional consultation, treatment, and rehabilitation, which remain essential for neurological patients. Nevertheless, mHealth solutions offer experts a means to facilitate, organise, and automate their work, while also providing an incentive for patients to take better care of themselves.

Conflict of interest

The authors declare that they have no conflict of interest related to the publication of this article.

Author contribution

Original concept of study; final approval of manuscript: KKŚ. Collection, recording and/or compilation of data; writing of manuscript: JL, KKŚ. Analysis and interpretation of data; critical review of manuscript: JL.

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