Digital health interventions in reducing loneliness and improving mental health in older adults - a literature review

Jakub Kołacz

Department of Internal Medicine, Szpital Murcki sp. z.o.o., Katowice, Poland

https://orcid.org/0009-0004-2377-5586

1kubasep@gmail.com

Patrycja Oleś

Faculty of Medical Sciences, Collegium Medicum, University of Zielona Góra, Poland

https://orcid.org/0009-0001-4825-9789

o.patrycja28@gmail.com

Marcin Kwiatkowski

Department of Internal Medicine, Szpital Murcki sp. z.o.o., Katowice, Poland

https://orcid.org/0009-0004-7238-0708

kwiatkowskimarcin@hotmail.com

Tomasz Koziński

University Clinical Centre, Gdańsk, Poland

https://orcid.org/0009-0009-3259-7861

tomkoz760@gmail.com

Marta Donderska

Department of Emergency Medicine, University Clinical Centre, Gdańsk, Poland

https://orcid.org/0000-0002-7144-4624

marta.donderska@outlook.com

Paulina Bochniak

Familia-Med non-public Healthcare centre in Bieruń, Poland

https://orcid.org/0009-0001-3787-6319

Polabochniak@gmail.com

Mateusz Bryła

Health Centre in Mikołów, Poland

https://orcid.org/0009-0000-4136-2575

mbryla@onet.pl

Zofia Bryła

Faculty of Medical Sciences, Medical University of Silesia, Katowice, Poland

https://orcid.org/0009-0006-9836-5658

zbrylaa@gmail.com

Monika Spaczyńska-Kwiatkowska

Faculty of Medical Sciences, Medical University of Silesia, Katowice, Poland

https://orcid.org/0000-0003-2660-8674

M.spaczynska94@gmail.com

Tomasz Włoch

Szpakmed Healthcare Centre, Ruda Śląska, Poland

https://orcid.org/0009-0001-7370-3212

tomaszwloch97@gmail.com

Introduction: Loneliness remains a concerning health issue, especially among the older population. It leads to numerous negative psychological and physiological negative health outcomes. Digital health interventions have presented themselves as promising strategies for mitigating loneliness and improving mental health in this demographic group.

Aim of the study: This review aims to evaluate existing literature on select digital health interventions in mitigating loneliness and improving mental well-being in the older population. We aimed to present strengths, limitations and obstacles to adoption of these types of interventions, while providing insights into areas of research which could be more thoroughly explored.

Materials and methods: To write this article, databases such as Scopus, PubMed and Google Scholar were searched using the key terms to find relevant information. Studies published between 2009 and 2025 were included.

Conclusions: Digital health interventions, including mHealth apps, virtual reality systems (VR), AI (artificial intelligence) chatbots, companion robots, and video communication platforms have shown potential of mitigating loneliness among older adults. However, the evidence is mixed due to differences in methods of measurement, short duration of follow-up research and obstacles to adoption such as digital literacy, technical barriers and ethical considerations. To fully determine their effectiveness, future studies should implement standardized measurement of outcomes, explore personalized interventions and mitigate the barriers to adoption. Possible risks of overreliance, personal data safety, and discouragement of human relations need to be addressed.

Key words: Loneliness; aged; digital health; virtual reality therapy; chatbot; companion robots; mHealth; videoconferencing;

Introduction and purpose

Loneliness is a problem that touches every age group in the population. While social causes of feeling lonely such as low level of social relationships are associated with being lonely regardless of age, the older population presents higher prevalence of functional limitations and higher proportion of singles [1]. Digital health interventions have presented themselves as a possible solution to decrease feelings of loneliness and enhance the quality of life among the elderly. This review aims to evaluate selected digital health interventions: Mobile health applications (mHealth app), Virtual reality (VR), Chatbots, Companion robots and Video calls as possible strategies to reduce loneliness and improve mental health in the older population. Identifying and comparing the strengths, limits and barriers to adoption of these methods could provide valuable insights into possible usage in improving the mental well-being in the elderly. We aim to provide suggestions into the areas of research which could be more thoroughly explored. Understanding the effectiveness of these types of interventions could help with developing strategies of integrating them into geriatric care.

Loneliness

Loneliness could be defined as "a subjective experience of mismatch between the quality and quantity of how we perceive our social networks to be, and how we want them to be'' [2]. Loneliness is prevalent among older adults, with estimates ranging from 25 to 35% in high-income countries [3,4,5]. It is particularly prevalent in long-term care residents with prevalence ranging from 56% up to 95% [6]. Prevalence rates differ between studies, possibly because of different measurement methods and approach to data collection [7]. The COVID-19 pandemic has resulted in prevalence rates increasing over time [8]. Risk factors for loneliness include

female gender, non-married status, living alone, poor health, functional decline, and lack of social engagement [9].The combination of living alone and having bad health was associated with 10 times higher odds of feeling lonely as compared to living together with someone and having good health [10]. Psychological symptoms associated with loneliness include poor mental health, low self-efficacy beliefs, negative life events, and cognitive deficits. Other issues raised in the interviewed groups included boredom, inactivity and recent losses of family and friends [11]. Social isolation and loneliness independently affect health through behavioral and biological factors, including increased risk of inactivity, smoking, elevated blood pressure and inflammatory markers [12]. It also leads to increased healthcare utilization, mainly physician visits among older adults [13]. Addressing the issue of older people feeling lonely would improve both mental and physical health of a large part of the population.

Virtual Reality

Virtual reality is a simulated experience that uses 3D goggles placed around a person's head to give the user an immersive feel of a virtual world. They also provide pose tracking, which makes the experience seem more real. Virtual reality technology shows promise in addressing loneliness among older adults. When compared to consuming other media passively, such as watching TV programs, it could provide a sense of involvement and a stronger connection to viewed content. Older adults generally respond positively to VR experiences, showing neutral to positive attitudes after first contact with this technology [14]. Desired content of VR simulations involve travel, continuing education, reminiscence, and self-care [15]. Studies indicate that VR can promote well-being, reduce social isolation, and decrease depressive symptoms when compared to the control group consuming the same content using television [16]. It was also found capable of significantly improving social engagement and reducing loneliness among older adults in long term care [17]. A research group performed a meta-analysis of 15 controlled trials and found out that immersive VR has the potential to improve the psychological health of older adults and may be widely applicable in promoting successful aging [18]. The adaptability of VR interventions allows for tailoring of content to meet individual needs of a patient. Gradually increasing the complexity of social scenarios and providing environments that align with user's personal interests and past experiences helps seniors avoid getting overwhelmed by unfamiliar technology [19]. It enables a methodical improvement in social skills through repeating the same social encounters while getting

immediate feedback. This allows researchers to measure improvement during each subsequent trial. It is worth noting that the controlled nature of VR minimizes risks of in-person contact such as physical injury or anxiety. However, this type of digital health intervention has its barriers, such as resistance to change in older people, technological adaptability and video quality. Other concerns include the risk of VR-induced discomfort or cybersickness, which could discourage older adults from engaging with this technology [20,21]. The cost of equipment and digital illiteracy could also make a widespread implementation of this type of technology problematic. In conclusion, VR could prove to be an effective treatment option for loneliness in older adults, as long as barriers to adoption are overcome. Standardization of VR environments is needed for better comparisons across studies [22].

Mobile health applications (mHealth app)

Mobile health application is a program created to operate on mobile devices, like smartphones and tablets. They are used for a range of purposes: disease prevention, management of chronic diseases, health promotion and strengthening social relations. These mHealth apps offer features like messaging services, virtual companions and reminders for social activities, encouraging users to maintain social connections. Research indicates that Mobile health applications show promise in reducing loneliness among older adults. Numerous studies show the effect of mHealth apps on improvement in mental health, reducing stress, loneliness and decreasing depressive symptoms in older populations [23,24,25]. Several mHealth apps like GezelschApp [26] and Smart Silver Care [27] were able to allow older people establish social connections and improve quality of life for its users. A research group concluded that using WhatsApp-based interventions has resulted in a mitigation of loneliness, improved confidence and cognitive abilities [25]. In another trial, researchers presented a smartphone-based videoconferencing program for nursing home residents. They found that the usage of this mHealth app resulted in a decrease in loneliness levels, which could illustrate that integration of mHealth solutions in institutional settings could prove valuable [28]. mHealth apps were also found to be quite effective at alleviating loneliness during Covid-19 pandemic [25]. Their adoption is, however, limited due to various design issues such as accessibility and user-

friendliness [28]. By combining traditional therapeutic methods with digital support, mobile apps could improve social connections and emotional well-being in older adults. However, every mobile application designed for the older population needs to be tailored to the targeted groups needs. This demographic's less frequent contact with digital technologies needs to be considered. mHealth apps designed to be used by older people should provide a simple, easily readable interface with a non-complicated design. Besides that, the increasing digitization of the healthcare sector brings concerns about data privacy [29]. These concerns should be thoroughly studied in the context of older adults, who may not be very well informed about the vulnerability of their sensitive data. Not adhering to the safety guidelines could lead to data breaches, which could result in lack of trust of older people in these kinds of technologies. Many mHealth apps fail to implement effective enough security measures, which results in issues like unencrypted communications or in extreme cases a presence of malicious code. Even though their safety measures are better than these in normal mobile applications, they still demonstrate a significant risk [30]. A systematic review by Choi and Lee (2021) proves that there are differences in methodologies and outcome measures in various studies on loneliness reduction linked to mHealth interventions and other methods of digital health [31]. This makes comparing similar studies problematic. Overall, integrating mHealth apps into geriatric care could leverage the widespread availability of smartphones in certain countries, offering a cost-effective approach to addressing the problem of loneliness and its drawbacks in this demographic - as long as security concerns are addressed, and proper design of these applications is presented.

AI Chatbots

A chatbot is an application or a website designed to converse in text or or through voice. Modern chatbots are usually online and use generative AI (artificial intelligence). These systems are capable of maintaining a conversation with a user by simulating the way a human would behave as a conversation partner. AI Chatbots show potential in alleviating loneliness in the elderly by initiating interactions and providing emotional support. They were found to decrease feelings of isolation almost as well as regular human interaction [32,33]. One research group concluded that using AI-powered personal voice assistant 'Amazon Echo' significantly lowered loneliness in adults aged 75+ in a 8-week long trial [34]. Systems relying on AI are increasingly more often becoming a part of everyday routines and helping with everyday tasks [23,35].

Researchers found that this technology could be met with a high level of satisfaction and acceptance of the elderly [23,36]. This indicates that integration of chatbots into the standards of loneliness management could be possible. A study from 2021 by Brown & Halpern reported that AI chatbots are effective at providing basic conversational engagement and immediate responses. However, they do not prove to be able to capture the full spectrum of human empathy. This research highlights AI chatbots not being able to recognize and respond to subtle emotional or nonverbal signals. The ability of noticing and responding to these signals is needed for creating an emotional connection between people. Users also reported that the AI chatbots were successful at reducing the feeling of isolation, but they did not manage to address deep emotional needs. This might suggest that chatbots, in their current state, can act as a supplement instead of replacing human interactions altogether. Authors suggested that further refinement of natural language processing might improve the limitations of AI chatbots, but for the time being they cannot fully replicate complex human emotions [37]. Other authors warned about ethical considerations such as privacy concerns [38]. A trial was performed, in which 7,099 adults and older adults consented to participate in a chatbot intervention on reducing social isolation and loneliness. It was found that older adults developed emotional bonds with the chatbot, presenting them as reliable sources of support. Users referred to the chatbot as "you" rather than using words like "it" or "the chatbot". This indicates that they are addressing it like they would a human. They were also reported to be assigning human traits to the chatbot, such as being helpful, caring, open to listen, and non-judgmental. Some of the users talked about how the chatbot is available anytime they need emotional comfort. This highlights that chatbots may be available to users when a traditional mental health professional is not, such as during weekends or at late hours, which indicates that chatbots are an accessible mental health resource. While this intervention shows an increase in emotional comfort, it could also lead to unintended overreliance on this technology - the risk of replacing human interaction must be addressed [36]. Another study by Marita Skjuve et al. from 2021 highlighted a few other concerns connected with using AI chatbots. Participants of the study were expressing concerns about the possible stigma associated with creating close relationships with chatbots. This stigma could lead to feelings of embarrassment or reluctance to discuss their chatbot interactions with others. This could lead to stronger feelings of loneliness and social isolation. Some users reported that their conversations with chatbots had a negative effect on their interactions with other people. Chatbot conversations were perceived as easier and more predictable, which

sometimes led to lack of motivation to engage in human relationships, which are more complex and demanding. The chatbots were also reported to have glitches and unexpected responses, which disrupted the experience and led to frustration or disappointment [39]. Recent technological advancements are exploring the integration of artificial intelligence with other digital health platforms by using it to personalize interventions according to the individual's emotional state and needs. This process could lead to a comprehensive approach to decrease loneliness in older populations. We have to take into account that the effectiveness of AI chatbots may be limited by the user's digital literacy and comfort with technology. Older adults with higher confidence in using technology are more likely to benefit from AI chatbots. User training and support are critical components of successful implementation. Combining AI technology and methods of digital health is a promising way of combating loneliness and improving mental well-being for the elderly people, however in their current state, they cannot fully replace normal human interactions. The risk of overreliance in this demographic group needs to be more thoroughly researched.

Companion robots

A companion robot is a robot created to create real or apparent companionship for human beings. Companion robots have shown promise as tools in reducing loneliness and improving well-being among older adults. This is true especially for long-term care patients. For instance, a randomized controlled trial demonstrated a therapeutic robotic seal named 'Paro'. Regular interaction with the robot significantly reduced loneliness and enhanced social engagement among nursing home residents [40]. Another experimental study reported that interventions provided by animal-shaped companion robots decreased loneliness, while also improving quality of life and emotional expression in patients [41]. A meta-analysis of companion robots' effect on loneliness in older adults found that social robot interventions had significant positive effects on decreasing depression and loneliness with large effect sizes. Group-based robot activities had a better effect on improving depression than individual-based robot activities [42]. However, while contact with a robot impacts patients positively, removal of the robot from their surroundings resulted in sadness instead [43]. The data is still inconsistent in some cases. Companion robots were also found to enhance engagement and reduce anxiety, but their benefits vary based on the design of the robot and preferences of the user [44]. Ethical concerns have been raised about discouraging genuine human interaction. Over reliance on robotic

companionship might lead to emotional dependency linked with technology [45]. Digital literacy plays a key role in the success of these interventions. Older adults who are more comfortable with technology were reported to benefit more from robot companionship - this suggests the importance of user training and support [43]. Overexposure and overreliance on a robot companion could lower the motivation to seek human interactions and relationships with other people. A research group reported that many participants reported not believing that companion robots would reduce their loneliness. Many older adults claimed feeling uneasy about relying on companion robots that mimic human empathy. They felt that reliance on these types of interventions might ultimately discourage authentic, meaningful social connections [46]. To summarise, companion robots show the ability to mitigate loneliness among older adults, but their design needs to be adjusted for each individual user. Ethical concerns need to be considered to ensure that robots only complement human interaction, instead of replacing it. Training staff and patients undergoing these types of interventions is essential. Fully exploring companion robots' overall effectiveness is needed before making any objective conclusions.

Video communication platforms

A video communication platform is a tool that enables individual patients or groups to hold audio and video conversations in real-time over the internet. Utilizing video calls enables face-to-face interactions with family, friends, physicians and other healthcare personnel. Video calls have shown benefits in reducing loneliness among older adults , but individual differences in areas such as personality and digital experience, result in inconsistent outcomes [47,48,49]. Other researchers found the impact of video calls on reducing loneliness in older populations to be inconclusive, due to varying intervention designs, small sample sizes, and short study durations [50,51]. Using video calls as a way of communication between older adults and their relatives could foster emotional connection, while also reducing the feeling of loneliness. Regularly scheduled calls could lead to more frequent contact with family and friends. Video calls also eliminate the need to travel long distances in order to visit relatives residing in care homes and other medical facilities, which could allow for consistent, regularly scheduled interactions. The length of the interaction can be tailored to individual patient's needs, according to their health and physical capabilities. Older adults may face technical barriers,

such as lack of skills, internet access, device availability. A study demonstrated that, in nursing home settings, video call interventions can significantly improve quality of life and reduce loneliness, but these benefits are often moderated by technical challenges such as poor internet connectivity and limited device familiarity among older adults [28]. Effectiveness of these interventions relies on many factors: the design of implementing them, individual characteristics of patients, and cooperation of healthcare personnel. A study conducted in 2020 included an online survey which included 836 participants aged 60 and above across Norway, UK, the USA and Australia. It examined the impact of video-based communication platforms on loneliness and psychological outcomes during the COVID-19 pandemic. In the age group 60-69 the use of video-based communication resulted in reduced loneliness. However, in participants aged 70+ there were no significant loneliness or quality of life changes associated with video calls. This could indicate that age plays a role in the impact of these kinds of interventions on loneliness reduction [49]. Another research group reported that video calls did not fully satisfy human need for physical contact in older adults during COVID-19 pandemic [52]. Sensory limitations, such as poor hearing and lacking eyesight are other factors which could possibly prevent seniors from benefiting from this type of intervention [53]. Some users could experience frustration when using unfamiliar technology, due to not understanding the software, or when technical difficulties are present. Overall, video calls remain a possible tool in reducing loneliness among older people, however technical, human and organizational barriers remain. More research needs to be present in the areas regarding the impact on loneliness and long-term follow ups.

Conclusion

Loneliness remains an important health problem in the older population, especially among long term care residents. It leads to multiple negative physiological and psychological outcomes. Technologies such as virtual reality, mobile health applications, chatbots, companion robots and video call platforms have shown promise as a tool in addressing loneliness in older populations. However, many studies on this topic have small sample size and short-term follow-ups, which limits the ability to assess the effectiveness of these kinds of interventions on loneliness reduction over long periods of time. Variation in measurement of loneliness across

studies further complicates comparisons and reviews. The effectiveness of digital technology interventions in this context brings hope for the future, but for the time being it remains inconclusive, with significant gaps in research. Barriers to adoption of these digital health interventions in reducing loneliness in the older population include: affordability, equity, outcomes, problems with accessibility, technological adaptation abilities of older people. Further research is essential to properly evaluate and refine these methods. Standardization of loneliness measurement is advised. Digital health interventions should take a personalized approach and adjust to an individual's needs. Risks of overreliance, personal data safety and discouragement of human relationships should be studied more thoroughly. Overcoming obstacles and ensuring that ethical issues are addressed is essential before a large-scale integration into geriatric care is possible.

DISCLOSURE

Authors' Contributions Statement:

Conceptualization: Jakub Kołacz, Tomasz Koziński, Patrycja Oleś

Methodology: Jakub Kołacz, Monika Spaczyńska-Kwiatkowska, Patrycja Oleś

Software: Tomasz Włoch, Tomasz Koziński

Check: Jakub Kołacz, Patrycja oleś, Tomasz koziński

Formal Analysis: Paulina Bochniak, Monika Spaczyńska-Kwiatkowska

Investigation: Marta Donderska, Marcin Kwiatkowski, Patrycja Oleś

Resources: Mateusz Bryła, Zofia Bryła, Marta Donderska

Data Curation: Zofia Bryła, Marcin Kwiatkowski, Tomasz Koziński

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