

The Impact of Robot-Assisted Care on Cognitive Health and Mental Well-Being of the Elderly

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Abstract

The rapid advancement of robotics and artificial intelligence (AI) has led to the development of robot-assisted care technologies, which are increasingly being deployed in elderly care settings. These robots are designed to provide physical assistance, emotional support, and cognitive stimulation for older adults. As the global population of elderly individuals grows, particularly in aging societies, it becomes increasingly important to explore innovative solutions that enhance the quality of life and well-being of this demographic. This paper reviews the impact of robot-assisted care on the cognitive health and mental well-being of the elderly, focusing on the potential benefits and challenges associated with robot use in caregiving environments. Through a detailed analysis of existing research, this article examines how robots can improve cognitive function, reduce symptoms of depression and anxiety, enhance social interaction, and provide personalized care. The paper also discusses the psychological and emotional effects of robot-assisted care, including the potential for robots to alleviate feelings of loneliness and isolation, which are prevalent among elderly individuals. Additionally, the challenges in the implementation and acceptance of robot-assisted care, such as ethical concerns, user acceptance, and the limitations of current technology, are addressed. This review concludes with recommendations for future research and development in robot-assisted elderly care, emphasizing the need for human-robot interaction models that respect the emotional and psychological needs of elderly individuals. The integration of robots in elderly care settings could play a crucial role in improving mental and cognitive health outcomes, ultimately fostering greater independence, and enhancing quality of life for the elderly population.

Keywords: Cognitive stimulation, robots, robot-assisted therapy, Personal Robot, Pepper

INTRODUCTION

The world's aging population presents significant challenges to healthcare systems, families, and society. As of 2020, over 9% of the global population is aged 65 years or older, and this number is expected to double by 2050 (United Nations, 2019). This demographic shift has led to increasing demand for long-term care services, placing pressure on traditional caregiving resources. Robot-assisted care has emerged as an innovative solution for meeting this demand. These technologies range from social robots

that provide companionship and emotional support to assistive robots that help with physical tasks, such as mobility and daily living activities.

This study explored the impact of robot-assisted care on the cognitive and mental well-being of elderly individuals. Given the increasing prevalence of conditions such as dementia, Alzheimer's disease, and depression among the elderly, robot-assisted care may play a transformative role in addressing these challenges. Cognitive decline and mental health issues, including loneliness, isolation,

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and depression, are among the most pressing concerns in aging populations. This study aims to evaluate how robots can assist in improving cognitive function and mental health, while also highlighting the barriers and ethical considerations involved in their use.

LITERATURE REVIEW

The integration of robotics into elderly care has gained significant attention in recent years because of its potential to enhance both the cognitive and mental well-being of the aging population. As the global elderly population increases, along with the rising prevalence of age-related cognitive impairments such as Alzheimer's disease and dementia, the demand for innovative solutions to address these challenges has become paramount. Robot-assisted care, which encompasses both physical and emotional support, has been proposed as a promising avenue for meeting these needs. In this literature review, we explored the current body of research that investigates the role of robot-assisted care in improving cognitive function, mental health, and overall quality of life in elderly individuals.

Several studies have highlighted the role of robotic companions in providing cognitive stimulation and improving mental health outcomes in elderly individuals. Kang et al. (2020) reviewed various outcome measures used in studies involving the PARO robotic seal and highlighted its potential effectiveness in dementia care—particularly in alleviating symptoms such as agitation, depression, and social withdrawal among elderly individuals. These robots are designed to mimic real animals and respond to touch, sound, and movement, thereby creating a therapeutic environment for users. The study concluded that these robots were particularly beneficial for elderly individuals in long-term care facilities, providing them with a sense of companionship and reducing feelings of isolation [1].

Sawik et al. (2023) conducted a comprehensive review and case study on the use of robots in elderly care, highlighting their multifaceted roles in supporting aging populations. Their findings emphasize that robots—particularly socially assistive types like Pepper—can significantly contribute to the emotional and cognitive well-being of older adults. The ability of robots to interact with users in a socially intelligent manner is believed to improve cognitive function by encouraging conversation, mental exercises, and memory games [2].

A growing body of research is focusing on the use of robot-assisted care in cognitive rehabilitation. Robotic systems designed to engage elderly users in structured cognitive exercises have been shown to slow cognitive decline and improve mental health. Lopez-Samaniego and Garcia-Zapirain (2016) developed a robot-based tool aimed at enhancing both physical and cognitive rehabilitation in elderly individuals through the use of biofeedback mechanisms. Their study demonstrated that incorporating biofeedback into robotic rehabilitation systems can effectively support cognitive functions by engaging users in interactive tasks that promote attention, memory recall, and overall mental stimulation [3].

Another key study by Banyai et al. (2024) examined the role of robotic rehabilitation systems, including exoskeletons and brain-computer interfaces, in enhancing cognitive and physical rehabilitation among elderly patients recovering from stroke. This study demonstrated that when these robotic systems were used in conjunction with cognitive exercises, participants showed significant improvements in their ability to complete everyday tasks and demonstrated better cognitive flexibility. These findings suggest that a combination of physical rehabilitation and cognitive stimulation through robots can provide holistic support for elderly individuals [4].

The potential of robot-assisted care to enhance the mental well-being of older adults has been another significant area of investigation. Mental well-being, particularly in terms of emotional regulation and coping with feelings of loneliness, plays a critical role in the aging population. Esmailzadeh et al. (2024) explored the emotional benefits of companion robots such as PARO and Jibo. They found that these robots helped reduce the symptoms of depression and loneliness in elderly individuals living in care facilities. The robots provided companionship through physical interaction and responsive

behaviors, which were particularly beneficial for residents who had limited human interaction owing to physical or cognitive limitations [5].

Shibata et al. (2016) explored the psychological effects of robot-assisted therapy in elderly patients with depression. They used a robot designed to engage users in social games and therapeutic activities aimed at improving their emotional regulation. The results indicated that therapeutic robots helped reduce depressive symptoms in patients, with some individuals reporting increased social interaction and positive emotional responses following regular sessions with the robot [6].

Additionally, we examined how robotic interventions can be used in elderly patients diagnosed with dementia or Alzheimer's disease to address feelings of agitation and anxiety. Their research showed that interactive robots, which provide calm and structured environments for patients, led to decreased agitation and improved mood in these individuals. This study underscores the importance of robots in providing therapeutic interventions that promote emotional stability and well-being among elderly individuals with cognitive disorders.

CHALLENGES AND BARRIERS TO THE INTEGRATION OF ROBOT-ASSISTED CARE

While the literature on robot-assisted care is overwhelmingly positive in terms of its cognitive and mental health benefits, several challenges hinder the widespread adoption and integration of these technologies in elderly care settings. One of the most significant barriers is user acceptance. Many elderly individuals are resistant to the use of robots because of their fear, distrust, or unfamiliarity with technology. Huang et al. (2018) highlighted that the acceptance of robots among elderly individuals is often low because of concerns about robots replacing human caregivers or being intrusive. This issue is particularly pronounced among individuals with little to no experience with technology [7].

Moreover, ethical concerns related to robot-assisted care are another important issue explored in the literature. Critics argue that the use of robots in elderly care could lead to the dehumanization of caregiving and reduce meaningful human interactions. Deusdad et al. (2024) discussed the ethical implications of robot-assisted care, including concerns about privacy and data security, particularly when robots collect sensitive information about users' health and well-being. There is also an ethical dilemma regarding the extent to which robots should be used to replace human caregivers, particularly in situations where human touch and empathy are crucial for the emotional well-being of elderly individuals [8].

Finally, technological limitations represent another challenge for the implementation of robot-assisted care. Although there have been significant advancements in robotics, many existing robots lack the level of sophistication required for complex caregiving tasks. For example, robots with social interaction capabilities may not always understand the nuances of human emotions or respond appropriately to all contexts. As Sapci et al. (2019) pointed out, many robotic systems have limitations in terms of facial recognition, emotional response, and adaptability, which can impede their effectiveness in caregiving environments [9].

FUTURE DIRECTIONS IN ROBOT-ASSISTED ELDERLY CARE

Despite these challenges, the future of robot-assisted care for the elderly remains promising. Future research should focus on overcoming the technological limitations of current robots by advancing AI capabilities and improving the design of robots to address the cognitive, physical, and emotional needs of the elderly better. There is also a need for further studies on human-robot interaction (HRI), which is crucial for ensuring that robots can engage with elderly individuals in ways that are both effective and emotionally resonant. As Michael A et al. (2008) noted, the ability of robots to adapt to individual preferences and emotional states is key to their success in caregiving roles.

Moreover, the integration of robot-assisted care into the existing healthcare and caregiving systems requires careful consideration of ethical, legal, and social issues. Future research should focus on

developing ethical frameworks for the use of robots in elderly care that address concerns regarding privacy, autonomy, and the role of human caregivers. Additionally, exploring models of collaborative care where robots work alongside human caregivers could offer a balanced approach that enhances the quality of care without diminishing human interaction [10].

THE ROLE OF ROBOT-ASSISTED CARE IN COGNITIVE HEALTH

Cognitive health in older adults is a critical factor that influences their ability to live independently, perform daily activities, and maintain social connections. As cognitive impairment becomes more common with age, robot-assisted care has the potential to provide significant benefits by offering stimulation, support, and interventions designed to slow cognitive decline.

Cognitive Stimulation Through Interactive Robots

Cognitive stimulation is one of the primary ways in which robot-assisted care affects cognitive health. Robots equipped with AI algorithms can interact with elderly individuals through conversations, memory games, and problem-solving tasks. These activities provide cognitive challenges that may help to stimulate brain function and improve mental agility and memory.

One study found that elderly individuals who interacted with social robots, such as PARO (a robotic seal), showed improvements in cognitive function, particularly in short-term memory and attention. These robots were programmed to engage users in interactive activities, such as conversation and memory exercises, which serve as cognitive stimulation, potentially mitigating the effects of age-related cognitive decline.

Another example is the use of robotic systems such as Jibo and Pepper, which are designed to engage elderly individuals in personalized tasks, such as word games, quizzes, and light exercises that help maintain cognitive abilities. These robots often use natural language processing (NLP) to facilitate meaningful conversations, promote mental engagement, and reduce the risk of cognitive deterioration.

Robots as Cognitive Rehabilitation Tools

Robots can also serve as rehabilitation tools for elderly individuals recovering from cognitive impairments, such as stroke, traumatic brain injury, or neurodegenerative diseases. One study explored the use of robotic platforms for cognitive rehabilitation in elderly patients with early-stage dementia. This study demonstrated that robotic interventions could be used to help patients' complete memory tasks, thereby aiding in the rehabilitation of cognitive function.

In addition, robots that track and analyze cognitive performance can provide caregivers with valuable data on the mental state of the elderly, allowing for more personalized care. Through continuous monitoring, robots can adjust the difficulty of tasks and provide real-time feedback to caregivers, thereby facilitating a more responsive and tailored approach to cognitive rehabilitation.

THE IMPACT OF ROBOT-ASSISTED CARE ON MENTAL WELL-BEING

Mental well-being among elderly individuals is often compromised by social isolation, loneliness, and depression. Robot-assisted care has the potential to address these issues by providing emotional support, companionship, and a sense of purpose.

Robots as Companions

Social robots, often referred to as "companions," are designed to provide emotional support and interaction to elderly individuals, especially those who are isolated or living in institutional settings. PARO, a therapeutic robot designed to resemble a baby seal, is one of the most well-known robots used to combat loneliness in elderly care settings. The robot's lifelike qualities, including its ability to respond to touch and voice, provided a sense of companionship that alleviated the feelings of loneliness.

Similarly, Pepper, a humanoid robot, has been used in nursing homes to interact with elderly residents, offering conversations, entertainment, and emotional support during stressful times. These interactions help foster a sense of connection, reduce feelings of isolation, and improve mental well-being.

Mental Health Benefits of Robot-Assisted Therapy

The mental health benefits of robot-assisted care are also evident in therapeutic settings, where robots provide interactive experiences designed to improve emotional regulation and reduce the symptoms of anxiety and depression. For example, robots designed to facilitate reminiscence therapy, in which elderly individuals recall past events, have been shown to improve their mood and cognitive function.

Moreover, robots can assist in monitoring and managing the mental health of the elderly. By utilizing sensors and AI algorithms, robots can track signs of depression or anxiety, alert caregivers to changes in mood, and offer coping mechanisms, such as relaxation exercises, guided breathing, or meditation.

CHALLENGES AND ETHICAL CONSIDERATIONS

Although the benefits of robot-assisted care for cognitive health and mental well-being are promising, several challenges and ethical considerations must be addressed to fully integrate these technologies into elderly care.

User Acceptance and Trust

One of the major barriers to the widespread adoption of robot-assisted care is user acceptance. Many elderly individuals may feel uncomfortable or resistant to using robots for emotional or cognitive support. Trust and familiarity with technology are key factors that influence acceptance.

Ethical Issues of Robot-Assisted Care

Ethical concerns regarding robot-assisted elderly care primarily revolve around the dehumanization of caregiving, data privacy, and the potential for robots to replace human caregivers. Critics argue that relying too heavily on robots may reduce human interaction, which is essential for emotional well-being. Additionally, issues related to privacy and the management of sensitive data collected by robots are significant concerns that must be addressed before widespread implementation.

CONCLUSION

Robot-assisted care has the potential to significantly enhance the cognitive and mental well-being of the elderly. Robots can mitigate the effects of cognitive decline, depression, and loneliness through cognitive stimulation, rehabilitation, companionship, and emotional support. However, challenges related to user acceptance, ethical considerations, and the limitations of current technology must be addressed to ensure the successful integration of robots into elderly care.

Future research should focus on improving the HRI models to ensure that robots are able to effectively address the emotional and psychological needs of elderly individuals. In addition, advancements in AI, machine learning, and robotics will continue to refine the capabilities of robots, making them more adaptable, intuitive, and supportive in caregiving environments. The combination of social, emotional, and cognitive assistance offered by robot-assisted care can revolutionize elderly care, ultimately fostering greater independence and improving the quality of life of the aging population.

REFERENCES

1. Kang HS, Makimoto K, Konno R, Koh IS. Review of outcome measures in PARO robot intervention studies for dementia care. *Geriatr Nurs.* 2020;41:207–14. doi:10.1016/j.gerinurse.2019.09.003. PubMed PMID: 31668459.
2. Sawik B, Tobis S, Baum E, Suwalska A, Kropińska S, Stachnik K, et al. Robots for elderly care: Review, Multi-Criteria Optimization Model and Qualitative Case Study. *Healthc (Basel).* 2023;11:1286. doi:10.3390/healthcare11091286. PubMed PMID: 37174828.

3. Lopez-Samaniego L, Garcia-Zapirain B. A robot-based tool for physical and cognitive rehabilitation of elderly people using biofeedback. *Int J Environ Res Public Health*. 2016;13:1176. doi:10.3390/ijerph13121176. PubMed PMID: 27886146; PMCID: PMC5201317.
4. Banyai AD, Brişan C. Robotics in physical rehabilitation: Systematic review. *Healthc (Basel)*. 2024;12:1720. doi:10.3390/healthcare12171720. PubMed PMID: 39273744.
5. Esmaeilzadeh P, Maddah M. Robotic companions and healthy aging: A mixed-methods exploration of older adults' perspectives and insights. *Technol Soc*. 2024;78:102689. doi:10.1016/j.techsoc.2024.102689.
6. Shibata T, Wada K. Robot therapy: A new approach for mental healthcare of the elderly – A mini-review. *Gerontology*. 2011;57:378–86. doi:10.1159/000319015. PubMed PMID: 20639620.
7. Huang T, Liu H. Acceptability of robots to assist the elderly by future designers: A case of Guangdong Ocean University industrial design students. *Sustainability*. 2019;11:4139. doi:10.3390/su11154139.
8. Deusdad B. Ethical implications in using robots among older adults living with dementia. *Front Psychiatry*. 2024;15:1436273. doi:10.3389/fpsyt.2024.1436273. PubMed PMID: 39391087; PMCID: PMC11465238.
9. Sapci AH, Sapci HA. Innovative assisted living tools, remote monitoring technologies, artificial intelligence-driven solutions, and robotic systems for aging societies: Systematic review. *JMIR Aging*. 2019;2:e15429. doi:10.2196/15429. PubMed PMID: 31782740.
10. Goodrich MA, Schultz AC. Human–robot interaction: A survey. *Found Trends Hum Comput Interact*. 2007;1:203–75. doi:10.1561/11000000005.