

CHAPTER 2

Digital Transformation in Improving Elderly Health with a Nursing Perspective: Artificial Intelligence Interventions

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Introduction

The proportion of older adults worldwide has increased rapidly compared to the younger population due to declining fertility rates and increasing life expectancy (Chu et al., 2022). It is estimated that the population aged 65 and over worldwide will double (17%) from 8.5% by 2050. While the number of people aged 65 and older, regarded as Turkey's senior citizens, was 6 million 651 thousand 503 in 2016, it ascended by 24.0% over the previous five years to 8 million 245 thousand 124 in 2021. Older adults accounted for 8.5% of the total population in 2017; however, that number rose to 9.9% by 2022. According to population projections, the percentage of older people is expected to be 12.9% in 2030, 22.6% in 2060, and 25.6% in 2080 (Turkish Statistical Institute [TUIK], 2022). Longer life expectancy leads to exposure to more disease risk factors and causes an increase in the number of chronic diseases. As a result, older adults face problems that may affect their ability to independently perform daily activities or functional capacity. While the old-age dependency ratio in our country was 12.6% in 2017, this ratio increased to 14.5% in 2022 (Turkish Statistical Institute [TUIK], 2022). Moreover, it increases the burden of elderly individuals on health care services due to the increased frequency of hospitalizations, morbidity, and mortality rates. In recent years, one of the most important contributions in reducing this burden in the healthcare sector and elderly care services has been the developments in information and network technologies. Especially smart watches and smartphone tracking technologies stand out with their applications for healthy living. In addition to these mobile technologies, models have been developed to improve the quality of life of older people living alone in many subjects, including health and safety, thanks to smart sensors and patient monitoring systems, wearable devices, and smart homes supported by the concepts of the Internet of Things (Chen, 2020; Rubeis, 2020; Chu et al., 2022).

To achieve the goals of the United Nations Decade of Healthy Aging, countries need to meet the health needs of current and future elderly populations with innovative solutions (Chen, 2018; Chu et al., 2022). Artificial intelligence's (AI) rapid development and

success have led to the reshaping of healthcare services for older people, similar to many other businesses and professions (Chen, 2020). The recent development of AI-enhanced methods to enhance and improve older people's health is due to the interaction between an aging population and rapid technological advancements. In considering this, research into the potential impact of AI-based technologies on the future has increasingly focused on the healthcare sector (Chen, 2020).

Equipped with functions that resemble human intelligence, including the ability to recognize, learn, reason, adapt, forecast, and make decisions, AI plays a current and important role in the care of older adults by monitoring their health status, complementing existing care services and reducing the burden of family caregivers (Rubeis, 2020). Artificial intelligence can act in virtual spaces based on software systems (for example, speech agents, and facial recognition systems) or in physical environments based on hardware (for example, robots). Using AI is a developing trend in technology encompassing a range of advanced computational techniques, primarily machine learning, and natural language processing. These techniques can be applied to healthcare datasets to increase the success of improving and predicting patients and healthcare outcomes, using them in clinical decision-making and care delivery (O'Connor et al., 2022). These innovations may increase the sustainability of the workforce in healthcare (for example, act as additional support to caregivers), address service inequality (for example, provide long-term care services for older people in remote areas with low availability and high demand), and increase productivity in the older population (Chu et al., 2022; O'Connor et al., 2022). For this reason, it is important to increase AI-based applications and develop new technologies, especially in elderly care, to increase the quality of life.

The Importance of Artificial Intelligence in Improving Elderly Health

Due to the biological changes accompanying aging, physical health problems that older adults may experience include hearing loss, decreased vision, joint and muscle pain, chronic diseases such as hypertension, diabetes, and cognitive disorders, including dementia. In addition, it is emphasized that AI techniques can help improve the patient and other health outcomes, as older adults are more likely to be frail and experience incontinence, falls, delirium, malnutrition, and pressure ulcers (Chu et al., 2022; O'Connor et al., 2022; Loveys et al., 2022). It has many physical and virtual world applications, such as predictive algorithms based on AI, clinical decision support systems, robotics, remote monitoring systems, mobile applications, wearable devices, virtual reality, and game technologies. AI systems collect and process large datasets to develop algorithms for chronic disease management and organization of care, optimize information delivery, and enable communication between caregivers and patients. For older adults to live an active, healthy, and independent life at home, assistive technologies utilize AI to organize data flow from monitoring tools, including sensors and alarm systems, smart home gadgets, and telehealth. Assistive robots for preserving mental and physical health, education, rehabilitation, and psychosocial support are among the human-computer interface technologies based on AI (Chen, 2018; Loveys et al., 2022). In this context, the importance of AI applications in increasing the effectiveness of healthy aging programs in the digital age is increasing.

Considering the studies, AI-based interventions significantly improve functional capacity, cognitive performance, depression, and nutritional status in older adults, facilitate the early identification of behavioral and psychological symptoms associated with geriatric syndromes, and improve quality of life by optimizing the care processes of older adults (Ronquillo et al., 2021; Chu et al., 2022; O'Connor et al., 2022; Loveys et al., 2022). In addition, the participation of elderly individuals in health services is supported through analysis based on the prediction of the prognosis and health risks

of chronic diseases, individualization of care management, prevention of health risks based on behavioral analytics, collection and sharing of health data (O'Connor et al., 2022; Loveys et al., 2022). For this reason, AI has been increasingly used in recent years to support the care of older adults, mainly by providing a new opportunity for gerontology nursing practices (Chen, 2020). In this context, it is important to integrate the knowledge and experience of nurses, which are an indispensable element of health service delivery, and artificial intelligence applications into the care process, and to have knowledge and awareness about improving the health of older people and increasing their quality of life by providing maximum efficiency from these applications.

Artificial Intelligence-Based Health Monitoring Technologies

Numerous commercially available gadgets and systems, including those found in readily available smartphones, gather health data (including information on physical activity, diet, blood pressure, and heart rate monitoring) that may provide an overview of a senior's overall quality of life (Luo et al., 2018; Ho, 2020). Especially if artificial intelligence monitoring technologies are integrated into the electronic health records of older adults, therapeutic interactions can be made easier. AI-based technologies can help support older people with cognitive problems or dementia or patients with difficulties expressing their symptoms and health needs.

Artificial intelligence health monitoring technologies are based on monitoring data such as physical activities, nutritional information, blood pressure, and heart rate monitoring. However, it has gone beyond collecting and monitoring various indicators in recent years. Based on this data, it has become a system that makes predictions and decisions for applications. It does this with machine learning. According to Ho (2000) and Luo et al. (2018), machine learning is a part of AI that utilizes statistical methods to enable computer programs to predict the future and make decisions based on previous data. This allows programs to improve their tasks over time. Many data from longitudinal observation may be continuously collected and analyzed by these optimization algorithms, which can also recognize and classify trends, utilize predictive analytics to determine the risk level, and offer recommendations on behavior or care (Galambos et al., 2019). For instance, AI-enabled blood pressure and electrocardiogram monitors can aid in predicting several health issues (hypertension, atrial fibrillation, etc.) (Luo et al., 2018; Ho, 2020). Advanced AI health monitoring systems, such as computer vision analytics, may classify actions like standing or walking and how long it takes to get out of bed before constantly learning the expected movements or actions, such as ease and comfort for a particular older adult in each setting.

The sensors, which are installed in various places in the home of seniors and can monitor the total daily activity, the time spent away from home, the walking speed, and the position at home, can also help to record the indoor activity durations, types, and characteristics of the older adults (Ho, 2020). In addition, early intervention can also play a key role by identifying unusual movements and activities that may indicate a decline in the cognitive and functional capacity of older people by AI health monitoring systems (Galambos et al., 2019). These technologies offer detailed real-time information and automated alarms to support immediate proper care, potentially preventing an older adult's unexpected decline in health status or severe injury. This can delay costly institutional care and allow older people to continue care in their homes where they feel more comfortable and safer (Giger et al., 2015; Galambos et al., 2019). For instance, AI monitoring systems that continuously analyze input data may detect that it takes

an older person progressively longer to regain their balance as they try to stand up or regain their balance. The automated analytical system can decide to take action based on a predetermined risk threshold by providing pre-warning messages or behavioral guidance to the older person and caregiver after calculating the health decline using the collected data (Giger et al., 2015; Galambos et al., 2019). Health assessments consider how the relevant markers can change over time under recognizable settings tracked by monitoring devices rather than just a set of markers at a specific time. In this situation, continuous data may also help understand the prognosis or dynamic nature of the illness affecting an older adult (Giger et al., 2015). The outputs from these monitoring systems can improve virtual support, preventive maintenance, and in-person consulting since they use information that AI algorithms have previously synthesized. For example, healthcare professionals accessing these automated systems' summarized outputs can switch from data entry and documentation responsibilities to therapeutic engagement and patient-focused activities during clinic visits (Ho, 2020).

It is emphasized that older people and family caregivers experience a greater sense of security by using artificial intelligence-supported automatic monitoring systems at home and that these technologies are an acceptable alternative to face-to-face monitoring and follow-up in supporting the independent life of older adults. The data of elderly individuals obtained with artificial intelligence supports the medical decision-making process and helps healthcare providers to prioritize cases and improve the quality of care to ensure that elderly patients have timely access to appropriate care (Luo et al., 2018; Sriram et al., 2019; Ho, 2020). Automated monitoring systems that provide an in-depth picture of seniors' general activity patterns and the environmental circumstances in which different symptoms occur have become crucial tools for healthy aging. These instruments assist older people, family caregivers, and healthcare professionals with intellectual tasks. These technologies may further improve current care services, lessen the burden on caregivers, and raise the standard of care. Such advancement may help delay or eliminate the need for institutional care by promoting autonomy in the rapidly growing older population. However, AI-based health monitoring technologies are also crucial in fulfilling the aging demands of older adults while empowering them and improving their quality of life (Luo et al., 2018; Sriram et al., 2019; Ho, 2020).

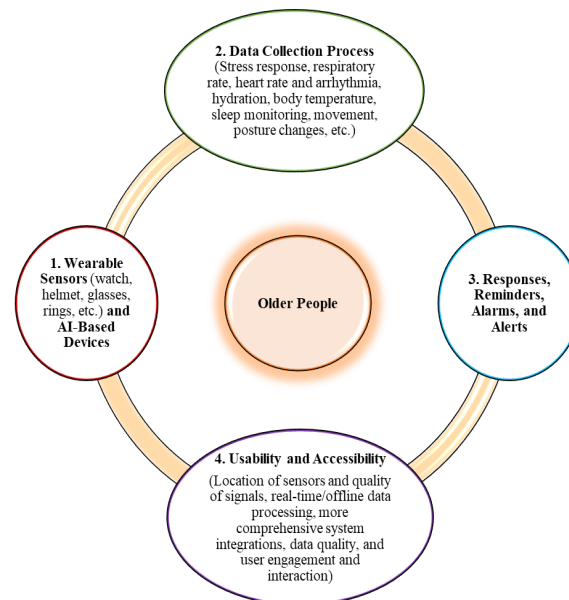
Wearable Devices Based on Machine Learning

Along with implanted fixed devices utilized in hospitals, wearable devices can also include medical objects on the internet. The combination of AI-enabled Internet of Things and wearable devices is being used to solve some of the problems brought on by aging by monitoring older adults remotely and allowing them to do their daily activities without fear (Baig et al., 2019). The Internet of Things is a generally new concept that provides health monitoring through wearable devices. Wearable devices have come to the fore in monitoring older individuals' day and night without interruption and discomfort, quickly recognizing sudden changes in their health status and intervening. Wearable devices such as watches, glasses, chest straps, and rings by mounting different types of sensors on the body and capturing signals from the body (Baig et al., 2019). These gadgets have a network connection to enable remote contact with mobile devices. Numerous sensors, such as temperature, accelerometers, optical, and biometric sensors, are included in wearable technology to analyze various human signals continually (Liu et al., 2020; Stavropoulos et al., 2020). The field of wearable technology is actively being investigated to increase the convenience and usability of monitoring vital physiological indicators and occasionally psychological or emotional

behaviors that can be recognized by analyzing data from various sensors. Medical device sensors and user interaction with these devices are acknowledged as a big data source from which features can be extracted for several healthcare and aged care interventions, such as disease diagnosis and health status assessment, allowing machine learning algorithms to detect and learn. Machine learning includes having wearable devices take action/decision without explicit programming for a particular scenario by learning from experience. Machine learning is often coded in terms of existing data, learning from experience, and data samples that may or may not be labeled. Studies to examine applying machine learning methods using body signals, discussed for health monitoring, aged care, and movement tracking, have increased in the last decade. In terms of nurses, machine learning includes especially fall detection, seizure detection, monitoring of vital signs, estimation and condition monitoring, and activity definition to determine daily activities. In addition, the use of wearable devices in stress detection and heart rate, arrhythmia detection, hydration monitoring, sleep monitoring, and rehabilitation tasks are also examined (Galambos et al., 2019; Baig et al., 2019; Stavropoulos et al., 2020).

Figure 1

Overview of Wearable Sensors and IoT-based Systems (Baig et al., 2019)



Artificial Intelligence-Based Robots

Technology is a trend that has an impact on human existence all over the world. Robots are an exciting example of the upcoming technology. Thanks to robotic technology, significant improvements are experienced in human life and industry (Baloğlu et al., 2019). Robots generally use AI techniques in internal software systems, especially machine learning with reinforcement learning, to interact and adapt to the world (Pu et al., 2019; Loveys et al., 2022). Therefore, robots, which serve primarily as an assistant to older adults, generally have an authoritarian function in supporting individuals to perform their care tasks without assistance. Care robots are technological devices generally integrated into healthcare workers or caregivers for care applications (Abbott et al., 2019). Elderly care robots are defined in different categories, such as assistive social robots and rehabilitation robots (Baloğlu et al., 2019) or healthcare robots that monitor physical assistance, companionship/friendship, and health status/safety (Broadbent et al., 2009). Assistant robots can be effective at home by performing various activities such as

home monitoring, assistive device management, personal assistance, safe environment, risk sensing, and entertainment.

Both rehabilitative and social robots can be used to help relieve the pressure on aged care systems as the global aging population and their needs become an increasingly important problem for healthcare providers, government officials, and caregivers (Baloğlu et al., 2019; Pu et al., 2019; Loveys et al., 2022; Broadbent et al., 2009). Robots are deployed specifically to provide comfort and psychological support to older adults living in nursing homes to help them overcome the loneliness and depression they experience (Abbott et al., 2019). Assistive robots can guide prevention and prognosis by collecting data such as previous medical cases of an elderly individual along with clinical findings. Robots developed to date can provide bed bathing, dressing, standing up, and assisting in rehabilitating stroke patients (Lo et al., 2010; Baloğlu et al., 2019). On the other hand, more miniature robots can remind elderly individuals to take their medications, act as personal assistants at home, observe them, exercise, and manage their daily living activities (Baloğlu et al., 2019). Thanks to these technological features, the importance of artificial intelligence-based robots in improving elderly care services, increasing the welfare and independence of older adults living alone at home by functioning as health professionals or caregiver resources in hospitals and elderly care institutions is increasing day by day.

Artificial Intelligence-Based Smart Homes

Health-assisting smart homes have taken their place in the digital age as an option that can improve older people's independence. Smart homes are a cutting-edge technology designed to assist older adults age in place by monitoring their home movements and intervening on their behalf when necessary (Liu et al., 2016; Wilson et al., 2019). Collecting data on the daily lives of elderly individuals living in a smart home is necessary for autonomous operations with the AI algorithms of the home. Through the collected data, these algorithms determine the behavior of the elderly living at home and make predictions for the following action (Cakir et al., 2022). Smart homes use hardware and computer software to help maintain health and prevent disease. Computer-based algorithms are complex probability and statistics programs. Due to their ability to detect patterns in daily activity and human behavior, these are activity-sensitive algorithms (Cook & Krishnan, 2014). They instantly determine and categorize data from sensors intended to sense the state of an environment to accomplish this. Smart homes utilize various sensors, including infrared motion, door use (contact sensors), temperature, light, humidity, vibration, pressure, and others, to detect motion inside the home environment (Liu et al., 2016; Wilson et al., 2019). Each sensor offers specific information to understand clinically significant human behaviors and activities. These sensors are small, continuously monitored, affordable, and relatively easy to store and manage data (Cook & Krishnan, 2014). This combination of sensors is essential as the collected data provides a comprehensive picture of an older adult's movements and behavior at home without needing a camera or microphone (Cook & Krishnan, 2014). Additional sensors can be incorporated to enhance the capture of particular movements (behaviors and activities). Ground pressure sensors can offer data on falls and older people's gait and walking pace (Cook & Krishnan, 2014; Wilson et al., 2019). Vibration sensors may improve knowledge about ambient noise levels and equipment usage and aid fall detection (Cook & Krishnan, 2014). These various sensors are critical in providing the opportunity to be aware of the safety of older adults. Thanks to these systems, smart homes can quickly respond by sending SMS, e-mail, or phone calls with the emergency

button, which is constantly exciting and can create special scenarios for older adults at home when necessary (Cakir et al., 2022). Many people use smart technology, including the smart home, to assist older individuals with their healthcare needs. The need for nurses to be at the forefront of incorporating new technology into patient care is growing (Fritz & Dermody, 2019; O'Connor et al., 2022). Despite the rigorous research work that nurses have done to support these technologies, particularly the integration of AI into complex systems such as modern healthcare, there appears to be a significant gap in the transfer of clinical knowledge from nursing to engineering. Further studies are needed to explain how nurses can guide AI education, such as smart homes, and how to incorporate clinical nursing knowledge into the education of AI algorithms designed to assist healthcare.

Artificial Intelligence Interventions Among Older Adults

Studies evaluating the effectiveness, risks, and attitudes toward developing and implementing AI interventions in older adults have gained importance in recent years. On the other hand, although gerontology nurses are not included in many studies examining how artificial intelligence can improve older adult health, the developed approach must be adopted in the use and care of health services. Bayen et al. (2021) developed and tested an AI-based video surveillance system among older adults with Alzheimer's disease. This monitoring system informed healthcare professionals in real-time and could respond quickly. As a result, AI-based monitoring systems help reduce the time older adults spend on the ground after falls. This type of AI-based system is essential to support gerontology nurses in their daily practice to help reduce healthcare costs while reducing secondary complications from falls and improving the post-fall prognosis of older adults. In another study, Al-Hameed et al. (2019) tested an AI-based speech recognition system at home in older adults at risk of developing dementia to determine whether linguistic changes indicative of the early stages of the neurodegenerative syndrome can be identified. These new approaches to preventive care should be considered as nurses can increase the care and support they provide for older adults and their families.

Interventions evaluating the potential of employing wearable devices to promote the success of healthy aging interventions have shown a significant improvement in physical function, cognitive performance, nutritional status, and depressive mood, among community-dwelling older people (Chen et al., 2020). Dolatabadi et al. (2019) reported on the viability of tracking the longitudinal gait of dementia-affected older people. It is crucial to monitor the gait of older people with dementia to ensure their safety. Further AI-based analysis may assist with the early detection of behavioral and mental disorders (Chen & Arai, 2020). One study demonstrated the short-term benefits of increasing physical activity in older adults using wearable devices. However, it has been reported that the effects on the older population and the long-term effects are uncertain (Liu et al., 2020). According to the study results, utilizing wearable devices to increase physical activity is inspiring, and the long-term effects should continue to be investigated in all populations. In another study, a data-driven machine learning model approach was used to create a multiple disease vulnerability index to predict the negative consequences of aging faced by older adults (Peng et al., 2020). AI-based approach's power in data analysis and outcome prediction; however, applying these findings to clinical practice is still complex for clinicians in this study. AI-based interventions captured vital outcome prediction variables and demonstrated the effectiveness of survival analysis to provide the best predictive results (Peng et al., 2020).

Studies have shown the potential of using AI-based emotional facial expressions, vocal cues, and language to early detect older individuals with potential risks for neurodegenerative diseases or dementia (Al-Hameed et al., 2019; Jiskoot et al., 2020). On the other hand, it is also essential to include robotic technology in care services due to the lack of an international caregiver workforce (Chen et al., 2020). Studies on robotic technologies seem to focus on the effectiveness of reducing behavioral and psychological symptoms in elderly individuals with dementia and the roles of social robots for people with depression (Abbott et al., 2019). Studies have reported that robots are friends with elderly individuals and positively increase elderly autonomy, social skills, and communication (Broadbent et al., 2009; Elsy, 2020). The critical point to be considered here is the communication and interaction problems between robots and older people. It is predicted that future care services will be unable to function without multitasking or task-specific robots that can assist older individuals with their daily living activities.

Limitations and Risks of Artificial Intelligence Interventions in Elderly Care

Despite all the advances in AI technology in elderly care, several concerns and risks are associated with AI applications in healthcare. The inability to individualize care due to algorithm-based standardization, prejudice against minority groups due to generalization, limiting the care connection through automation, and disciplining users through monitoring and surveillance are a few examples of such issues (Rubeis, 2020). Nevertheless, these possible threats underline the requirements and difficulties to be met when creating AI and gerontechnology-based services. Older consumers' viewpoints, knowledge, and comprehension of AI-based services are crucial in all circumstances involving the implementation of new technologies (Vandemeulebroucke et al., 2018; Rubeis, 2020). Algorithmic bias is a potential risk, as digital health datasets that train and test AI algorithms may be missing information from specific populations. Poor-quality datasets used to develop AI can skew predictive models and lead to inappropriate clinical decision-making. This can negatively impact older adult care and reinforce existing inequalities in healthcare (Chu et al., 2022). The retrospective nature of many health data sets on which artificial intelligence techniques are developed and the lack of critical variables that may affect older adult health in probability models may also reduce the ability to predict future events (Chin et al., 2019). Therefore, gerontology nurses need to be aware of the limitations of AI-based systems and continue to use their clinical expertise to support the care of older adults.

Along with these limitations and risks, some important ethical considerations for AI-enhanced interventions as part of healthcare have also been reported. Older people may have a variety of reactions to social robots. While it has been demonstrated that some older people get along well with robots, others are uninterested in them or react poorly because of increased baseline agitation (Vandemeulebroucke et al., 2018; Rubeis, 2020). Some technologies may put older people with dementia in danger of infantilization by tricking them into thinking the robot is a natural pet. Many older adults develop bonds with robots, and they may face psychological issues when separated. However, the severity and chronicity of the problem of separation from robots have not been sufficiently studied, and it remains unclear what strategies are appropriate to end older people's relationships with robots.

On the other hand, Stokes and Palmer (2020) also highlight several ethical issues that may be encountered when artificial intelligence is integrated into robotics. There are some concerns that robotic technologies may replace gerontology nurses or automate some aspects of their caring role. Robots lacking human emotions such as empathy could

lead to less personalized care and poorer therapeutic relationships with older adults, compromising their physical, mental, and social health. Furthermore, personal privacy is another concern affecting the autonomy and well-being of older adults. Incorporating AI into robotics and home/remote monitoring technologies may lead to increased surveillance and possible inappropriate disclosure and use of personal information (Hasal et al., 2021). Galambos et al., (2019) assessed older adults' and their families' perceptions of using smart sensors. They emphasized that as people age, the advantages and disadvantages of using AI-based technologies should be considered by older adults and their caregivers. Many studies reported concerns about surveillance and data privacy (Vandemeulebroucke et al., 2018; Rubeis, 2020; Hasal et al., 2021). Therefore, robust data protection measures are crucial for accepting and adopting these technologies in healthcare.

Conclusion and Recommendation

At the point of provision of technological health care services to elderly individuals, they are collecting the data of older people in an environment and sharing them from this environment when necessary, providing care services that can be done remotely, using sensors and robots, and supporting these systems with artificial intelligence. Most artificial intelligence interventions in the older population focus on mental capacity, social participation, or psychosocial outcomes. Artificial intelligence applications developed, such as AI monitoring systems, diagnosis and early detection systems, wearable devices, robotic technologies, smart homes, have the potential to improve the quality of life of older adults, especially those living alone in institutions or at home, by focusing on helping elderly individuals in their daily life activities and managing their chronic health conditions. However, studies involving more AI interventions are needed to detect consequences, including frailty, falls, fractures, disease exacerbations, abnormal daily activities, neuropsychiatric symptoms, and changes in health status, especially in older people with multiple comorbid diseases.

Given the rapid development of AI in older adult care, gerontology nurses also need to have greater awareness and knowledge of this technological trend as it will impact their practice, and they can guide patients on using AI-based tools. Therefore, nurses need more educational opportunities to learn about the range of AI techniques available and how to apply them to datasets for the older population (Ronquillo et al., 2021). This knowledge will allow nurses to conduct AI research and assess whether these predictive algorithms can benefit clinical decision-making and patient care and whether it is worth introducing AI-based technologies into gerontology nursing practice. As nurses collaborate with colleagues in the computer science, engineering, and technology industry, they can encourage the active engagement of patients to help co-design AI-based tools to meet the needs of older adults (Blakey et al., 2020). As the digital age accelerates, the nursing profession, especially those working in gerontology, should embrace AI applications to help support and improve the health and well-being of older adults, considering the risks and ethical issues that AI interventions may pose.

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Gulbahar Eren, M. & Sert, H. (2023). Digital Transformation in Improving Elderly Health with a Nursing Perspective: Artificial Intelligence Interventions. In S.N. Guner, Y. Uzun & I. Cetin (Eds.), *Current Studies in Healthcare and Technology* (pp. 19–32). ISRES Publishing.